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ENCYCLOPÆDIA BRITANNICA.

SCRIPTURE continued from laſt Volume.

55 Jeremiah.

JEREMIAH was called to the prophetic office in the 13th year of the reign of Joſiah the ſon of Amon, A. M. 3376, A. C. 628, and continued to prophecy upwards of 40 years, during the reigns of the degenerate princes of Judah, to whom he boldly threatened thoſe marks of the divine vengeance which their rebellious conduct drew on themſelves and their country. After the deſtruction of Jeruſalem by the Chaldeans, he was ſuffered by Nebuchadnezzar to remain in the deſolate land of Judea to lament the calamities of his infatuated countrymen. He was afterwards, as he himſelf informs us, carried with his diſciple Baruch into Egypt, by Johanan the ſon of Kareah.

It appears from ſeveral paſſages that Jeremiah committed his prophecies to writing. In the 36th chapter we are informed, that the prophet was commanded to write upon a roll all the prophecies which he had uttered; and when the roll was deſtroyed by Jehoiakim the king, Jeremiah dictated the ſame prophecies to Baruch, who wrote them together with many additional circumſtances. The works of Jeremiah extend to the laſt verſe of the 51ſt chapter; in which we have theſe words, "Thus far the words of Jeremiah." The 52d chapter was therefore added by ſome other writer. It is, however, a very important ſupplement, as it illuſtrates the accompliſhment of Jeremiah's prophecies reſpecting the fate of Zedekiah.

56 Chronological arrangement of his writings.

The prophecies of Jeremiah are not arranged in the chronological order in which they were delivered. What has occaſioned this tranſpoſition cannot now be determined. It is generally maintained, that if we conſult their dates, they ought to be thus placed:

In the reign of Joſiah the firſt 12 chapters.

In the reign of Jehoiakim, chapters xiii. xx. xxi. v. 11, 14.; xxii. xxiii. xxv. xxvi. xxxv. xxxvi. xlv.—xlix. 1—33.

In the reign of Zedekiah, chap. xxi. 1—10. xxiv. xxvii. xxxiv. xxxvii. xxxix. xlix. 34—39. l. and li.

Under the government of Gedaliah, chapters xl. xliv.

The prophecies which related to the Gentiles were contained in the 46th and five following chapters, being placed at the end, as in ſome meaſure unconnected with the reſt. But in ſome copies of the Septuagint theſe ſix chapters follow immediately after the 13th verſe of the 25th chapter.

Jeremiah, though deficient neither in elegance nor ſublimity, muſt give place in both to Iſaiah. Jerome ſeems to object againſt him a ſort of ruſticity of language, no veſtige of which Dr Lowth was able to diſcover. His ſentiments, it is true, are not always the moſt elevated, nor are his periods always neat and compact; but theſe are faults common to thoſe writers whoſe principal aim is to excite the gentler affections, and to call forth the tear of ſympathy or ſorrow. This obſervation is very ſtrongly exemplified in the Lamentations, where theſe are the prevailing paſſions; it is, however, frequently inſtanced in the prophecies of this author, and moſt of all in the beginning of the book (L), which is chiefly poetical. The middle of it is almoſt entirely hiſtorical. The latter part, again, conſiſting of the laſt ſix chapters, is altogether poetical (M); it contains ſeveral different predictions, which are diſtinctly marked; and in theſe the prophet approaches very near the ſublimity of Iſaiah. On the whole, however, not above half the book of Jeremiah is poetical.

57 The book of Lamentations.

The book of Lamentations, as we are informed in the title, was compoſed by Jeremiah. We ſhall preſent to our reader an account of this elegiac poem from the elegant pen of Dr Lowth.

The Lamentations of Jeremiah (for the title is properly and ſignificantly plural) conſiſt of a number of plaintive effuſions, compoſed on the plan of the funeral dirges, all on the ſame ſubject, and uttered without connection as they roſe in the mind, in a long courſe of ſeparate ſtanzas. Theſe have afterwards been put together, and formed into a collection or correſpondent whole. If any reader, however, ſhould expect to find in them an artificial and methodical arrangement of the general ſubject, a regular diſpoſition of the parts, a perfect connection and orderly ſucceſſion in the matter,

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(L) See the whole of chap. ix. chap. xiv. 17, &c. xx. 14—18.

(M) Chap. xlvi.—li. to ver. 59. Chap. lii. properly belongs to the Lamentations, to which it ſerves as an exordium.

and with all this an uninterrupted ſeries of elegance and correctneſs, he will really expect what was foreign to the prophet's deſign. In the character of a mourner, he celebrates in plaintive ſtrains the obſequies of his ruined country: whatever preſented itſelf to his mind in the midſt of deſolation and miſery, whatever ſtruck him as particularly wretched and calamitous, whatever the inſtant ſentiment of ſorrow dictated, he pours forth in a kind of ſpontaneous effuſion. He frequently pauſes, and, as it were, ruminates upon the ſame object; frequently varies and illuſtrates the ſame thought with different imagery, and a different choice of language; ſo that the whole bears rather the appearance of an accumulation of correſponding ſentiments, than an accurate and connected ſeries of different ideas, arranged in the form of a regular treatiſe. There is, however, no wild incoherency in the poem; the tranſitions are eaſy and elegant.

58 How divided.

The work is divided into five parts: in the firſt, ſecond, and fourth chapters, the prophet addreſſes the people in his own perſon, or introduces Jeruſalem as ſpeaking. In the third chapter a chorus of the Jews is repreſented. In the fifth the whole captive Jews pour forth their united complaints to Almighty God. Each of theſe five parts is diſtributed into 22 ſtanzas, according to the number of the letters of the alphabet. In the firſt three chapters theſe ſtanzas conſiſt of three lines. In the firſt four chapters the initial letter of each period follows the order of the alphabet; and in the third chapter each verſe of the ſame ſtanza begins with the ſame letter. In the fourth chapter all the ſtanzas are evidently diſtichs, as alſo in the fifth, which is not acroſtic. The intention of the acroſtic was to aſſiſt the memory to retain ſentences not much connected. It deſerves to be remarked, that the verſes of the firſt four chapters are longer by almoſt one half than Hebrew verſes generally are: The length of them ſeems to be on an average about 12 ſyllables. The prophet appears to have choſen this meaſure as being ſolemn and melancholy.

Lowth. 59 The ſubject and beauty of it.

“ That the ſubject of the Lamentations is the deſtruction of the holy city and temple, the overthrow of the ſtate, the extermination of the people; and that theſe events are deſcribed as actually accompliſhed, and not in the ſtyle of prediction merely, muſt be evident to every reader; though ſome authors of conſiderable reputation * have imagined this poem to have been compoſed on the death of King Joſiah. The prophet, indeed, has ſo copiouſly, ſo tenderly, and poetically, bewailed the misfortunes of his country, that he ſeems completely to have fulfilled the office and duty of a mourner. In my opinion, there is not extant any poem which diſplays ſuch a happy and ſplendid ſelection of imagery in ſo concentrated a ſtate. What can be more elegant and poetical, than the deſcription of that once flouriſhing city, lately chief among the nations, ſitting in the character of a female, ſolitary, afflicted, in a ſtate of widowhood, deſerted by her friends, betrayed by her deareſt connections, imploring relief, and ſeeking conſolation in vain? What a beautiful perſonification is that of “ the ways of Sion mourning becauſe none are come to her ſolemn feaſts?” How tender and pathetic are the following complaints?

Chap. i. 12, 16.

Is this nothing to all you who paſs along the way? behold and ſee,
If there be any ſorrow, like unto my ſorrow, which is inflicted on me;
Which Jehovah inflicted on me in the day of the violence of his wrath.
For theſe things I weep, my eyes ſtream with water;
Becauſe the comforter is far away, that ſhould tranquilize my ſoul:
My children are deſolate, becauſe the enemy was ſtrong.

But to detail its beauties would be to tranſcribe the entire poem.”

60 Ezekiel.

Ezekiel was carried to Babylon as a captive, and received the firſt revelations from heaven, in the fifth year of Jehoiakim's captivity, A. C. 595. The book of Ezekiel is ſometimes diſtributed under different heads. In the three firſt chapters the commiſſion of the prophet is deſcribed. From the fourth to the thirty-ſecond chapter incluſive, the calamities that befel the enemies of the Jews are predicted, viz. the Ammonites, the Moabites, and Philiſtines. The ruin of Tyre and of Sidon, and the fall of Egypt, are particularly foretold; prophecies which have been fulfilled in the moſt literal and aſtoniſhing manner, as we have been often aſſured by the relation of hiſtorians and travellers. From the 32d chapter to the 40th he inveighs againſt the hypocriſy and murmuring ſpirit of his countrymen, admoniſhing them to reſignation by promiſes of deliverance. In the 38th and 39th chapters he undoubtedly predicts the final return of the Jews from their diſperſion in the latter days, but in a language ſo obſcure that it cannot be underſtood till the event take place. The nine laſt chapters of this book furniſh the deſcription of a very remarkable viſion of a new temple and city, of a new religion and polity.

61 Character as a writer. *Lowth.*

“ Ezekiel is much inferior to Jeremiah in elegance; in ſublimity he is not even excelled by Iſaiah: but his ſublimity is of a totally different kind. He is deep, vehement, tragical; the only ſenſation he affects to excite is the terrible; his ſentiments are elevated, fervid, full of fire, indignant; his imagery is crowded, magnificent, terrific, ſometimes almoſt to diſguſt: his language is pompous, ſolemn, auſtere, rough, and at times unpoliſhed: he employs frequent repetitions, not for the ſake of grace or elegance, but from the vehemence of paſſion and indignation. Whatever ſubject he treats of, that he ſedulouſly purſues, from that he rarely departs, but cleaves as it were to it; whence the connection is in general evident and well preſerved. In many reſpects he is perhaps excelled by the other prophets; but in that ſpecies of compoſition to which he ſeems by nature adapted, the forcible, the impetuous, the great and ſolemn, not one of the ſacred writers is ſuperior to him. His diction is ſufficiently perſpicuous; all his obſcurity conſiſts in the nature of the ſubject. Viſions (as for inſtance, among others, thoſe of Hoſea, Amos, and Jeremiah) are neceſſarily dark and confuſed. The greater part of Ezekiel, towards the middle of the book eſpecially, is poetical, whether we regard the matter or the diction. His periods, however, are frequently ſo rude and incompact, that I am often at a loſs how to pronounce concerning his performance in this reſpect.

“ Iſaiah, Jeremiah, and Ezekiel, as far as relates to ſtyle, may be ſaid to hold the ſame rank among the Hebrews, as Homer, Simonides, and Æſchylus among the Greeks.”

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* *Joſephus, Jerome, Uſſerius,* &c.

62
Daniel.

So full an account of Daniel and his writings has been already given under the article DANIEL, that little remains to be ſaid on that ſubject. Daniel flouriſhed during the ſucceſſive reigns of ſeveral Babyloniſh and Median kings to the conqueſt of Babylon by Cyrus. The events recorded in the 6th chapter were contemporary with Darius the Mede; but in the 7th and 8th chapters Daniel returns to an earlier period, to relate the viſions which he beheld in the three firſt years of Belſhazzar's reign; and thoſe which follow in the four laſt chapters were revealed to him in the reign of Darius. The laſt ſix chapters are compoſed of prophecies delivered at different times; all of which are in ſome degree connected as parts of one great ſcheme. They extend through many ages, and furniſh the moſt ſtriking deſcription of the fall of ſucceſſive kingdoms, which were to be introductory to the eſtabliſhment of the Meſſiah's reign. They characterize in deſcriptive terms the four great monarchies of the world, to be ſucceeded by "that kingdom which ſhould not be deſtroyed."

63
Character of his prophecies.

The whole book of Daniel being no more than a plain relation of facts, partly paſt and partly future, muſt be excluded the claſs of poetical prophecy. Much indeed of the parabolic imagery is introduced in that book; but the author introduces it as a prophet only; as viſionary and allegorical ſymbols of objects and events, totally untinctured with the true poetical colouring. The Jews, indeed, would refuſe to Daniel even the character of a prophet: but the arguments under which they ſhelter this opinion are very futile; for thoſe points which they maintain concerning the conditions on which the gift of prophecy is imparted, the different gradations, and the diſcriminations between the true prophecy and mere inſpiration, are all trifling and abſurd, without any foundation in the nature of things, and totally deſtitute of ſcriptural authority. They add, that Daniel was neither originally educated in the prophetic diſcipline and precepts, nor afterwards lived conformably to the manner of the prophets. It is not, however, eaſy to comprehend how this can diminiſh his claim to a divine miſſion and inſpiration; it may poſſibly enable us, indeed, to aſſign a reaſon for the diſſimilarity between the ſtyle of Daniel and that of the other prophets, and for its poſſeſſing ſo little of the diction and character of poetry, which the reſt ſeem to have imbibed in common from the ſchools and diſcipline in which they were educated.

64
Their authenticity.

The prophecies of Daniel appear ſo plain and intelligible after their accompliſhment, that Porphyry, who wrote in the 3d century, affirms, that they were written after the events to which they refer took place. A little reflection will ſhow the abſurdity of this ſuppoſition. Some of the prophecies of Daniel clearly refer to Antiochus Epiphanes, with whoſe oppreſſions the Jews were too well acquainted. Had the book of Daniel not made its appearance till after the death of Epiphanes, every Jew who read it muſt have diſcovered the forgery. And what motive could induce them to receive it among their ſacred books? It is impoſſible to conceive *one*. Their character was quite the reverſe: their reſpect for the Scripture had degenerated into ſuperſtition. But we are not left to determine this important point from the character of the Jews; we have acceſs to more deciſive evidence; we are ſure that the book of Daniel contains prophecies, for ſome of them have been accompliſhed ſince the time of Porphyry; particularly thoſe reſpecting Antichriſt: now, if it contains any prophecies, who will take upon him to affirm that the divine Spirit, which dictated theſe many centuries before they were fulfilled, could not alſo have delivered prophecies concerning Antiochus Epiphanes?

The language in which the book of Daniel is compoſed proves that it was written about the time of the Babyloniſh captivity. Part of it is pure Hebrew: a language in which none of the Jewiſh books were compoſed after the age of Epiphanes. Theſe are arguments to a deiſt. To a Chriſtian the internal marks of the book itſelf will ſhow the time in which it was written, and the teſtimony of Ezekiel will prove Daniel to be at leaſt his contemporary *.

65
Twelve minor prophets.

The twelve minor prophets were ſo called, not from any ſuppoſed inferiority in their writings, but on account of the ſmall ſize of their works. Perhaps it was for this reaſon that the Jews joined them together, and conſidered them as one volume. Theſe 12 prophets preſented in ſcattered hints a lively ſketch of many particulars relative to the hiſtory of Judah and of Iſrael, as well as of other kingdoms; they prophecy with hiſtorical exactneſs the fate of Babylon, of Nineveh, of Tyre, of Sidon, and of Damaſcus. The three laſt prophets eſpecially illuſtrate many circumſtances at a period when the hiſtorical pages of Scripture are cloſed, and when profane writers are entirely wanting. At firſt the Jewiſh prophets appeared only as ſingle lights, and followed each other in individual ſucceſſion; but they became more numerous about the time of the captivity. The light of inſpiration was collected into one blaze, previous to its ſuſpenſion; and it ſerved to keep alive the expectations of the Jews during the awful interval which prevailed between the expiration of prophecy and its grand completion on the advent of Chriſt.

Gray's Key to the Old Teſtament.

66
Prophecies of Hoſea.

Hoſea has been ſuppoſed the moſt ancient of the 12 minor prophets. He flouriſhed in the reign of Jeroboam II. king of Iſrael, and during the ſucceſſive reigns of Uzziah, Jotham, Ahaz, and Hezekiah, kings of Judah. He was therefore nearly contemporary with Iſaiah, Amos, and Jonah. The prophecies of Hoſea being ſcattered through the book without date or connection, cannot with any certainty be chronologically arranged.

67
Character of their ſtyle.

Hoſea is the firſt in order of the minor prophets, and is perhaps, Jonah excepted, the moſt ancient of them all. His ſtyle exhibits the appearance of very remote antiquity; it is pointed, energetic, and conciſe. It bears a diſtinguiſhed mark of poetical compoſition, in that priſtine brevity and condenſation which is obſervable in the ſentences, and which later writers have in ſome meaſure neglected. This peculiarity has not eſcaped the obſervation of Jerome: "He is altogether (ſays he, ſpeaking of this prophet) laconic and ſententious." But this very circumſtance, which anciently was ſuppoſed no doubt to impart uncommon force and elegance, in the preſent ruinous ſtate of the Hebrew literature is productive of ſo much obſcurity, that although the general ſubject of this writer be ſufficiently obvious, he is the moſt difficult and perplexed of all the prophets. There is, however, another reaſon for the obſcurity of his ſtyle: Hoſea propheſied during the reigns of the four kings of Judah, Uzziah, Jotham, Ahaz, and Hezekiah. The duration of his miniſtry, therefore, in what-

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* Ezek. xiv. 14. xxviii. 3.

ever manner we calculate, muſt include a very conſiderable ſpace of time. We have now only a ſmall volume of his remaining, which ſeems to contain his principal prophecies; and theſe are extant in a continued ſeries, with no marks of diſtinction as to the times in which they were publiſhed, or the ſubjects of which they treat. There is, therefore, no cauſe to wonder if, in peruſing the prophecies of Hoſea, we ſometimes find ourſelves in a ſimilar predicament with thoſe who conſulted the ſcattered leaves of the Sibyl.

As a ſpecimen of Hoſea's ſtyle, we ſelect the following beautiful pathetic paſſage:

How ſhall I reſign thee, O Ephraim!
How ſhall I deliver thee up, O Iſrael!
How ſhall I reſign thee as Admah!
How ſhall I make thee as Zeboim!
My heart is changed within me;
I am warmed alſo with repentance towards thee.
I will not do according to the fervour of my wrath;
I will not return to deſtroy Ephraim:
For I am God, and not man;
Holy in the midſt of thee, though I inhabit not thy cities.

68
Prophecies of Joel.

Concerning the date of the prophecy of Joel there are various conjectures. The book itſelf affords nothing by which we can diſcover when the author lived, or upon what occaſion it was written. Joel ſpeaks of a great famine, and of miſchiefs that happened in conſequence of an inundation of locuſts; but nothing can be gathered from ſuch general obſervations to enable us to fix the period of his prophecy. St Jerome thinks (and it is the general opinion) that Joel was contemporary with Hoſea. This is poſſibly true; but the foundation on which the opinion reſts is very precarious, viz. That when there is no proof of the time in which a prophet lived, we are to be guided in our conjectures reſpecting it by that of the preceding prophet whoſe epoch is better known. As this rule is not infallible, it therefore ought not to hinder us from adopting any other opinion that comes recommended by good reaſons. Father Calmet places him under the reign of Joſiah, at the ſame time with Jeremiah, and thinks it probable that the famine to which Joel alludes, is the ſame with that which Jeremiah predicted, ch. viii. 13.

69
Character of their ſtyle.

Lowth on Hebrew Poetry, Sect. 21.

The ſtyle of Joel is eſſentially different from that of Hoſea; but the general character of his diction, though of a different kind, is not leſs poetical. He is elegant, perſpicuous, copious, and fluent; he is alſo ſublime, animated, and energetic. In the firſt and ſecond chapters he diſplays the full force of the prophetic poetry, and ſhows how naturally it inclines to the uſe of metaphors allegories, and compariſons. Nor is the connection of the matter leſs clear and evident than the complexion of the ſtyle: this is exemplified in the diſplay of the impending evils which gave riſe to the prophecy; the exhortation to repentance; the promiſes of happineſs and ſucceſs both terreſtrial and eternal to thoſe who become truly penitent; the reſtoration of the Iſraelites; and the vengeance to be taken of their adverſaries. But while we allow this juſt commendation to his perſpicuity both in language and arrangement, we muſt not deny that there is ſometimes great obſcurity obſervable in his ſubject, and particularly in the latter part of the prophecy.

The following prophecy of a plague of locuſts is deſcribed with great ſublimity of expreſſion:

For a nation hath gone up on my land,
Who are ſtrong, and without number:
They have deſtroyed my vine, and have made my fig-tree a broken branch.
They have made it quite bare, and caſt it away: the branches thereof are made white.
The field is laid waſte; the ground mourneth *.

70
Prophecies of Amos.

Amos was contemporary with Hoſea. They both began to prophecy during the reigns of Uzziah over Judah, and of Jeroboam II. over Iſrael. Amos ſaw his firſt viſion two years before the earthquake, which Zechariah informs us happened in the days of Uzziah. See AMOS.

Amos was a herdſman of Tekoa, a ſmall town in the territory of Judah, and a gatherer of ſycamore fruit. In the ſimplicity of former times, and in the happy climates of the Eaſt, theſe were not conſidered as diſhonourable occupations. He was no prophet (as he informed Amaziah †), neither was he a prophet's ſon, that is, he had no regular education in the ſchools of the prophets.

The prophecies of Amos conſiſt of ſeveral diſtinct diſcourſes, which chiefly reſpect the kingdom of Iſrael; yet ſometimes the prophet inveighs againſt Judah, and threatens the adjacent nations, the Syrians, Philiſtines, Tyrians, Edomites, Ammonites, and Moabites.

71
Their ſtyle.

Jerome calls Amos "rude in ſpeech, but not in knowledge ‡;" applying to him what St Paul modeſtly profeſſes of himſelf §. "Many (ſays Dr Lowth) have followed the authority of Jerome in ſpeaking of this prophet, as if he were indeed quite rude, ineloquent, and deſtitute of all the embelliſhments of compoſition. The matter is, however, far otherwiſe. Let any perſon who has candour and perſpicacity enough to judge, not from the man but from his writings, open the volume of his predictions, and he will, I think, agree with me, that our ſhepherd 'is not a whit behind the very chief of the prophets ‖.' He will agree, that as in ſublimity and magnificence he is almoſt equal to the greateſt, ſo in ſplendour of diction and elegance of expreſſion he is ſcarcely inferior to any. The ſame celeſtial Spirit indeed actuated Iſaiah and Daniel in the court and Amos in the ſheep-folds; conſtantly ſelecting ſuch interpreters of the divine will as were beſt adapted to the occaſion, and ſometimes 'from the mouth of babes and ſucklings perfecting praiſe:' occaſionally employing the natural eloquence of ſome, and occaſionally making others eloquent."

Mr Locke has obſerved, that the compariſons of this prophet are chiefly drawn from lions and other animals with which he was moſt accuſtomed; but the fineſt images and alluſions are drawn from ſcenes of nature. There are many beautiful paſſages in the writings of Amos, of which we ſhall preſent one ſpecimen:

Wo to them that are at eaſe in Zion,
And truſt in the mountains of Samaria;
Who are named chief of the nations,
To whom the houſe of Iſrael came:
Paſs ye unto Calneh and ſee,
And from thence go to Hamath the Great;

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* Joel i. 6, 7, 10, &c.

† Amos vii. 14.

‡ *Proem. Comment. in Amos.*

§ 2 Cor. xi. 6.

‖ 2 Cor. xi.

Then go down to Gath of the Philiſtines ;
Are they better than theſe kingdoms ?
Or their borders greater than their borders ?
Ye that put far away the evil day,
And cauſe the ſeat of violence to come near ;
That lie upon beds of ivory,
And ſtretch yourſelves upon couches ;
That eat the lambs out of the flock,
And the calves out of the midſt of the ſtall ;
That chant to the ſound of the viol,
And like David deviſe inſtruments of muſic ;
That drink wine in bowls,
And anoint yourſelves with chief ointments ;
But are not grieved for the affliction of Joſeph ||.

|| Ch. vi. 1. —6.

72
Of Obadiah.

The writings of Obadiah, which conſiſt of one chapter are compoſed with much beauty, and unfold a very intereſting ſcene of prophecy. Of this prophet little can be ſaid, as the ſpecimen of his genius is ſo ſhort, and the greater part of it included in one of the prophecies of Jeremiah. Compare Ob. 1—9. with Jer. xlix. 14, 15, 16. See OBADIAH.

73
Of Jonah.

Though Jonah be placed the ſixth in the order of the minor prophets both in the Hebrew and Septuagint, he is generally conſidered as the moſt ancient of all the prophets, not excepting Hoſea. He lived in the kingdom of Iſrael, and propheſied to the ten tribes under the reign of Joaſh and Jeroboam. The book of Jonah is chiefly hiſtorical, and contains nothing of poetry but the prayer of the prophet. The ſacred writers, and our Lord himſelf, ſpeak of Jonah as a prophet of conſiderable eminence *. See JONAH.

* 2 Kings xiv. 25. Matth. xii. 39. 41. xvi. 4. Luke xi. 29.

74
Of Micah.

Micah began to propheſy ſoon after Iſaiah, Hoſea, Joel, and Amos ; and he propheſied between A. M. 3246, when Jotham began to reign, and A. M. 3305, when Hezekiah died, One of his predictions is ſaid † to have ſaved the life of Jeremiah, who under the reign of Jehoiakim would have been put to death for propheſying the deſtruction of the temple, had it not appeared that Micah had foretold the ſame thing under Hezekiah above 100 years before ‡. Micah is mentioned as a prophet in the book of Jeremiah and in the New Teſtament ||. He is imitated by ſucceeding prophets (N), as he himſelf had borrowed expreſſions from his predeceſſors (O). Our Saviour himſelf ſpoke in the language of this prophet (P).

† Jer. xxv. 18—24.

‡ *Joſ. Ant.* lib. x. c. 7. Micah iii. 12.

|| Matt. ii. 5. John vii. 42.

75
His ſtyle.

The ſtyle of Micah is for the moſt part cloſe, forcible, pointed, and conciſe ; ſometimes approaching the obſcurity of Hoſea ; in many parts animated and ſublime ; and in general truly poetical. In his prophecies there is an elegant poem, which Dr Lowth thinks is a citation from the anſwer of Balaam to the king of the Moabites :

Wherewith ſhall I come before Jehovah ?
Wherewith ſhall I bow myſelf unto the High God ?
Shall I come before him with burnt-offerings,
With calves of a year old ?
Will Jehovah be pleaſed with thouſands of rams ?
With ten thouſands of rivers of oil ?
Shall I give my firſt-born for my tranſgreſſion ?
The fruit of my body for the ſin of my ſoul ?
He hath ſhowed thee, O man, what is good :
And what doth Jehovah require of thee,
But to do juſtice, and to love mercy,
And to be humble in walking with thy God ?

76
Of Nahum.

Joſephus aſſerts, that Nahum lived in the time of Jotham king of Judah ; in which caſe he may be ſuppoſed to have propheſied againſt Nineveh when Tiglath-Pileſer king of Aſſyria carried captive the natives of Galilee and other parts about A. M. 3264. It is, however, probable, that his propheſies were delivered in the reign of Hezekiah ; for he appears to ſpeak of the taking of No-Ammon a city of Egypt, and of the inſolent meſſengers of Sennacherib, as of things paſt ; and he likewiſe deſcribes the people of Judah as ſtill in their own country, and deſirous of celebrating their feſtivals.

While Jeruſalem was threatened by Sennacherib, Nahum promiſed deliverance to Hezekiah, and predicted that Judah would ſoon celebrate her ſolemn feaſts ſecure from invaſion, as her enemy would no more diſturb her peace. In the ſecond and third chapters Nahum foretels the downfal of the Aſſyrian empire and the final deſtruction of Nineveh, which was probably accompliſhed by the Medes and Babylonians, whoſe combined forces overpowered the Aſſyrians by ſurpriſe " while they were folden together as thorns, and while they were drunken as drunkards," when the gates of the river were opened, the palace demoliſhed, and an " over-running flood" aſſiſted the conquerors in their devaſtation ; who took an endleſs ſtore of ſpoil of gold and ſilver, making an utter end of the place of Nineveh, of that vaſt and populous city, whoſe walls were 100 feet high, and ſo broad that three chariots could paſs abreaſt. Yet ſo completely was this celebrated city deſtroyed, that even in the 2d century the ſpot on which it ſtood could not be aſcertained, every veſtige of it being gone.

It is impoſſible to read of the exact accompliſhment of the prophetic denunciations againſt the enemies of the Jews, without reflecting on the aſtoniſhing proofs which that nation enjoyed of the divine origin of their religion. From the Babyloniſh captivity to the time of Chriſt they had numberleſs inſtances of the fulfilment of their prophecies.

The character of Nahum as a writer is thus deſcribed by Dr Lowth : " None of the minor prophets ſeem to equal Nahum in boldneſs, ardour, and ſublimity. His prophecy, too, forms a regular and perfect poem ; the exordium is not merely magnificent, it is truly majeſtic ; the preparation for the deſtruction of Nineveh, and the deſcription of its downfal and deſolation, are expreſſed in the moſt vivid colours, and are bold and luminous in the higheſt degree."

77
Of Habakkuk.

As the prophet Habakkuk makes no mention of the Aſſyrians, and ſpeaks of the Chaldean invaſions as near at hand, he probably lived after the deſtruction of the Aſſyrian

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(N) Compare Zephan. iii. 19. with Micah iv. 7. and Ezek. xxii. 27. with Micah iii. 11.

(O) Compare Micah iv. 1—3. and Iſaiah ii. 2—4. Micah iv. 13. with Iſaiah xli. 15.

(P) Compare Micah viii. 6. with Matt. x. 35, 36.

Aſſyrian empire in the fall of Nineveh, A. M. 3392, and not long before the devaſtation of Judea by Nebuchadnezzar. Habakkuk was then nearly contemporary with Jeremiah, and predicted the ſame events. A general account of Habakkuk's prophecies has already been given under the word HABAKKUK, which may be conſulted. We ſhould, however, farther obſerve, that the prayer in the third chapter is a moſt beautiful and perfect ode, poſſeſſing all the fire of poetry and the profound reverence of religion.

God came from Teman,
And the Holy One from Mount Paran:
His glory covered the heavens,
And the earth was full of his praiſe.
His brightneſs was as the light;
Beams of glory iſſued from his ſide;
And there was the hiding of his power.
Before him went the peſtilence;
And burning coals went forth at his feet.
He ſtood and meaſured the earth;
He beheld and drove aſunder the nations;
The everlaſting mountains were ſcattered;
The perpetual hills did bow.

The prophet illuſtrates this ſubject throughout with equal ſublimity; ſelecting from ſuch an aſſemblage of miraculous incidents the moſt noble and important, diſplaying them in the moſt ſplendid colours, and embelliſhing them with the ſublimeſt imagery, figures, and diction; the dignity of which is ſo heightened and recommended by the ſuperior elegance of the concluſion, that were it not for a few ſhades which the hand of time has apparently caſt over it in two or three paſſages, no compoſition of the kind would appear more elegant or more perfect than this poem.

Habakkuk is imitated by ſucceeding prophets, and his words are borrowed by the evangelical writers ||.

78 Prophecies of Zephaniah.

Zephaniah, who was contemporary with Jeremiah, propheſied in the reign of Joſiah king of Judah; and from the idolatry which he deſcribes as prevailing at that time, it is probable that his prophecies were delivered before the laſt reformation made by that pious prince A. M. 3381.

The account which Zephaniah and Jeremiah give of the idolatries of their age is ſo ſimilar, that St Iſiodore aſſerts, that Zephaniah abridged the deſcriptions of Jeremiah. But it is more probable that the prophecies of Zephaniah were written ſome years before thoſe of his contemporary; for Jeremiah ſeems to repreſent the abuſes as partly removed which Zephaniah deſcribes as flagrant and exceſſive (Q).

In the firſt chapter Zephaniah denounces the wrath of God againſt the idolaters who worſhipped Baal and the hoſt of heaven, and againſt the violent and deceitful. In the ſecond chapter the prophet threatens deſtruction to the Philiſtines, the Moabites, the Ammonites, and Ethiopians; and deſcribes the fate of Nineveh in emphatic terms: "Flocks ſhall lie down in the midſt of her; all the beaſts of the nations, both the cormorant and bittern, ſhall lodge in her; their voice ſhall ſing in the windows; deſolation ſhall be in the threſholds." In the third chapter the prophet inveighs againſt the pollutions and oppreſſions of the Jews; and concludes with the promiſe, "That a remnant would be ſaved, and that multiplied bleſſings would be beſtowed upon the penitent." The ſtyle of Zephaniah is poetical, but is not diſtinguiſhed by any peculiar elegance or beauty, though generally animated and impreſſive.

79 Of Haggai.

Haggai, the tenth of the minor prophets, was the firſt who flouriſhed among the Jews after the Babyloniſh captivity. He began to propheſy in the ſecond year of Darius Hyſtaſpes, about 520 years before Chriſt.

The intention of the prophecy of Haggai was to encourage the diſpirited Jews to proceed with the building of the temple. The only prediction mentioned refers to the Meſſiah, whom the prophet aſſures his countrymen would fill the new temple with glory. So well was this prediction underſtood by the Jews, that they looked with earneſt expectation for the Meſſiah's appearing in this temple till it was deſtroyed by the Romans. But as the victorious Meſſiah, whom they expected, did not then appear, they have ſince applied the prophecy to a third temple, which they hope to ſee reared in ſome future period.

The ſtyle of Haggai, in the opinion of Dr Lowth, is proſaic. Dr Newcome, on the contrary, thinks that a great part of it is poetical.

80 Of Zechariah.

Zechariah was undoubtedly a contemporary of Haggai, and began to propheſy two months after him, in the eighth month of the ſecond year of Darius Hyſtaſpes, A. M. 3484, being commiſſioned as well as Haggai to exhort the Jews to proceed in the building of the temple after the interruption which the work had ſuffered. We are informed by Ezra (vi. 14.), that the Jews proſpered through the propheſying of Zechariah and Haggai.

Zechariah begins with general exhortations to his countrymen, exciting them to repent from the evil ways of their fathers, whom the prophets had admoniſhed in vain. He deſcribes angels of the Lord interceding for mercy on Jeruſalem and the deſolate cities of Judah, which had experienced the indignation of the Moſt High for 70 years, while the neighbouring nations were at peace. He declares, that the houſe of the Lord ſhould be built in Jeruſalem, and that Zion ſhould be comforted. The prophet then repreſents the increaſe and proſperity of the Jews under ſeveral typical figures. He deſcribes the eſtabliſhment of the Jewiſh government and the coming of the Meſſiah. He admoniſhes thoſe who obſerved ſolemn faſts without due contrition, to execute juſtice, mercy, and compaſſion, every man to his brother; not to oppreſs the widow nor the fatherleſs, the ſtranger nor the poor. He promiſes, that God would again ſhow favour to Jeruſalem; that their mournful faſts ſhould be turned into cheerful feaſts; and that the church of the Lord ſhould be enlarged by the acceſſion of many nations.

The 12th verſe of the 11th chapter of this book, which exhibits a prophetic deſcription of ſome circumſtances afterwards fulfilled in our Saviour, appears to be

|| Heb. x. 37. 38. Rom. i. 17. Gal. iii. 2. Acts xiii. 41. compare with Hab. i. 5.

(Q) Compare Zephaniah i. 4, 5, 9. with Jeremiah ii. 5, 20, 32.

be cited by St Matthew (xxvii. 9, 10.) as ſpoken by Jeremiah; and as the 11th, 12th, and 13th chapters have been thought to contain ſome particulars more ſuitable to the age of Jeremiah than to that of Zechariah, ſome learned writers are of opinion that they were written by the former prophet, and have been from ſimilarity of ſubject joined by miſtake to thoſe of Zechariah. But others are of opinion that St Matthew might allude to ſome traditional prophecy of Jeremiah, or, what is more probable, that the name of Jeremiah was ſubſtituted by miſtake in place of Zechariah.

The 12th, 13th, and 14th chapters contain prophecies which refer entirely to the Chriſtian diſpenſation; the circumſtances attending which he deſcribes with a clearneſs which indicated their near approach.

The ſtyle of Zechariah is ſo ſimilar to that of Jeremiah, that the Jews were accuſtomed to remark that the ſpirit of Jeremiah had paſſed into him. He is generally proſaic till towards the concluſion of his work, when he becomes more elevated and poetical. The whole is beautifully connected by eaſy tranſitions, and preſent and future ſcênes are blended with the greateſt delicacy.

81 Of Malachi.

Malachi was the laſt prophet that flouriſhed under the Jewiſh diſpenſation; but neither the time in which he lived, nor any particulars of his hiſtory, can now be aſcertained. It is even uncertain whether the word *Malachi* be a proper name, or denote, as the Septuagint have rendered it, *his angel* (R), that is, "the angel of the Lord." Origen ſuppoſed, that Malachi was an angel incarnate, and not a man. The ancient Hebrews, the Chaldee paraphraſt, and St Jerome, are of opinion he was the ſame perſon with Ezra: but if this was the caſe, they ought to have aſſigned ſome reaſon for giving two different names to the ſame perſon.

As it appears from the concurring teſtimony of all the ancient Jewiſh and Chriſtian writers, that the light of prophecy expired in Malachi, we may ſuppoſe that the termination of his miniſtry coincided with the accompliſhment of the firſt ſeven weeks of Daniel's prophecy, which was the period appointed for ſealing the viſion and prophecy. This, according to Prideaux's account, took place in A. M. 3595; but, according to the calculations of Biſhop Lloyd, to A. M. 3607, twelve years later. Whatever reckoning we prefer, it muſt be allowed that Malachi completed the canon of the Old Teſtament about 400 years before the birth of Chriſt.

It appears certain that Malachi propheſied under Nehemiah, and after Haggai and Zechariah, at a time when great diſorders reigned among the prieſts and people of Judah, which are reproved by Malachi. He inveighs againſt the prieſts (i 6, &c. ii. 1, 2, &c.); he reproaches the people with having taken ſtrange wives (ii. 11.); he reproves them for their inhumanity towards their brethren (ii. 10. iii. 5.); their too frequently divorcing their wives; their neglect of paying their tithes and firſt-fruits (Mal. iii. 13.). He ſeems to allude to the covenant that Nehemiah renewed with the Lord (iii. 10. and ii. 4, 5, &c.), aſſiſted by the prieſts and the chief of the nation. He ſpeaks of the ſacrifice of the new law, and of the abolition of thoſe of the old, in theſe words (i. 10, 11, 12, 13.): "I have no pleaſure in you, ſaith the Lord of hoſts, neither will I accept an offering at your hand. For from the riſing of the ſun, even unto the going down of the ſame, my name ſhall be great among the Gentiles, and in every place incenſe ſhall be offered unto my name, and a pure offering: for my name ſhall be great among the Heathen, ſaith the Lord of hoſts." He declares that the Lord was weary with the impiety of Iſrael; and aſſures them, that the Lord whom they ſought ſhould ſuddenly come to his temple preceded by the meſſenger of the covenant, who was to prepare his way; that the Lord when he appeared ſhould purify the ſons of Levi from their unrighteouſneſs, and refine them as metal from the droſs; and that then the offering of Judah, the ſpiritual ſacrifice of the heart, ſhould be pleaſant to the Lord. The prophet, like one who was delivering a laſt meſſage, denounces deſtruction againſt the impenitent in emphatic and alarming words. He encourages thoſe who feared the name of the Lord with the animating promiſe, that the "Sun of righteouſneſs ſhould ariſe with ſalvation in his rays," and render them triumphant over the wicked. And now that prophecy was to ceaſe, and miracles were no more to be performed till the coming of the Meſſiah; now that the Jews were to be left to the guidance of their own reaſon, and the written inſtructions of their prophets—Malachi exhorts them to remember the law of Moſes, which the Lord had revealed from Horeb for the ſake of all Iſrael. At length he ſeals up the prophecies of the Old Teſtament, by predicting the commencement of the new diſpenſation, which ſhould be uſhered in by John the Baptiſt with the power and ſpirit of Elijah; who ſhould turn the hearts of fathers and children to repentance; but if his admonitions ſhould be rejected, that the Lord would ſmite the land with a curſe.

82 NEW TESTAMENT.

THE collection of writings compoſed after the aſcenſion of Chriſt, and acknowledged by his followers to be divine, is known in general by the name of καινη διαθηκη.

83 Title.

This title, though neither given by divine command, nor applied to theſe writings by the apoſtles, was adopted in a very early age, though the preciſe time of its introduction is uncertain, it being juſtified by ſeveral paſſages in Scripture *, and warranted by the authority of St Paul in particular, who calls the ſacred books before the time of Chriſt παλαια διαθηκη †. Even long before that period, either the whole of the Old Teſtament, or the five books of Moſes, were entitled βιβλιον διαθηκης, or book of the covenant ‡.

As the word διαθηκη admits of a two-fold interpretation, we may tranſlate this title either the *New Covenant* or *New Teſtament*. The former tranſlation muſt be adopted, if reſpect be had to the texts of Scripture, from which the name is borrowed, ſince thoſe paſſages evidently convey the idea of a covenant; and, beſides a being incapable of death can neither have made an old nor make a new teſtament. It is likewiſe probable, that the earlieſt Greek diſciples, who made uſe of this expreſſion, had no other notion in view than that of covenant.

* Matth. xxvi. 28. Gal. iii. 17. Heb. viii. 8. ix. 15—20.

† 2 Cor. iii.

‡ 1 Mac. i. 57.

(R) מלאכי *Malachi* ſignifies properly *my angel*.

venant. We, on the contrary, are accuſtomed to give this ſacred collection the name of *Teſtament;* and ſince it would be not only improper, but even abſurd, to ſpeak of the Teſtament of God, we commonly underſtand the Teſtament of Chriſt; an explanation which removes but half the difficulty, ſince the new only, and not the old, had Chriſt for its teſtator.

84
Importance of the argument from the authenticity of the books.

In ſtating the evidence for the truth of Chriſtianity, there is nothing more worthy of conſideration than the authenticity of the books of the New Teſtament. This is the foundation on which all other arguments reſt; and if it is ſolid, the Chriſtian religion is fully eſtabliſhed. The proofs for the authenticity of the New Teſtament have this peculiar advantage, that they are plain and ſimple, and involve no metaphyſical ſubtilties.—Every man who can diſtinguiſh truth from falſehood muſt ſee their force; and if there are any ſo blinded by prejudice, or corrupted by licentiouſneſs, as to attempt by ſophiſtry to elude them, their ſophiſtry will be eaſily detected by every man of common underſtanding, who has read the hiſtorical evidence with candour and attention. Inſtead, therefore, of declaiming againſt the infidel, we ſolicit his attention to this ſubject, convinced, that where truth reſides, it will ſhine with ſo conſtant and clear a light, that the combined ingenuity of all the deiſts ſince the beginning of the world will never be able to extinguiſh or to obſcure it. If the books of the New Teſtament are really genuine, oppoſition will incite the Chriſtian to bring forward the evidence; and thus by the united efforts of the deiſt and the Chriſtian, the arguments will be ſtated with all the clearneſs and accuracy of which they are ſuſceptible in ſo remarkable a degree.

It is ſurpriſing that the adverſaries of Chriſtianity have not always made their firſt attacks in this quarter; for if they admit that the writings of the New Teſtament are as ancient as we affirm, and compoſed by the perſons to whom they are aſcribed, they muſt allow, if they reaſon fairly, that the Chriſtian religion is true.

Michaelis's Introduction to the New Teſtament.

The apoſtles frequently allude in their epiſtles to the gift of miracles, which they had communicated to the Chriſtian converts by the impoſition of hands, in confirmation of the doctrine delivered in their ſpeeches and writings, and ſometimes to miracles which they themſelves had performed. Now if theſe epiſtles are really genuine, it is hardly poſſible to deny thoſe miracles to be true. The caſe is here entirely different from that of an hiſtorian, who relates extraordinary events in the courſe of his narrative, ſince either credulity or an actual intention to deceive may induce him to deſcribe as true a ſeries of falſehoods reſpecting a foreign land or diſtant period. Even to the Evangeliſts might an adverſary of the Chriſtian religion make this objection: but to write to perſons with whom we ſtand in the neareſt connection, "I have not only performed miracles in your preſence, but have likewiſe communicated to you the ſame extraordinary endowments," to write in this manner, if nothing of the kind had ever happened, would require ſuch an incredible degree of effrontery, that he who poſſeſſed it would not only expoſe himſelf to the utmoſt ridicule, but by giving his adverſaries the faireſt opportunity to detect his impoſture, would ruin the cauſe which he attempted to ſupport.

St Paul's Firſt Epiſtle to the Theſſalonians is addreſſed to a community to which he had preached the goſpel only three Sabbath days, when he was forced to quit it by the perſecution of the populace. In this epiſtle he appeals to the miracles which he had performed, and to the gifts of the Holy Spirit which he had communicated. Now, is it poſſible, without forfeiting all pretenſions to common ſenſe, that, in writing to a community which he had lately eſtabliſhed, he could ſpeak of miracles performed, and gifts of the Holy Ghoſt communicated, if no member of the ſociety had ſeen the one, or received the other?

To ſuppoſe that an impoſtor could write to the converts or adverſaries of the new religion ſuch epiſtles as theſe, with a degree of triumph over his opponents, and yet maintain his authority, implies ignorance and ſtupidity hardly to be believed. Credulous as the Chriſtians have been in later ages, and even ſo early as the third century, no leſs ſevere were they in their inquiries, and guarded againſt deception, at the introduction of Chriſtianity. This character is given them even by Lucian, a writer of the ſecond century, who vented his ſatire not only againſt certain Chriſtians *, who had ſupplied Peregrinus with the means of ſubſiſtence, but alſo againſt heathen oracles and pretended wonders. He relates of his impoſtor (Pſeudomantis), that he attempted nothing ſupernatural in the preſence of the Chriſtians and Epicureans. This Pſeudomantis exclaims before the whole aſſembly, "Away with the Chriſtians, away with the Epicureans, and let thoſe only remain who believe in the Deity!" (*πιϛευοντες τῳ Θεῳ*) on which the populace took up ſtones to drive away the ſuſpicious; while the other philoſophers, Pythagoreans, Platoniſts, and Stoics, as credulous friends and protectors of the cauſe, were permitted to remain †.

It is readily acknowledged, that the arguments drawn from the authenticity of the New Teſtament only eſtabliſh the truth of the miracles performed by the apoſtles, and are not applicable to the miracles of our Saviour; yet, if we admit the firſt three goſpels to be genuine, the truth of the Chriſtian religion will be proved from the prophecies of Jeſus. For if theſe goſpels were compoſed by Matthew, Mark, and Luke, at the time in which all the primitive Chriſtians affirm, that is, previous to the deſtruction of Jeruſalem, they muſt be inſpired; for they contain a circumſtantial prophecy of the deſtruction of Jeruſalem, and determine the period at which it was accompliſhed. Now it was impoſſible that human ſagacity could foreſee that event; for when it was predicted nothing was more improbable. The Jews were reſolved to avoid an open rebellion, well knowing the greatneſs of their danger, and ſubmitted to the oppreſſions of their governors in the hope of obtaining redreſs from the court of Rome.—The circumſtance which gave birth to theſe misfortunes is ſo trifling in itſelf, that independent of its conſequences, it would not deſerve to be recorded. In the narrow entrance to a ſynagogue in Cæſarea, ſome perſon had made an offering of birds merely with a view to irritate the Jews. The inſult excited their indignation, and occaſioned the ſhedding of blood. Without this trifling accident, which no human wiſdom could foreſee even the day before it happened, it is poſſible that the prophecy of Jeſus would never have been fulfilled.

* *De morte Peregrini,* § 12, 13, 16. *Ed. Reitz.* tom. iii. p. 334—338. 341.

† *Alexander ſeu Pſeudomantis,* § 25. 32. tom. ii. p. 232, 233. 244, 245.

fulfilled. But Florus, who was then procurator of Judea, converted this private quarrel into public hoſtilities, and compelled the Jewiſh nation to rebel contrary to its wiſh and reſolution, in order to avoid what the Jews had threatened, an impeachment before the Roman emperor for his exceſſive cruelties. But even after this rebellion had broken out, the deſtruction of the temple was a very improbable event. It was not the practice of the Romans to deſtroy the magnificent edifices of the nations which they ſubdued; and of all the Roman generals, none was more unlikely to demoliſh ſo ancient and auguſt a building as Titus Veſpaſian.

So important then is the queſtion, Whether the books of the New Teſtament be genuine? that the arguments which prove their authenticity, prove alſo the truth of the Chriſtian religion. Let us now conſider the evidence which proves the authenticity of the New Teſtament.

85
Their authenticity proved.

We receive the books of the New Teſtament as the genuine works of Matthew, Mark, Luke, John, and Paul, for the ſame reaſon that we receive the writings of Xenophon, of Polybius, of Plutarch, of Cæſar, and of Livy. We have the uninterrupted teſtimony of all ages, and we have no reaſon to ſuſpect impoſition. This argument is much ſtronger when applied to the books of the New Teſtament than when applied to any other writings; for they were addreſſed to large ſocieties, were often read in their preſence, and acknowledged by them to be the writings of the apoſtles.—Whereas, the moſt eminent profane writings which ſtill remain were addreſſed only to individuals, or to no perſons at all: and we have no authority to affirm that they were read in public; on the contrary, we know that a liberal education was uncommon; books were ſcarce, and the knowledge of them was confined to a few individuals in every nation.

The New Teſtament was read over three quarters of the world, while profane writers were limited to one nation or to one country. An uninterrupted ſucceſſion of writers from the apoſtolic ages to the preſent time quote the ſacred writings, or make alluſions to them: and theſe quotations and alluſions are made not only by friends but by enemies. This cannot be aſſerted of even the beſt claſſic authors. And it is highly probable, that the tranſlations of the New Teſtament were made ſo early as the ſecond century; and in a century or two after, they became very numerous. After this period, it was impoſſible to forge new writings, or to corrupt the ſacred text, unleſs we can ſuppoſe that men of different nations, of different ſentiments and different languages, and often exceedingly hoſtile to one another, ſhould all agree in one forgery. This argument is ſo ſtrong, that if we deny the authenticity of the New Teſtament, we may with a thouſand times more propriety reject all the other writings in the world: we may even throw aſide human teſtimony itſelf. But as this ſubject is of great importance, we ſhall conſider it at more length; and to enable our readers to judge with the greater accuracy, we ſhall ſtate, from the valuable work of Michaelis, as tranſlated by the judicious and learned Mr Marſh, the reaſons which may induce a critic to ſuſpect a work to be ſpurious.

86
Negatively.

87
The reaſons that would prove a book to be ſpurious.

1. When doubts have been made from its firſt appearance in the world, whether it proceeded from the author to whom it is aſcribed. 2. When the immediate friends of the pretended author, who were able to decide upon the ſubject, have denied it to be his production. 3. When a long ſeries of years has elapſed after his death, in which the book was unknown, and in which it muſt unavoidably have been mentioned and quoted, had it really exiſted. 4. When the ſtyle is different from that of his other writings, or, in caſe no other remain, different from that which might reaſonably be expected. 5. When events are recorded which happened later than the time of the pretended author. 6. When opinions are advanced which contradict thoſe he is known to maintain in his other writings. Though this latter argument alone leads to no poſitive concluſion, ſince every man is liable to change his opinion, or through forgetfulneſs to vary in the circumſtances of the ſame relation, of which Joſephus, in his Antiquities and War of the Jews, affords a ſtriking example.

88
Do not apply to the New Teſtament.

1. But it cannot be ſhown that any one doubted of its authenticity in the period in which it firſt appeared. 2. No ancient accounts are on record whence we may conclude it to be ſpurious. 3. No conſiderable period elapſed after the death of the apoſtles, in which the New Teſtament was unknown; but, on the contrary, it is mentioned by their very contemporaries, and the accounts of it in the ſecond century are ſtill more numerous. 4. No argument can be brought in its diſfavour from the nature of the ſtyle, it being exactly ſuch as might be expected from the apoſtles, not Attic but Jewiſh Greek. 5. No facts are recorded which happened after their death. 6. No doctrines are maintained which contradict the known tenets of the authors, ſince, beſide the New Teſtament, no writings of the apoſtles exiſt. But, to the honour of the New Teſtament be it ſpoken, it contains numerous contradictions to the tenets and doctrines of the fathers in the ſecond and third century, whoſe morality was different from that of the goſpel, which recommends fortitude and ſubmiſſion to unavoidable evils, but not that enthuſiaſtic ardour for martyrdom for which thoſe centuries are diſtinguiſhed; it alludes to ceremonies which in the following ages were either in diſuſe or totally unknown: all which circumſtances infallibly demonſtrate that the New Teſtament is not a production of either of thoſe centuries.

89
Poſitively.

We ſhall now conſider the poſitive evidence for the authenticity of the New Teſtament. Theſe may be arranged under the three following heads:

1. The impoſſibility of a forgery, ariſing from the nature of the thing itſelf. 2. The ancient Chriſtian, Jewiſh, and Heathen teſtimony in its favour. 3. Its own internal evidence.

90
Impoſſibility of a forgery ariſing from the nature of the thing.

1. The impoſſibility of a forgery ariſing from the nature of the thing itſelf is evident. It is impoſſible to eſtabliſh forged writings as authentic in any place where there are perſons ſtrongly inclined and well qualified to detect the fraud. Now the Jews were the moſt violent enemies of Chriſtianity. They put the founder of it to death; they perſecuted his diſciples with implacable fury; and they were anxious to ſtifle the new religion in its birth. If the writings of the New Teſtament had been forged, would not the Jews have detected the impoſture? Is there a ſingle inſtance on record where a few individuals have impoſed a hiſtory upon the world

againſt the teſtimony of a whole nation? Would the inhabitants of Paleſtine have received the goſpels, if they had not had ſufficient evidence that Jeſus Chriſt really appeared among them, and performed the miracles aſcribed to him? Or would the churches of Rome or of Corinth have acknowledged the epiſtles addreſſed to them as the genuine works of Paul, if Paul had never preached among them? We might as well think to prove, that the hiſtory of the Reformation is the invention of hiſtorians; and that no revolution happened in Great Britain during the laſt century.

91
From teſtimony.

2. The ſecond kind of evidence which we produce to prove the authenticity of the New Teſtament, is the teſtimony of ancient writers, Chriſtians, Jews, and Heathens.

In reviewing the evidence of teſtimony, it will not be expected that we ſhould begin at the preſent age, and trace backwards the authors who have written on this ſubject to the firſt ages of Chriſtianity. This indeed, though a laborious taſk, could be performed in the moſt complete manner; the whole ſeries of authors, numerous in every age, who have quoted from the books of the New Teſtament, written commentaries upon them, tranſlated them into different languages, or who have drawn up a liſt of them, could be exhibited ſo as to form ſuch a perfect body of evidence, that we imagine even a jury of deiſts would find it impoſſible, upon a deliberate and candid examination, to reject or diſbelieve it. We do not, however, ſuppoſe that ſcepticiſm has yet arrived at ſo great a height as to render ſuch a tedious and circumſtantial evidence neceſſary. Paſſing over the intermediate ſpace, therefore, we ſhall aſcend at once to the fourth century, when the evidence for the authenticity of the New Teſtament was fully eſtabliſhed, and trace it back from that period to the age of the apoſtles. We hope that this method of ſtating the evidence will appear more natural, and will afford more ſatisfaction, than that which has been uſually adopted.

It is ſurely more natural, when we inveſtigate the truth of any fact which depends on a ſeries of teſtimony, to begin with thoſe witneſſes who lived neareſt the preſent age, and whoſe characters are beſt eſtabliſhed. In this way we ſhall learn from themſelves the foundation of their belief, and the characters of thoſe from whom they derived it; and thus we aſcend till we arrive at its origin. This mode of inveſtigation will give more ſatisfaction to the deiſt than the uſual way; and we believe no Chriſtian, who is confident of the goodneſs of his cauſe, will be unwilling to grant any proper conceſſions. The deiſt will thus have an opportunity of examining, ſeparately, what he will conſider as the weakeſt parts of the evidence, thoſe which are exhibited by the earlieſt Chriſtian writers, conſiſting of expreſſions, and not quotations, taken from the New Teſtament. The Chriſtian, on the other hand, ought to wiſh, that theſe apparently weak parts of the evidence were diſtinctly examined, for they will afford an irrefragable proof that the New Teſtament was not forged: and ſhould the deiſt reject the evidence of thoſe early writers, it will be incumbent on him to account for the origin of the Chriſtian religion, which he will find more difficult than to admit the common hypotheſis.

In the fourth century we could produce the teſtimonies of numerous witneſſes to prove that the books of the New Teſtament exiſted at that time; but it will be ſufficient to mention their names, the time in which they wrote, and the ſubſtance of their evidence. This we ſhall preſent in a conciſe form in the following table, which is taken from Jones's New and Full Method of eſtabliſhing the canon of the New Teſtament.

The names of the Writers.	*Times in which they lived.*	*The variation or agreement of their catalogues with ours now received.*	*The books in which theſe catalogues are.*
I. Athanaſius biſhop of Alexandria.	A. C. 315.	The ſame perfectly with ours now received.	*Fragment. Epiſt. Teſtal.* tom. ii. *in Synopſ.* tom. i.
II. Cyril biſhop of Jeruſalem.	340.	The ſame with ours, only the Revelation is omitted.	*Catech. IV.* § *ult.* p. 101.
III. The biſhops aſſembled in the council of Laodicea.	364.	The Revelation is omitted.	*Canon LIX.* N. B. The Canons of this council were not long afterwards received into the body of the canons of the univerſal church.
IV. Epiphanius biſhop of Salamis in Cyprus.	370.	The ſame with ours now received.	*Hæreſ.* 76. *cont. Anom.* p. 399.
V. Gregory Nazianzen biſhop of Conſtantinople.	375.	Omits the Revelation.	*Carm. de veris et genuin. Scriptur.*

The Names of the Writers.	*Times in which they lived.*	*The variation or agreement of their catalogues with ours now received.*	*The books in which theſe catalogues are.*
VI. Philaſtrius biſhop of Brixia in Venice.	380.	The ſame with ours now received; except that he mentions only 13 of St Paul's epiſtles (omitting very probably the Epiſtle to the Hebrews), and leaves out the Revelation.	*Lib. de Hæreſ. Numb.* 87.
VII. Jerome.	382.	The ſame with ours; except that he ſpeaks dubiouſly of the Epiſtle to the Hebrews; though in other parts of his writings he receives it as canonical.	*Ep. ad Paulin. Tract.* 6. p. 2. Alſo commonly prefixed to the Latin vulgar.
VIII. Ruffin preſbyter of Aquilegium.	390.	It perfectly agrees with ours.	*Expoſ. in Symb. Apoſtol.* § 36. *int. Ep. Hieron. Par.* 1. *Tract.* 3. p. 110. *et inter Op. Cypr.* p. 575.
IX. Auſtin biſhop of Hippo in Africa.	394.	It perfectly agrees with ours.	*De Doctrin. Chriſt.* lib. ii. c. 8. *Tom. Op.* 3. p. 25.
X. The XLIV biſhops aſſembled in the third council of Carthage.	St Auſtin was preſent at it.	It perfectly agrees with ours.	*Vid. Canon XLVII. et cap. ult.*

92
Teſtimonies of the ancient Chriſtians.

Paley's Evidences of Chriſtianity.

We now go back to Euſebius, who wrote about the year 315, and whoſe catalogue of the books of the New Teſtament we ſhall mention at more length. "Let us obſerve (ſays he) the writings of the apoſtle John, which are *uncontradicted*; and, firſt of all, muſt be mentioned, as acknowledged of all, the goſpel, according to him, well known to all the churches under heaven." The author then proceeds to relate the occaſions of writing the goſpels, and the reaſons for placing St John's the laſt, manifeſtly ſpeaking of all the four as equal in their authority, and in the certainty of their original. The ſecond paſſage is taken from a chapter, the title of which is, "Of the Scriptures univerſally acknowledged,

93
Of Euſebius.

and of thoſe that are not ſuch." Euſebius begins his enumeration in the following manner: "In the firſt place, are to be ranked the ſacred four Goſpels, then the book of the Acts of the Apoſtles; after that are to be reckoned the epiſtles of Paul: in the next place, that called the firſt Epiſtle of John and the Epiſtle of Peter are to be eſteemed authentic: after this is to be placed, if it be thought fit, the Revelation of John; about which we ſhall obſerve the different opinions at proper ſeaſons. Of the controverted, but yet well known or approved by the moſt, are that called the Epiſtle of James and that of Jude, the ſecond of Peter, and the ſecond and third of John, whether they were written by the evangeliſt or by another of the ſame name." He then proceeds to reckon up five others, not in our canon, which he calls in one place *ſpurious*, in another *controverted*; evidently meaning the ſame thing by theſe two words (s).

94
Of Victorin.

A. D. 290, Victorin biſhop of Pettaw in Germany, in a commentary upon this text of the Revelation, "The firſt was like a lion, the ſecond was like a calf, the third like a man, and the fourth like a flying eagle," makes out, that by the four creatures are intended the four goſpels; and to ſhow the propriety of the ſymbols, he recites the ſubject with which each evangeliſt opens his hiſtory. The explication is fanciful, but the teſtimony poſitive. He alſo expreſsly cites the Acts of the Apoſtles.

95
Of Cyprian

A. D. 230, Cyprian biſhop of Carthage gives the following teſtimony: "The church (ſays this father) is watered like Paradiſe by four rivers, that is, by four goſpels." The Acts of the Apoſtles are alſo frequently quoted by Cyprian under that name, and under the name of the *Divine Scriptures*." In his various writings are ſuch frequent and copious citations of Scripture, as to place this part of the teſtimony beyond controverſy. Nor is there, in the works of this eminent African biſhop, one quotation of a ſpurious or apocryphal Chriſtian writing."

96
Of Origen.

A. D. 210, Origen is a moſt important evidence. Nothing can be more peremptory upon the ſubject now

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(s) That Euſebius could not intend, by the word rendered *ſpurious*, what we at preſent mean by it, is evident from a clauſe in this very chapter, where, ſpeaking of the Goſpels of Peter and Thomas, and Matthias and ſome others, he ſays, "They are not ſo much as to be reckoned among the *ſpurious*, but are to be rejected as altogether abſurd and impious." *Lard. Cred.* vol. viii. p. 98.

under conſideration, and, from a writer of his learning and information, nothing more ſatisfactory, than the declaration of Origen, preſerved in an extract of his works by Euſebius: "That the four goſpels alone are received without diſpute by the whole church of God under heaven:" to which declaration is immediately ſubjoined a brief hiſtory of the reſpective authors, to whom they were then, as they are now, aſcribed. The ſentiments expreſſed concerning the goſpels in all the works of Origen which remain, entirely correſpond with the teſtimony here cited. His atteſtation to the Acts of the Apoſtles is no leſs poſitive: "And Luke alſo once more ſounds the trumpet relating the Acts of the Apoſtles." That the ſcriptures were then univerſally read, is plainly affirmed by this writer in a paſſage in which he is repelling the objections of Celſus, "That it is not in private books, or ſuch as are read by few only, and thoſe ſtudious perſons, but in books read by every body, that it is written, The inviſible things of God from the creation of the world are clearly ſeen, being underſtood by things that are made." It is to no purpoſe to ſingle out quotations of Scripture from ſuch a writer as this. We might as well make a ſelection of the quotations of Scripture in Dr Clarke's ſermons. They are ſo thickly ſown in the works of Origen, that Dr Mill ſays, "if we had all his works remaining, we ſhould have before us almoſt the whole text of the Bible."

97 Of Tertullian. A. D. 194, Tertullian exhibits the number of the goſpels then received, the names of the evangeliſts, and their proper deſignations, in one ſhort ſentence.—"Among the apoſtles, John and Matthew teach us the faith; among apoſtolical men, Luke and Mark refreſh it." The next paſſage to be taken from Tertullian affords as complete an atteſtation to the authenticity of the goſpels as can be well imagined. After enumerating the churches which had been founded by Paul at Corinth, in Galatia, at Philippi, Theſſalonica, and Epheſus, the church of Rome eſtabliſhed by Peter and Paul, and other churches derived from John, he proceeds thus: "I ſay then, that with them, but not with them only which are apoſtolical, but with all who have fellowſhip with them in the ſame faith, is that goſpel of Luke received from its firſt publication, which we ſo zealouſly maintain;" and preſently afterwards adds, "The ſame authority of the apoſtolical churches will ſupport the other goſpels, which we have from them, and according to them, I mean John's and Matthew's, although that likewiſe which Mark publiſhed may be ſaid to be Peter's, whoſe interpreter Mark was." In another place Tertullian affirms, that the three other goſpels, as well as St Luke's, were in the hands of the churches from the beginning. This noble teſtimony proves inconteſtably the antiquity of the goſpels, and that they were univerſally received; that they were in the hands of all, and had been ſo from the firſt. And this evidence appears not more than 150 years after the publication of the books. Dr Lardner obſerves, "that there are more and larger quotations of the ſmall volume of the New Teſtament in this one Chriſtian author, than there are of all the works of Cicero, in writers of all characters, for ſeveral ages."

98 Of Irenæus. A. D. 178, Irenæus was biſhop of Lyons, and is mentioned by Tertullian, Euſebius, Jerome, and Photius. In his youth he had been a diſciple of Polycarp, who was a diſciple of John. He aſſerts of himſelf and his contemporaries, that they were able to reckon up in all the principal churches the ſucceſſion of biſhops to their firſt inſtitution. His teſtimony to the four goſpels and Acts of the Apoſtles is expreſs and poſitive. "We have not received," ſays Irenæus, "the knowledge of the way of our ſalvation by any others than thoſe by whom the goſpel has been brought to us. Which goſpel they firſt preached, and afterwards by the will of God, committed to writing, that it might be for time to come the foundation and pillar of our faith. For after that our Lord roſe from the dead, and they (the apoſtles) were endowed from above with the power of the Holy Ghoſt coming down upon them, they received a perfect knowledge of all things. They then went forth to all the ends of the earth, declaring to men the bleſſing of heavenly peace, having all of them, and every one alike, the goſpel of God. Matthew then, among the Jews, wrote a goſpel in their own language, while Peter and Paul were preaching the goſpel at Rome, and founding a church there. And after their exit, Mark alſo, the diſciple and interpreter of Peter, delivered to us in writing the things that had been preached by Peter. And Luke, the companion of Paul, put down in a book the goſpel preached by him (Paul). Afterwards John, the diſciple of the Lord, who alſo leaned upon his breaſt, likewiſe publiſhed a goſpel while he dwelt at Epheſus in Aſia." Irenæus then relates how Matthew begins his goſpel, how Mark begins and ends his, and gives the ſuppoſed reaſons for doing ſo. He enumerates at length all the paſſages of Chriſt's hiſtory in Luke, which are not found in any of the other evangeliſts. He ſtates the particular deſign with which St John compoſed his goſpel, and accounts for the doctrinal declarations which precede the narrative. If any modern divine ſhould write a book upon the genuineneſs of the goſpels, he could not aſſert it more expreſsly, or ſtate their original more diſtinctly, than Irenæus hath done within little more than 100 years after they were publiſhed.

Reſpecting the book of the Acts of the Apoſtles, and its author, the teſtimony of Irenæus is no leſs explicit. Referring to the account of St Paul's converſion and vocation, in the ninth chapter of that book, "Nor can they (ſays he, meaning the parties with whom he argues) ſhow that he is not to be credited, who has related to us the truth with the greateſt exactneſs." In another place, he has actually collected the ſeveral texts, in which the writer of the hiſtory is repreſented as accompanying St Paul, which led him to exhibit a ſummary of almoſt the whole of the laſt twelve chapters of the book.

According to Lardner, Irenæus quotes twelve of Paul's epiſtles, naming their author; alſo the firſt epiſtle of Peter, the two firſt epiſtles of John, and the Revelation. The epiſtles of Paul which he omits are thoſe addreſſed to Philemon and the Hebrews. Euſebius ſays, that he quotes the epiſtle to the Hebrews, though he does not aſcribe it to Paul. The work, however, is loſt.

99 Of Tatian. A. D. 172, Tatian, who is ſpoken of by Clemens Alexandrinus, Origen, Euſebius, and Jerome, compoſed a harmony of the four goſpels, which he called *Diateſſaron* of the four. This title, as well as the work, is remarkable,

markable, becauſe it ſhows that then as well as now there were four, and only four, goſpels in general uſe among Chriſtians.

A. D. 170, the churches of Lyons and Vienne in France ſent an account of the ſufferings of their martyrs to the churches of Aſia and Phrygia, which has been preſerved entire by Euſebius. And what carries in ſome meaſure the teſtimony of theſe churches to a higher age is, that they had now for their biſhop Pothinus, who was 90 years old, and whoſe early life conſequently muſt have immediately followed the times of the apoſtles. In this epiſtle are exact references to the goſpels of Luke and John, and to the Acts of the Apoſtles. The form of reference is the ſame as in all the preceding articles. That from St John is in theſe words: "Then was fulfilled that which was ſpoken by the Lord, that whoſoever killeth you, will think that he doth God ſervice *."

Diſtinct references are alſo made to other books, viz. Acts, Romans, Epheſians, Philippians, 1 Timothy, 1 Peter, 1 John, Revelation.

100 Of Juſtin Martyr. A. D. 140, Juſtin Martyr compoſed ſeveral books, which are mentioned by his diſciple Tatian, by Tertullian, Methodius, Euſebius, Jerome, Epiphanius, and Photius. In his writings between 20 and 30 quotations from the goſpels and Acts of the Apoſtles are reckoned up, which are clear, diſtinct, and copious; if each verſe be counted ſeparately, a much greater number; if each expreſſion, ſtill more. Jones, in his book on the Canon of the New Teſtament, ventures to affirm that he cites the books of which it conſiſts, particularly the four goſpels, above 200 times.

We meet with quotations of three of the goſpels within the compaſs of half a page; "and in other words, he ſays, Depart from me into outer darkneſs, which the Father hath prepared for Satan and his Angels," (which is from Matthew xxv. 41.). "And again he ſaid in other words, I give unto you power to tread upon ſerpents and ſcorpions, and venomous beaſts, and upon all the power of the enemy." (This from Luke x. 19.). "And, before he was crucified, he ſaid, The ſon of man muſt ſuffer many things, and be rejected of the Scribes and Phariſees, and be crucified, and riſe again the third day." (This from Mark viii. 31.).

All the references in Juſtin are made without mentioning the author; which proves that theſe books were perfectly well known, and that there were no other accounts of Chriſt then extant, or, at leaſt, no others ſo received and credited as to make it neceſſary to add any marks of diſtinction. But although Juſtin mentions not the authors names, he calls the books *Memoirs compoſed by the Apoſtles: Memoirs compoſed by the Apoſtles and their Companions;* which deſcriptions, the latter eſpecially, exactly ſuit the titles which the Goſpels and Acts of the Apoſtles now bear.

He informs us, in his firſt apology, that *the Memoirs of the Apoſtles*, or the writings of the prophets, are read according as the time allows; and, when the reader has ended, the preſident makes a diſcourſe, exhorting to the imitation of ſuch excellent things.

A few ſhort obſervations will ſhow the value of this teſtimony. 1. The Memoirs of the Apoſtles, Juſtin in another place expreſsly tells us are what are called *goſpels*. And that they were the goſpels which we now uſe is made certain by Juſtin's numerous quotations of them, and his ſilence about any others. 2. He deſcribes the general uſage of the Chriſtian church. 3. He does not ſpeak of it as recent or newly inſtituted, but in the terms in which men ſpeak of eſtabliſhed cuſtoms.

Juſtin alſo makes ſuch alluſions to the following books as ſhews that he had read them: Romans, 1 Corinthians, Galatians, Epheſians, Philippians, Coloſſians, 2 Theſſalonians, Hebrews, 2 Peter; and he aſcribes the Revelation to John the Apoſtle of Chriſt.

101 Of Papias. A. D. 116, Papias, a hearer of John, and companion of Polycarp, as Irenæus atteſts, and of the apoſtolical age as all agree, in a paſſage quoted by Euſebius, from a work now loſt, expreſsly aſcribes the two firſt goſpels to Matthew and Mark; and in a manner which proves that theſe goſpels muſt have publicly borne the names of theſe authors at that time, and probably long before; for Papias does not ſay, that one goſpel was written by Matthew, and another by Mark; but, aſſuming this as perfectly well known, he tells us from what materials Mark collected his account, viz. from Peter's preaching, and in what language Matthew wrote, viz. in Hebrew. Whether Papias was well informed in this ſtatement or not, to the point for which this teſtimony is produced, namely, that theſe books bore theſe names at this time, his authority is complete.

Papias himſelf declares that he received his accounts of Chriſtianity from thoſe who were acquainted with the apoſtles, and that thoſe accounts which he thus received from the older Chriſtians, and had committed to memory, he inſerted in his books. He farther adds, that he was very ſolicitous to obtain every poſſible information, eſpecially to learn what the apoſtles ſaid and preached, valuing ſuch information more than what was written in books *.

102 Of Polycarp. A. D. 108, Polycarp was the biſhop of Smyrna, and diſciple of John the Apoſtle. This teſtimony concerning Polycarp is given by Irenæus, who in his youth had ſeen him. "I can tell the place," ſaith Irenæus, "in which the bleſſed Polycarp ſat and taught, and his going out and coming in, and the manner of his life, and the form of his perſon, and the diſcourſes he made to the people, and how he related his converſation with John and others who had ſeen the Lord, and how he related their ſayings, and what he had heard concerning the Lord, both concerning his miracles and his doctrine, as he had received them from the eye-witneſſes of the word of life; all which Polycarp related agreeable to the ſcriptures."

Of Polycarp, whoſe proximity to the age and country and perſons of the apoſtles is thus atteſted, we have one undoubted epiſtle remaining; which, though a ſhort performance, contains nearly 40 clear alluſions to the books of the New Teſtament. This is ſtrong evidence of the reſpect which was paid to them by Chriſtians of that age. Amongſt theſe, although the writings of St Paul are more frequently uſed by Polycarp than other parts of ſcripture, there are copious alluſions to the goſpel of St Matthew, ſome to paſſages found in the goſpels both of Matthew and Luke, and ſome which more nearly reſemble the words in Luke.

He thus fixes the authority of the Lord's Prayer, and the uſe of it among Chriſtians. If, therefore, we pray the

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* John xvi. 2.

* *Præfat. in Op. apud. Euſeb. Hiſt. Eccl.* lib. iii. c. 39.

Scripture.

the Lord to *forgive us, we ought alſo to forgive*. And again, With ſupplication *beſeeching* the all-ſeeing God *not to lead us into temptation*.

In another place, he quotes the words of our Lord: "But remembering what the Lord ſaid, teaching, Judge not, that ye be not judged. Forgive, and ye ſhall be forgiven; be ye merciful, that ye may obtain mercy; with what meaſure ye mete, it ſhall be meaſured to you again *." Suppoſing Polycarp to have had theſe words from the books in which we now find them, it is manifeſt that theſe books were conſidered by him, and by his readers, as he thought, as authentic accounts of Chriſt's diſcourſes; and that this point was inconteſtable.

* Mat. viii. 1. i. 2. v. 7.

He quotes alſo the following books, the firſt of which he aſcribes to St Paul: 1 Corinthians, Epheſians, Philippians, 1 and 2 Theſſalonians; and makes evident references to others, particularly to Acts, Romans, 2 Corinthians, Galatians, 1 Timothy, 2 Timothy, 1 Peter, 1 John.

103
Of Ignatius.

Ignatius, as it is teſtified by ancient Chriſtian writers, became biſhop of Antioch about 37 years after Chriſt's aſcenſion; and therefore, from his time, and place, and ſtation, it is probable that he had known and converſed with many of the apoſtles. Epiſtles of Ignatius are referred to by Polycarp his contemporary. Paſſages, found in the epiſtles now extant under his name, are quoted by Irenæus, A. D. 178, by Origen, A. D. 230; and the occaſion of writing them is fully explained by Euſebius and Jerome. What are called the ſmaller epiſtles of Ignatius are generally reckoned the ſame which were read by Irenæus, Origen, and Euſebius.

They are admitted as genuine by Voſſius, and have been proved to be ſo by Biſhop Pearſon with a force of argument which ſeems to admit of no reply. In theſe epiſtles are undoubted alluſions to Matt. iii. 15. xi. 16. to John iii. 8; and their venerable author, who often ſpeaks of St Paul in terms of the higheſt reſpect, once quotes his epiſtle to the Epheſians by *name*.

104
Of Hermas.

Near the concluſion of the epiſtle to the Romans, St Paul, amongſt others, ſends the following ſalutation: —"Salute Aſyncritus, Phlegon, *Hermas*, Patrobus, Hermes, and the brethren which are with them." Of Hermas, who appears in this catalogue of Roman Chriſtians as contemporary with St Paul, there is a book ſtill remaining, the authenticity of which cannot be diſputed. It is called the *Shepherd*, or *Paſtor of Hermas*. Its antiquity is inconteſtable, from the quotations of it in Irenæus, A. D. 178, Clement of Alexandria, A. D. 194, Tertullian, A. D. 200, Origen, A. D. 230. The notes of time extant in the epiſtle itſelf agree with its title, and with the teſtimonies concerning it, which intimate that it was written during the lifetime of Clement. In this piece are tacit alluſions to St Matthew's, St Luke's, and St John's goſpels; that is to ſay, there are applications of thoughts and expreſſions found in theſe goſpels, without citing the place or writer from which they were taken. In this form appear in Hermas the confeſſing and denying of Chriſt †; the parable of the ſeed ſown ‡; the compariſion of Chriſt's diſciples to little children; the ſaying, "he that putteth away his wife, and marrieth another, committeth adultery §;" the ſingular expreſſion, "having received all power from his Father," is probably an alluſion to Matt. xxviii. 18. and Chriſt being the "gate," or only way of coming "to God," is a plain alluſion to John xiv. 6. x. 7. 9. There is alſo a probable alluſion to Acts v. 32.

† Matt. x. 32, 33, or Luke xii. 8, 9.
‡ Matt. xiii. 3, or Luke viii. 5.
§ Luke xvi. 18.

The Shepherd of Hermas has been conſidered as a fanciful performance. This, however, is of no importance in the preſent caſe. We only adduce it as evidence that the books to which it frequently alludes exiſted in the firſt century; and for this purpoſe it is ſatisfactory, as its authenticity has never been queſtioned. However abſurd opinions a man may entertain, while he retains his underſtanding his teſtimony to a matter of fact will ſtill be received in any court of juſtice.

105
Of Clemens Romanus.

A. D. 96, we are in poſſeſſion of an epiſtle written by Clement biſhop of Rome, whom ancient writers, without any ſcruple, aſſert to have been the Clement whom St Paul mentions Philippians iv. 3. "with Clement alſo, and other my fellow labourers, whoſe names are in the book of life." This epiſtle is ſpoken of by the ancients as an epiſtle acknowledged by all; and, as Irenæus well repreſents its value, "written by Clement, who had ſeen the bleſſed apoſtles and converſed with them, who had the preaching of the apoſtles ſtill ſounding in his ears, and their traditions before his eyes." It is addreſſed to the church of Corinth; and what alone may ſeem a deciſive proof of its authenticity, Dionyſius biſhop of Corinth, about the year 170, i. e. about 80 or 90 years after the epiſtle was written, bears witneſs, "that it had been uſually read in that church from ancient times." This epiſtle affords, amongſt others, the following valuable paſſages: "Eſpecially remembering the words of the Lord Jeſus, which he ſpake, teaching gentleneſs and long ſuffering; for thus he ſaid (T), Be ye merciful, that ye may obtain mercy; forgive, that it may be forgiven unto you; as you do, ſo ſhall it be done unto you; as you give, ſo ſhall it be given unto you; as ye judge, ſo ſhall ye be judged; as ye ſhew kindneſs, ſo ſhall kindneſs be ſhewn unto you; with what meaſure ye mete, with the ſame it ſhall be meaſured to you. By this command, and by theſe rules, let us eſtabliſh ourſelves, that we may always walk obediently to his holy words."

Again, "Remember the words of the Lord Jeſus, for he ſaid, Wo to that man by whom offences come; it were better for him that he had not been born, than that he ſhould offend one of my elect; it were better for him that a millſtone ſhould be tied about his neck, and that he ſhould be drowned in the ſea, than that he ſhould offend one of my little ones (U)."

He

(T) "Bleſſed are the merciful, for they ſhall obtain mercy," Matt. v. 7. "Forgive, and ye ſhall be forgiven; give, and it ſhall be given unto you," Luke vi. 37, 38. "Judge not, that ye be not judged; for with what judgement ye judge, ye ſhall be judged, and with what meaſure ye mete, it ſhall be meaſured to you again," Matt. vii. 2.

(U) Matt. xviii. 6. "But whoſo ſhall offend one of theſe little ones which believe in me, it were better for him that a millſtone were hanged about his neck, and that he were caſt into the ſea." The latter part of the paſſage in

He aſcribes the firſt epiſtle to the Corinthians to Paul, and makes ſuch alluſions to the following books as are ſufficient to ſhew that he had ſeen and read them: Acts, Romans, 2 Corinthians, Galatians, Epheſians, Philippians, Coloſſians, 1 Theſſalonians, 1 Timothy, 2 Timothy, Titus, 1 Peter, 2 Peter.

It may be ſaid, as Clement has not mentioned the books by name from which we aſſert theſe alluſions or references are made, it is uncertain whether he refers to any books, or whether he received theſe expreſſions from the diſcourſes and converſation of the apoſtles. Mr Paley has given a very ſatisfactory anſwer to this objection: 1ſt, That Clement, in the very ſame manner, namely, without any mark of reference, uſes a paſſage now found in the epiſtle to the Romans *; which paſſage, from the peculiarity of the words that compoſe it, and from their order, it is manifeſt that he muſt have taken from the epiſtle. The ſame remark may be applied to ſome very ſingular ſentiments in the epiſtle to the Hebrews. Secondly, That there are many ſentences of St Paul's firſt epiſtle to the Corinthians, to be found in Clement's epiſtle, without any ſign of quotation, which yet certainly are quotations; becauſe it appears that Clement had St Paul's epiſtle before him; for in one place he mentions it in terms too expreſs to leave us in any doubt. "Take into your hands the epiſtle of the bleſſed apoſtle Paul." Thirdly, That this method of adopting words of ſcripture, without reference or acknowledgement, was a method in general uſe amongſt the moſt ancient Chriſtian writers. Theſe analogies not only repel the objection, but caſt the preſumption on the other ſide; and afford a conſiderable degree of poſitive proof, that the words in queſtion have been borrowed from the places of ſcripture in which we now find them. But take it, if you will, the other way, that Clement had heard theſe words from the apoſtles or firſt teachers of Chriſtianity; with reſpect to the preciſe point of our argument, viz. that the ſcriptures contain what the apoſtles taught, this ſuppoſition may ſerve almoſt as well.

We have now traced the evidence to the times of the apoſtles; but we have not been anxious to draw it out to a great length, by introducing every thing. On the contrary, we have been careful to render it as conciſe as poſſible, that its force might be diſcerned at a glance. The evidence which has been ſtated is of two kinds. Till the time of Juſtin Martyr and Irenæus it conſiſts chiefly of alluſions, references, and expreſſions, borrowed from the books of the New Teſtament, without mentioning them by name. After the time of Irenæus it became uſual to cite the ſacred books, and mention the authors from whom the citations were taken.

106 The alluſions and references to the New Teſtament by the firſt Chriſtian writers prove that it exiſted in their time.

The firſt ſpecies of evidence will perhaps appear to ſome exceptionable; but it muſt be remembered that it was uſual among the ancient Chriſtians as well as Jews to adopt the expreſſions of Scripture without naming the authors. Why they did ſo it is not neceſſary to inquire. The only point of importance to be determined is, whether thoſe references are a ſufficient proof of the exiſtence of the books to which they allude? This, we preſume, will not be denied; eſpecially in the preſent age, when it is ſo common to charge an author with plagiariſm if he happen to fall upon the ſame train of ideas, or expreſs himſelf in a ſimilar manner with authors who have written before him. We may farther affirm, that theſe tacit references afford a complete proof that thoſe ancient writers had no intention of impoſing a forgery upon the world. They prove the exiſtence of the Chriſtian religion and of the apoſtolical writings, without ſhowing any ſuſpicious earneſtneſs that men ſhould believe them. Had theſe books been forged, thoſe who wiſhed to paſs them upon the world would have been at more pains than the firſt Chriſtians were to prove their authenticity. They acted the part of honeſt men; they believed them themſelves, and they never imagined that others would ſuſpect their truth.

It is a conſideration of great importance, in reviewing the evidence which has been now ſtated, that the witneſſes lived in different countries; Clemens flouriſhed at Rome, Polycarp at Smyrna, Juſtin Martyr in Syria, Irenæus in France, Tertullian at Carthage, Origen at Alexandria, and Euſebius at Cæſarea. This proves that the books of the New Teſtament were equally well known in diſtant countries by men who had no intercourſe with one another.

107 Teſtimonies of Heretics.

The ſame thing is proved by teſtimonies if poſſible leſs exceptionable. The ancient heretics, whoſe opinions were ſometimes groſſer and more impious than thoſe which any modern ſectary has ventured to broach, and whoſe zeal in the propagation of them equalled that of the moſt flaming enthuſiaſt of the laſt century, never called in queſtion the authenticity of the books of the New Teſtament. When they met with any paſſage in the goſpels or epiſtles which they could not reconcile to their own heretical notions, they either eraſed it, or denied that the author was inſpired; but they nowhere contend that the book in which it ſtood was not written by the apoſtle or evangeliſt whoſe name it bore. Euſebius relates, that the Ebionites rejected all the epiſtles of Paul, and called him an apoſtate, becauſe he departed from the Levitical law; and they adopted as their rule of faith the goſpel of St Matthew, though indeed they greatly corrupted it. This proves therefore that the goſpel according to Matthew was then publiſhed, and that St Paul's epiſtles were then known.

Of the heretics who eraſed or altered paſſages to make the Scriptures agree with their doctrines, we may produce Marcion as an inſtance, who lived in the beginning of the ſecond century. He lived in an age when he could have eaſily diſcovered if the writings of the New Teſtament had been forged; and as he was much incenſed againſt the orthodox party, if ſuch a forgery had been committed, unqueſtionably he would not have failed to make the diſcovery, as it would have afforded the moſt ample means of revenge and triumph, and enabled him to eſtabliſh his own opinions with leſs difficulty. But his whole conduct ſhows clearly, that he believed the writings of the New Teſtament to be authentic.

* Chap. i. 29.

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in Clement agrees more exactly with Luke xvii. 2. "It were better for him that a millſtone were hanged about his neck, and he caſt into the ſea, than that he ſhould offend one of theſe little ones."

authentic. He ſaid, that the goſpel according to St Matthew, the epiſtle to the Hebrews, with thoſe of St Peter and St James, as well as the Old Teſtament in general, were writings not for Chriſtians but for Jews. He publiſhed a new edition of the goſpel according to Luke, and the firſt ten epiſtles of Paul; in which it has been affirmed by Epiphanius, that he altered every paſſage that contradicted his own opinions: but as many of theſe alterations are what modern critics call *various readings*, though we receive the teſtimony of Epiphanius, we muſt not rely upon his opinion (x). Hence it is evident that the books of the New Teſtament above mentioned did then exiſt, and were acknowledged to be the works of the authors whoſe names they bear.

Dr Lardner in his General Review, ſums up this head of evidence in the following words: "Noetus, Paul of Samoſata, Sabellius, Marcellus, Photinus, the Novatians, Donatiſts, Manicheans (y), Priſcillaniſts, beſide Artemon, the Audians, the Arians, and divers others, all received moſt or all the ſame books of the New Teſtament which the Catholics received; and agreed in a like reſpect for them as writ by apoſtles or their diſciples and companions."

108
Teſtimonies of Heathens.

Celſus and Porphyry, both enemies of the Chriſtian religion, are powerful witneſſes for the antiquity of the New Teſtament. Celſus, who lived towards the end of the ſecond century, not only mentions by name, but quotes paſſages from the books of the New Teſtament: and that the books to which he refers were no other
109 Of Celſus.
than our preſent goſpels, is evident from the alluſions to various paſſages ſtill found in them. Celſus takes notice of the genealogies, which fixes two of theſe goſpels; of the precepts, Reſiſt not him that injures you, and, If a man ſtrike thee on the one cheek, offer to him the other alſo; of the woes denounced by Chriſt; of his predictions; of his ſaying, that it is impoſſible to ſerve two maſters; of the purple robe, the crown of thorns, and the reed which was put into the hand of Jeſus; of the blood that flowed from his body upon the croſs, a circumſtance which is recorded only by John; and (what is *inſtar omnium* for the purpoſe for which we produce it) of the difference in the accounts given of the reſurrection by the evangeliſts, ſome mentioning two angels at the ſepulchre, others only one.

It is extremely material to remark, that Celſus not only perpetually referred to the accounts of Chriſt contained in the four goſpels, but that he referred to no other accounts; that he founded none of his objections to Chriſtianity on any thing delivered in ſpurious goſpels.

110
Of Porphyry.

The teſtimony of Porphyry is ſtill more important than that of Celſus. He was born in the year 213, of Tyrian origin. Unfortunately for the preſent age, ſays Michaelis, the miſtaken zeal of the Chriſtian emperors has baniſhed his writings from the world; and every real friend of our religion would gladly give the works of one of the pious fathers to reſcue thoſe of Porphyry from the flames. But Mr Marſh, the learned and judicious tranſlator of Michaelis, relates, that, according to the accounts of Iſaac Voſſius, a manuſcript of the works of Porphyry is preſerved in the Medicean library at Florence, but kept ſo ſecret that no one is permitted to ſee it. It is univerſally allowed, that Porphyry is the moſt ſenſible, as well as the moſt ſevere, adverſary of the Chriſtian religion that antiquity can produce. He was verſed not only in hiſtory, but alſo in philoſophy and politics. His acquaintance with the Chriſtians was not confined to a ſingle country; for he had converſed with them in Tyre, in Sicily, and in Rome. Enabled by his birth to ſtudy the Syriac as well as the Greek authors, he was of all the adverſaries to the Chriſtian religion the beſt qualified to inquire into the authenticity of the ſacred writings. He poſſeſſed therefore every advantage which natural abilities or a ſcientific education could afford to diſcover whether the New Teſtament was a genuine work of the apoſtles and evangeliſts, or whether it was impoſed upon the world after the deceaſe of its pretended authors. But no trace of this ſuſpicion is any where to be found in his writings. In the fragments which ſtill remain, mention is made of the goſpels of St Matthew, St Mark, and St John, the Acts of the Apoſtles, and the epiſtle to the Galatians; and it clearly appears from the very objections of Porphyry, that the books to which he alludes were the ſame which we poſſeſs at preſent. Thus he objects to the repetition of a generation in St Matthew's genealogy; to Matthew's call; to the quotation of a text from Iſaiah, which is found in a pſalm aſcribed to Aſaph; to the calling of the lake of Tiberias a ſea; to the expreſſion in St Matthew, "the abomination of deſolation;" to the variation in Matthew and Mark upon the text "the voice of one crying in the wilderneſs," Matthew citing it from Iſaias, Mark from the prophets; to John's application of the term *Word;* to Chriſt's change of intention about going up to the feaſt of tabernacles (John vii. 8.); to the judgment denounced by St Peter upon Ananias and Sapphira, which he calls an imprecation of death.

The inſtances here alleged ſerve in ſome meaſure to ſhow the nature of Porphyry's objections, and prove that Porphyry had read the goſpels with that ſort of attention which a writer would employ who regarded them as the depoſitaries of the religion which he attacked. Beſide theſe ſpecifications, there exiſts in the writings of ancient Chriſtians general evidence, that the places of Scripture, upon which Porphyry had made remarks, were very numerous.

111
Authenticity of the New Teſtament proved from internal evidence.

The internal evidence to prove the authenticity of the New Teſtament conſiſts of two parts: The nature of the ſtyle, and the coincidence of the New Teſtament with the hiſtory of the times.

112
From the ſtyle.

The ſtyle of the New Teſtament is ſingular, and differs very widely from the ſtyle of claſſical authors. It is full of Hebraiſms and Syriaſms; a circumſtance which pious ignorance has conſidered as a fault, and which, even ſo late as the preſent century, it has attempted to remove; not knowing that theſe very deviations from Grecian purity afford the ſtrongeſt preſumption in its favour: for they prove *that the New Teſtament was written by men of Hebrew origin, and is therefore a production*

(x) Dr Loeffer has written a learned diſſertation to prove that Marcion did not corrupt the ſacred writings.

(y) This muſt be with an exception, however, of Fauſtus, who lived ſo late as the year 384.

duction of the firſt century. After the death of the firſt Jewiſh converts, few of the Jews turned preachers of the goſpel; the Chriſtians were generally ignorant of Hebrew, and conſequently could not write in the ſtyle of the New Teſtament. After the deſtruction of Jeruſalem and the diſperſion of the Jews, their language muſt have been blended with that of other nations, and their vernacular phraſeology almoſt entirely loſt. The language of the early fathers, though not always the pureſt claſſic Greek, has no reſemblance to that of the New Teſtament, not even excepting the works of the few who had a knowledge of the Hebrew; as Origen, Epiphanius, and Juſtin Martyr, the laſt of whom being a native of Paleſtine, might have written in a ſtyle ſimilar to that of the New Teſtament, had ſuch a ſtyle then prevailed. He that ſuſpects the New Teſtament to be the forgery of a more recent period, ought to produce ſome perſon who has employed a ſimilar diction; but thoſe who are converſant with eaſtern writings know well that a foreigner, who has not been accuſtomed to eaſtern manners and modes of thinking from his infancy, can never imitate with ſucceſs the oriental ſtyle, much leſs forge a hiſtory or an epiſtle which contains a thouſand incidental alluſions, which nothing but truth could ſuggeſt. To imitate cloſely the ſtyle of the New Teſtament is even more difficult than to imitate that of any other oriental book; for there is not a ſingle author, even among the Jews themſelves, ſince the deſtruction of Jeruſalem, that has compoſed in a ſtyle in the leaſt degree like it (z).

But though the books of the New Teſtament bear ſo cloſe a reſemblance in idiom, there is a diverſity of ſtyle which ſhows them to be the work of different perſons. Whoever reads with attention the epiſtles of Paul, muſt be convinced that they were all written by the ſame author. An equal degree of ſimilarity is to be found between the goſpel and 1ſt epiſtle of John. The writings of St John and St Paul exhibit marks of an original genius which no imitation can ever attain. The character of Paul as a writer is drawn with great judgement by Michaelis: "His mind overflows with ſentiment, yet he never loſes ſight of his principal object, but hurried on by the rapidity of thought, diſcloſes frequently in the middle a concluſion to be made only at the end. To a profound knowledge of the Old Teſtament he joins the acuteneſs of philoſophical wiſdom, which he diſplays in applying and expounding the ſacred writings; and his explanations are therefore ſometimes ſo new and unexpected, that ſuperficial obſervers might be tempted to ſuppoſe them erroneous. The fire of his genius, and his inattention to ſtyle, occaſion frequently a twofold obſcurity, he being often too conciſe to be underſtood except by thoſe to whom he immediately wrote, and not ſeldom on the other hand ſo full of his ſubject, as to produce long and difficult parentheſes, and a repetition of the ſame word even in different ſenſes. With a talent for irony and ſatire, he unites the moſt refined ſenſibility, and tempers the ſeverity of his cenſures by expreſſions of tenderneſs and affection; nor does he ever forget in the vehemence of his zeal the rules of modeſty and decorum. He is a writer, in ſhort, of ſo ſingular and wonderful a compoſition, that it would be difficult to find a rival. That truly ſenſible and ſagacious philoſopher Locke was of the ſame opinion, and contended that St Paul was without an equal."

Poems have been forged and aſcribed to former ages with ſome ſucceſs. Philoſophical treatiſes might be invented which it would be difficult to detect; but there is not a ſingle inſtance on record where an attempt has been made to forge a hiſtory or a long epiſtle, where the fraud has not been either fully proved, or rendered ſo ſuſpicious that few are weak enough to believe it. Whoever attempts to forge a hiſtory or an epiſtle in the name of an ancient author, will be in great danger of contradicting the hiſtory or the manners of that age, eſpecially if he relate events which are not mentioned in general hiſtory, but ſuch as refer to a ſingle city, ſect, religion, or ſchool.

The difficulty of forging ſuch hiſtories as the goſpels, and ſuch epiſtles as thoſe of Paul, cannot be overcome by all the genius, learning, and induſtry, of any individual or ſociety of men that ever lived. They contain a purer ſyſtem of ethics than all the ancient philoſophers could invent: They diſcover a candour and modeſty unexampled: They exhibit an originality in the character of Jeſus, and yet ſuch a conſiſtency as the imagination of our beſt poets has never reached. Now it is a very remarkable circumſtance, that hiſtories written by four different men ſhould preſerve ſuch dignity and conſiſtency, though frequently relating different actions of Jeſus, and deſcending to the moſt minute circumſtances in his life. The ſcene of action is too extenſive, and the agreement of facts with the ſtate of the times as repreſented by other hiſtorians is too cloſe, to admit the poſſibility of forgery.

The ſcene of action is not confined to one country, it is ſucceſſively laid in the greateſt cities of the Roman empire; in Rome, in Antioch, in Corinth, in Athens, as well as in Jeruſalem and the land of Paleſtine. Innumerable alluſions are made to the manners and opinions of the Greeks, the Romans, and the Jews; and reſpecting the Jews, they extend even to the trifles and follies of their ſchools. Yet after the ſtricteſt examination, the New Teſtament will be found to have a wonderful coincidence and harmony with Joſephus, the principal hiſtorian of theſe times, and an enemy of Chriſtianity.

113
And from remarkable inſtances of coincidence between Joſephus and the New Teſtament.

It has been a queſtion who the ſoldiers were who are ſaid in the goſpel of Luke to have addreſſed John the Baptiſt in theſe words, *What ſhall we do?* An anſwer to this queſtion may be found in Joſephus *. Herod the tetrarch of Galilee was engaged in a war with his father-in-law Aretas, a petty king in Arabia Petræa, at the very time that John was preaching in the wilderneſs; and the road from Galilee to Arabia running through that wilderneſs, the ſoldiers on their march had this interview with the Baptiſt. A coincidence like this, which

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* *Antiq.* lib. xviii. cap. 5. ſect. 1, 2.

(z) The ſtyle of Clemens Romanus may perhaps be an exception. By many eminent critics it has been thought ſo like to that of the epiſtle to the Hebrews, as to give room for the opinion that Clement either was the author of that epiſtle, or was the perſon who tranſlated it from the Syro-Chaldaic language, in which it was originally compoſed.

which has been overlooked by all the commentators, would not probably be attended to in a forgery.

Chap. ii. § 11.

Another inſtance of an agreement no leſs remarkable we ſhall quote from the valuable work of Michaelis. It has been a queſtion of ſome difficulty among the learned, who was the Ananias who commanded St Paul to be ſmitten on the mouth when he was making his defence before the council in Jeruſalem*. Krebs, in his remarks taken from Joſephus, has ſhown him to have been the ſon of Nebedeni. But if ſo, how can it be reconciled with chronology, that Ananias was, at that time, called high prieſt, when it is certain from Joſephus that the time of his holding that office was much earlier? And how comes it to paſs that St Paul ſays, "I wiſt not, brethren, that he was the high prieſt?" The ſacerdotal garb muſt have diſcovered who he was: a jeſt would have ill-ſuited the gravity of a tribunal; and a falſehood is inconſiſtent with the character of St Paul.

* Acts xxiii. 2—5.

All theſe difficulties vaniſh as ſoon as we examine the ſpecial hiſtory of that period: "Ananias the ſon of Nebedeni was high prieſt at the time that Helena queen of Adiabene ſupplied the Jews with corn from Egypt during the famine which took place in the fourth year of Claudius, mentioned in the eleventh chapter of the Acts. St Paul therefore, who took a journey to Jeruſalem at that period, could not have been ignorant of the elevation of Ananias to that dignity. Soon after the holding of the firſt council, as it is called, at Jeruſalem, Ananias was diſpoſſeſſed of his office, in conſequence of certain acts of violence between the Samaritans and the Jews, and ſent priſoner to Rome; but being afterwards releaſed, he returned to Jeruſalem. Now from that period he could not be called *high-prieſt* in the proper ſenſe of the word, though Joſephus has ſometimes given him the title of αρχιερευς, taken in the more extenſive meaning of a prieſt who had a ſeat and voice in the Sanhedrim; and Jonathan, though we are not acquainted with the circumſtances of his elevation, had been raiſed in the mean time to the ſupreme dignity in the Jewiſh church. Between the death of Jonathan, who was murdered by order of Felix, and the high-prieſthood of Iſmael, who was inveſted with that dignity by Agrippa, elapſed an interval during which the ſacerdotal office was vacant. Now it happened preciſely in this interval that St Paul was apprehended in Jeruſalem: and, the Sanhedrim being deſtitute of a preſident, he undertook of his own authority the diſcharge of that office, which he executed with the greateſt tyranny. It is poſſible therefore that St Paul, who had been only a few days in Jeruſalem, might be ignorant that Ananias, who had been diſpoſſeſſed of the prieſthood, had taken upon himſelf a truſt to which he was not entitled; he might therefore very naturally exclaim, 'I wiſt not, brethren, that he was the high-prieſt!' Admitting him on the other hand to have been acquainted with the fact, the expreſſion muſt be conſidered as an indirect reproof, and a tacit refuſal to recognize uſurped authority."

Could ſuch a correſpondence as this ſubſiſt between truth and falſehood, between a forgery and an authentic hiſtory? or is it credible that theſe events could be related by any perſon but a contemporary?

Impreſſed with the love of truth, and feeling contempt as well as deteſtation at pious frauds, we heſitate not to acknowledge, that in ſome particular facts there is a difference either real or apparent between Joſephus and the writers of the New Teſtament. The objections ariſing from theſe differences are of two kinds: 1. Such as would prove a book not to have been written by the author to whom it is aſcribed. 2. Such as would prove that the author was miſtaken, and therefore not divinely inſpired. To the firſt claſs belongs the following objection: St Paul ſays (2 Cor. xi. 32.) that the governor of Damaſcus was under Aretas the king: but if we are to judge from the 18th book of the Jewiſh Antiquities, which correſponds with the period of St Paul's journey to Damaſcus, that city muſt have belonged at that time to the Romans; and what authority could Aretas, a petty king in Arabia Petræa, have in ſuch a city? In anſwer to this queſtion, J. G. Hyne, in a diſſertation publiſhed in 1755, has ſhown it to be highly probable that Aretas, againſt whom the Romans, not long before the death of Tiberius, made a declaration of war, which they neglected to put in execution, took the opportunity of ſeizing Damaſcus, which had once belonged to his anceſtors; an event omitted by Joſephus, as forming no part of the Jewiſh hiſtory, and by the Roman hiſtorians as being a matter not flattering in itſelf, and belonging only to a diſtant province. Secondly, That Aretas was by religion a Jew; a circumſtance the more credible, when we reflect that Judaiſm had been widely propagated in that country, and that even kings in Arabia Felix had recognized the law of Moſes. The difficulty then is ſo far removed, that it ceaſes to create ſuſpicion againſt an epiſtle which has ſo many evident marks of authenticity; and it is only to be regretted that, in order to place the ſubject in the cleareſt point of view, we are not ſufficiently acquainted with the particular hiſtory of Damaſcus.

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There are alſo apparent inconſiſtencies, but theſe probably ariſe from overſight in Joſephus;

Examples of the ſecond kind are ſuch as, if allowed their full force, might indeed prove a writer not divinely inſpired, but could afford no reaſon to conclude that he was not the author of the writings which bear his name, ſince miſtakes may be committed by the moſt accurate hiſtorian. The chief difficulties of this nature are found in the goſpel according to St Luke, and do not apply to the writings of Matthew, John, Paul, and Peter. Laying aſide the idea of inſpiration altogether, let us inquire whether Luke or Joſephus be moſt intitled to credit in thoſe paſſages where they differ; which of them is moſt accurate, and which of them had the beſt opportunities of exploring the truth of the facts which they relate. Now Joſephus relates the ſame ſtory differently in different parts of his works, and is ſometimes equally miſtaken in them all. We do not recollect to have ſeen ſuch inconſiſtencies in the writings of St Luke. Luke knew the characters, and witneſſed many of the facts, of which he ſpeaks; and he could receive the beſt information reſpecting thoſe facts which were tranſacted in his abſence. Joſephus was born A. D. 37, ſome years after our Saviour's aſcenſion. Now it is a very important obſervation of Michaelis, that the period of hiſtory with which mankind are leaſt acquainted is that which includes the time of their childhood and youth, together with the twenty or thirty years immediately preceding their birth. Concerning the affairs tranſacted during that period, we are much more liable to fall into miſtakes than concerning

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or to his want of authentic information concerning the events that happened near his birth.

those of a remoter age. The reaſon is, that authentic hiſtory never comes down to the period of our birth; our knowledge of the period immediately preceding depends on hearſay; and the events, which paſs within the firſt eighteen or twenty years of our lives, we are too young and heedleſs to obſerve with attention. This muſt have been more remarkably the caſe in the time of Joſephus than at preſent, when there were neither daily papers, nor periodical journals to ſupply the want of regular annals. There was no hiſtorian from whom Joſephus could derive any knowledge of the times that immediately preceded his birth. There is a period then of forty or fifty years, in which, even with the moſt diligent inquiry, he was expoſed to error.

When we find therefore the relations of Luke and Joſephus ſo different as not to be reconciled, it would be very unfair to determine without any further inquiry in favour of Joſephus. Let their character, and works, and ſituation, be ſtrictly examined; let their teſtimony be duly weighed and compared; and then let the preference be given to that author who, according to the ſtricteſt rules of equity and juſtice, ſeems intitled to the higheſt degree of credit. The deciſion of a jury, we ſhall venture to ſay, would in every inſtance turn out in favour of Luke.

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Inſpiration of the New Teſtament,

Having thus aſcertained the authenticity of the books of the New Teſtament, the next thing to be conſidered is their inſpiration. It is certainly of ſome importance to know how far the apoſtles and evangeliſts were guided in their writings by the immediate influence of the ſpirit of God; though this knowledge, if attainable, is not equally important with that of the authenticity of theſe writings. Michaelis indeed aſſerts, that the divinity of the New Teſtament may be proved whether we can evince it to be written by immediate inſpiration or not *. "The queſtion (ſays he), whether the books of the New Teſtament are inſpired? is not ſo important as the queſtion, whether they are genuine? The truth of our religion depends upon the latter, not abſolutely on the former. Had the Deity inſpired not a ſingle book of the New Teſtament, but left the apoſtles and evangeliſts without any other aid than that of natural abilities to commit what they knew to writing, admitting their works to be authentic, and poſſeſſed of a ſufficient degree of credibility, the Chriſtian religion would ſtill be well founded. The miracles by which it is confirmed would equally demonſtrate its truth, even if the perſons who atteſted them were not inſpired, but ſimply human witneſſes; and their divine authority is never preſuppoſed, when we diſcuſs the queſtion of miracles, but merely their credibility as human evidence. If the miracles are true which the evangeliſts relate, the doctrines of Chriſt recorded in the goſpels are proved to be the infallible oracles of God; and, even if we admit the apoſtles to be miſtaken in certain not eſſential circumſtances, yet as the main points of the religion which Chriſt commiſſioned them to preach are ſo frequently repeated, their epiſtles would inſtruct us as well in the tenets of the Chriſtian ſyſtem, as the works of Maclaurin in the philoſophy of Newton. It is poſſible therefore to doubt, and even deny, the inſpiration of the New Teſtament, and yet be fully perſuaded of the truth of the Chriſtian religion: and many really entertain theſe ſentiments either publicly or in private, to whom we ſhould render great injuſtice, if we ranked them in the claſs of unbelievers.

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not neceſſary to the truth of Chriſtianity according to the opinion of Michaelis.

"Yet the Chriſtian religion would be attended with difficulty, if our *principium cognoſcendi* reſted not on firmer ground; and it might be objected, that ſufficient care had not been taken for thoſe whoſe conſciences were tender, and who were anxiouſly fearful of miſtaking the ſmalleſt of the divine commands. The chief articles indeed of Chriſtianity are ſo frequently repeated, both by Chriſt and his apoſtles, that even were the New Teſtament not inſpired, we could entertain no doubt of the following doctrines: 'Jeſus was the Meſſias of the Jews, and an infallible meſſenger of God: he died for our iniquity; and by the ſatisfaction made by his death we obtain remiſſion of ſins, if on our part be faith and amendment of life: the Levitical law is aboliſhed, and moral precepts, with the ceremonies of Baptiſm and the Supper of the Lord, are appointed in its ſtead; after the preſent follows an everlaſting life, in which the virtuous ſhall be rewarded and the wicked puniſhed, and where Chriſt himſelf ſhall be the Judge.'

"To the epiſtles indeed (ſays Michaelis), inſpiration is of real conſequence; but with reſpect to the hiſtorical books, viz. the Goſpels and the Acts of the Apoſtles, we ſhould really be no loſers if we abandoned the ſyſtem of inſpiration, and in ſome reſpects have a real advantage. We ſhould be no loſers, if we conſidered the apoſtles in hiſtorical facts as merely human witneſſes, as Chriſt himſelf has done in ſaying, 'Ye alſo ſhall bear witneſs, becauſe ye have been with me from the beginning *.' And no one that attempts to convince an unbeliever of the truth of Chriſtianity, would begin his demonſtration by preſuppoſing a doctrine which his adverſary denies, but would ground his arguments on the credibility of the evangeliſts as human hiſtorians, for the truth of the miracles, the death, and the reſurrection of Chriſt. Even thoſe who examine the grounds of their faith for their own private conviction, muſt treat the evangeliſts as human evidence; ſince it would be arguing in a circle to conclude that the facts recorded in the goſpels are true, becauſe they are inſpired, when we conclude the Scriptures to be inſpired in conſequence of their contents. In theſe caſes, then, we are obliged to conſider the evangeliſts as human evidence; and it would be no detriment to the Chriſtian cauſe to conſider them at all times as ſuch in matters of hiſtorical fact. We find it nowhere expreſsly recorded that the public tranſactions which the apoſtles knew by their own experience, and of which St Luke informed himſelf by diligent inquiry, ſhould be particular objects of divine inſpiration. We ſhould even be conſiderable gainers, in adjuſting the harmony of the goſpels, if we were permitted to ſuppoſe that ſome one of the evangeliſts had committed an immaterial error, and that St John has rectified ſome trifling miſtakes in the preceding goſpels. The moſt dangerous objections which can be made to the truth of our religion, and ſuch as are moſt difficult to anſwer, are thoſe drawn from the different relations of the four evangeliſts."

118
Different meanings of the word *inſpiration.*

Before any inquiry is made reſpecting the inſpiration of the books of the New Teſtament, it is neceſſary to determine the meaning of the term; for theologians have given to it a variety of ſignifications. Moſt of the German divines make it to conſiſt in an infuſion of

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* Chap. iii. § 1.

* John xv. 27.

words as well as ideas. Luther, Beza, and Salmaſius, reſtrict it to ideas alone. Doddridge underſtands by it an intervention of the Deity, by which the natural faculties of the mind were directed to the diſcovery of truth. Warburton and Law think it was a negative intervention to preſerve the ſacred writers from eſſential errors. Some believe every circumſtance was dictated by the Holy Ghoſt; others ſuppoſe that no ſupernatural aſſiſtance was granted except in the epiſtolary writings. See INSPIRATION.

As there is an evident diſtinction between inſpiration and revelation, and as the origin of the Chriſtian religion may be ſtill proved divine, even though it were denied that thoſe who record its facts and doctrines were inſpired in the act of writing, it will be moſt judicious and ſafe to employ the word *inſpiration* in that ſenſe which can be moſt eaſily defended and ſupported. By doing this, much may be gained and nothing loſt. It is difficult to prove to a deiſt that the words of Scripture are divine, becauſe he ſees that every writer has words and phraſes peculiar to himſelf. It is difficult alſo to prove that the ideas were infuſed into the mind of the authors while they were engaged in the act of writing; becauſe concerning facts they appeal not to divine inſpiration, but declare *what they have ſeen and heard*. In reaſoning they add their own ſentiments to what they had received from the Lord, and ſubjoin, eſpecially in their epiſtles, things not connected with religion. The definition which Doddridge gives, ſeems applicable to ordinary gifts or the uſual endowments of rational creatures, rather than to the extraordinary gifts of the Holy Spirit, which were beſtowed on the apoſtles. Thoſe who maintain that every fact or circumſtance was ſuggeſted by divine inſpiration, will find it no eaſy matter to prove their poſition. The opinion of Warburton and Law, with proper explanations, ſeems moſt probable. The opinion of Grotius, that only the epiſtles were inſpired, may be eaſily refuted.

The proof of the authenticity of the New Teſtament depends on human teſtimony: The proof of its inſpiration is derived from the declaration of inſpired perſons.

119 The proof of it depends on the declarations of Chriſt and his apoſtles.

In proving that the New Teſtament is inſpired, we preſuppoſed its authenticity, that the ſacred books were written by the apoſtles whoſe names they bear, and that they have been conveyed to us pure and uncorrupted. This we have already attempted to prove, and we hope with ſucceſs. The evidence of inſpiration is the teſtimony of Chriſt and his apoſtles, which we receive as credible, becauſe they confirmed their doctrines by miracles. From the important miſſion of Chriſt and his apoſtles, we infer that every power was beſtowed which divine wiſdom thought expedient; and from their conduct we conclude, that it is morally impoſſible that they could lay claim to any powers which they did not poſſeſs. It is proper therefore to inquire into the declarations of Chriſt and his apoſtles concerning the nature, degree, and extent, of the inſpiration beſtowed on the writers of the ſacred books.

120 The declarations of Chriſt.

If we conſider Chriſt's more immediate promiſes of inſpiration to the apoſtles, we ſhall find that he has given them, in the moſt proper ſenſe of the word, at three ſeveral periods, 1ſt, When he ſent the apoſtles to preach the goſpel [*]; 2dly, In holding a public diſcourſe relating to the goſpel, at which were preſent a conſiderable multitude; 3dly, In his prophecy of the deſtruction of Jeruſalem [†]. When he ſent the apoſtles to preach the goſpel, he thus addreſſed them: "When they deliver you up, take no thought how or what ye ſhall ſpeak, for it ſhall be given you in that ſame hour what ye ſhall ſpeak; for it is not you that ſpeak, but the ſpirit of your Father that ſpeaketh in you." The ſame promiſe was made almoſt in the ſame words in the preſence of an immenſe multitude (Luke xii. 11, 12.). From theſe paſſages it has been urged, that if the apoſtles were to be inſpired in the preſence of magiſtrates in delivering ſpeeches, which were ſoon to be forgotten, it is ſurely reaſonable to conclude that they would be inſpired when they were to compoſe a ſtandard of faith for the uſe of all future generations of Chriſtians. If this concluſion be fairly deduced, it would follow that the writings of the New Teſtament are the dictates of inſpiration, not only in the doctrines and precepts, but in the very words. But it is a concluſion to which ſincere Chriſtians have made objections; for, ſay they, though Chriſt promiſes to aſſiſt his apoſtles in caſes of great emergency, where their own prudence and fortitude could not be ſufficient, it does not follow that he would dictate to them thoſe facts which they know already, or thoſe reaſonings which their own calm reflection might ſupply. Beſides, ſay they, if the New Teſtament was dictated by the Holy Spirit, and only penned by the apoſtles, what reaſon can be given for the care with which Chriſt inſtructed them, both during his miniſtry and after his crucifixion, in thoſe things pertaining to the kingdom of God?

121 Proper ideas of inſpiration.

In anſwer to this we may obſerve, that though it be difficult to prove that the identical words of the New Teſtament were dictated by the Holy Spirit, or the train of ideas infuſed into the minds of the ſacred writers, there is one ſpecies of inſpiration to which the New Teſtament has an undoubted claim. It is this, that the memories of the apoſtles were ſtrengthened and their underſtandings preſerved from falling into eſſential errors. This we prove from theſe words of our Saviour, "and I will pray the Father, and he will give you another comforter, that he may abide with you for ever. He ſhall teach you all things, and bring all things to your remembrance whatſoever I have ſaid unto you [*]." This promiſe was ſurely not reſtrained to the day of Pentecoſt: it muſt have been a permanent gift, enabling the apoſtles at all times to remember with accuracy the diſcourſes of our Saviour. When the apoſtles therefore (Matthew and John) relate thoſe precepts of Chriſt which they themſelves had heard, they write indeed from memory, but under the protection of the ſpirit who ſecures them from the danger of miſtake: and we muſt of courſe conclude that their goſpels are inſpired.

Were we called upon more particularly to declare what parts of the New Teſtament we believe to be inſpired, we would anſwer, The doctrines, the precepts, and the prophecies, every thing eſſential to the Chriſtian religion. From theſe the idea of inſpiration is inſeparable. As to the events, the memory of the apoſtles was ſufficient to retain them. If this opinion be juſt, it would enable us to account for the diſcrepancies between the ſacred writers, which are chiefly confined to the relation of facts and events.

All the books of the New Teſtament were originally written in Greek, except the Goſpel according to Matthew

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[*] Matt. x. 19, 20.

[†] Mark xiii. 11; Luke xxi. 14, 15.

[*] John xiv. 16, 26.

thew and the epiſtle to the Hebrews, which there is reaſon to believe were compoſed in the Syro-Chaldaic language, which in the New Teſtament is called Hebrew.

122
Language in which the New Teſtament was compoſed.

123
Why the greateſt part of it is written in Greek.

Various reaſons have been aſſigned why the greateſt part of the New Teſtament was written in Greek ; but the true reaſon is this, It was the language beſt underſtood both by writers and readers. Had St Paul written to a community in the Roman province of Africa, he might have written perhaps in Latin ; but epiſtles to the inhabitants of Corinth, Galatia, Epheſus, Philippi, and Theſſalonica, to Timothy, Titus, and Philemon, from a native of Tarſus, could hardly be expected in any other language than Greek. The ſame may be ſaid of the epiſtles of St Peter, which are addreſſed to the Chriſtians of different countries, who had no other language in common than the Greek ; and likewiſe of the epiſtles of St James, who wrote to Jews, that lived at a diſtance from Paleſtine, and were ignorant of Hebrew. The native language of St Luke, as well as of Theophilus, to whom he addreſſed his goſpel, and Acts of the apoſtles, appears to have been Greek ; and that St John wrote his goſpel in that language, and not in Hebrew, is by no means a matter of ſurpriſe, ſince he wrote at Epheſus.

Michaelis, vol. i. chap. iv. ſect. 1. p. 101.

With reſpect to the epiſtle to the Romans, it may be aſked indeed why St Paul did not write in Latin ? Now, whoever propoſes this queſtion, muſt preſuppoſe that St Paul was maſter of the Latin language in ſuch a degree as to find no difficulty in writing it ; a matter which remains to be proved. It is very probable that St Paul was acquainted with the Latin ; but between underſtanding a language, and being able to write it, there is a very material difference. As St Paul was a native of Tarſus, his native language was Greek ; he had travelled during ſeveral years through countries in which no other language was ſpoken, and when he addreſſed the Roman centurion at Jeruſalem, he ſpoke not Latin, but Greek. Is it extraordinary, then, that in writing to the inhabitants of Rome he ſhould have uſed a language which was there ſo generally underſtood ? It has been long remarked, that Greek was at that time as well known in Rome as French in any court of modern Europe ; that according to Juvenal even the female ſex made uſe of Greek as the language of familiarity and paſſion ; and that in letters of friendſhip Greek words and phraſes were introduced with greater freedom than French expreſſions in German letters, as appears from Cicero's epiſtles to Atticus, and from thoſe of Auguſtus preſerved in the works of Suetonius. To this muſt be added a material circumſtance, that a great part of the Roman Chriſtians conſiſted of native Jews, who were better acquainted with Greek than with Latin, as either they themſelves or their anceſtors had come from Greece, Aſia Minor, or Egypt, in which Greek was the language of the country. At leaſt they read the Bible in that language, as no Latin tranſlation of the Old Teſtament at that time exiſted ; and the Chriſtian church at that period conſiſting chiefly of Jews, the heathen converts in Rome were of courſe under the neceſſity of accuſtoming themſelves to the Greek language. In ſhort, St Paul in his epiſtle to the Romans made uſe of a language in which alone thoſe who were ignorant of Hebrew could read the Bible. What has been here advanced reſpecting the epiſtle to the Romans is equally applicable to the Greek of St Mark, on the ſuppoſition that it was written at Rome.

To the above arguments may be added the example of Joſephus, who, as well as the apoſtles, was by birth a Jew. He even lived in Rome, which is more than can be ſaid of St Paul and St Mark, who reſided there only a certain time : he was likewiſe younger than either ; he came to Italy at an age which is highly ſuitable to the learning of a language, and previous to that period had ſpent ſeveral years in the Roman camp. The Jewiſh antiquities, the hiſtory of the Jewiſh war, and the account of his own life, he wrote undoubtedly with a view of their being read by the Romans ; and yet he compoſed all theſe writings in Greek. He expreſſes his motive for writing his Greek account of the Jewiſh war in the following terms : "That having written in his native language (i. e. the Hebrew dialect at that time ſpoken) a hiſtory of the war, in order that Parthians, Babylonians, Arabians, Adiabenes, and the Jews beyond the Euphrates, might be informed of thoſe events, he was now reſolved to write for the Greeks and Romans, who had not been engaged in the campaigns, a more certain account than had hitherto been given." The motives which induced Joſephus to write in Greek are fully as applicable to St Paul and St Mark.

Michaelis, vol. i. chap. iv. ſect. 3. p 111.

Michaelis has thus characterized the ſtyle of the New Teſtament. "The New Teſtament (ſays he) was written in a language at that time common among the Jews, which may be named Hebraic Greek ; the firſt traces of which we find in the tranſlation of the LXX.

124
Is full of Hebraiſms,

"Every man acquainted with the Greek language, who had never heard of the New Teſtament, muſt immediately perceive, on reading only a few lines, that the ſtyle is widely different from that of the claſſic authors. We find this character in all the books of the New Teſtament in a greater or leſs degree, but we muſt not therefore conclude that they poſſeſs an uniformity of ſtyle. The harſheſt Hebraiſms, which extended even to grammatical errors in the government of caſes, are the diſtinguiſhing marks of the book of Revelation ; but they are accompanied with tokens of genius and poetical enthuſiaſm of which every reader muſt be ſenſible who has taſte and feeling. There is no tranſlation of it which is not read with pleaſure even in the days of childhood ; and the very faults of grammar are ſo happily placed as to produce an agreeable effect. The goſpels of St Matthew and St Mark have ſtrong marks of this Hebraic ſtyle ; the former has harſher Hebraiſms than the latter, the fault of which may be aſcribed to the Greek tranſlator, who has made too literal a verſion, and yet the goſpel of St Mark is written in worſe language, and in a manner that is leſs agreeable. The epiſtles of St James and St Jude are ſomewhat better ; but even theſe are full of Hebraiſms, and betray in other reſpects a certain Hebrew tone. St Luke has in ſeveral paſſages written pure and claſſic Greek, of which the firſt four verſes of his goſpel may be given as an inſtance : in the ſequel, where he deſcribes the actions of Chriſt, he has very harſh Hebraiſms, yet the ſtyle is more agreeable than that of St Matthew or St Mark. In the Acts of the apoſtles he is not free from Hebraiſms, which he ſeems to have never ſtudiouſly avoided ; but his periods are more claſſically turned, and ſometimes poſſeſs beauty

beauty devoid of art. St John has numerous, though not uncouth, Hebraiſms both in his goſpel and epiſtles; but he has written in a ſmooth and flowing language, and ſurpaſſes all the Jewiſh writers in the excellence of narrative. St Paul again is entirely different from them all; his ſtyle is indeed neglected and full of Hebraiſms, but he has avoided the conciſe and verſe-like conſtruction of the Hebrew language, and has upon the whole a conſiderable ſhare of the roundneſs of Grecian compoſition. It is evident that he was as perfectly acquainted with the Greek manner of expreſſion as with the Hebrew, and he has introduced them alternately, as either the one or the other ſuggeſted itſelf the firſt, or was the beſt approved."

125
and foreign idioms.

Michaelis has ſhown that the New Teſtament not only contains Hebraiſms but Rabbiniſms, Syriaſms, Chaldaiſms, Arabiſms, Latiniſms, and Perſian words, of which he has exhibited many ſpecimens. To theologians, whoſe duty it certainly is to ſtudy the language of the New Teſtament with attention, we would ſtrenuouſly recommend the peruſal of this work, which in the Engliſh tranſlation is one of the moſt valuable acceſſions to ſcriptural criticiſm that has yet appeared. We ſpeak of the Engliſh tranſlation, which the large and judicious notes of Mr Marſh has rendered infinitely ſuperior to the original.

126
Peculiarities in the compoſition.
Dr Campbell's Preliminary Diſſertations to the Tranſlations of his Goſpels.

To the obſervations which have been made reſpecting the language of the New Teſtament, a few remarks may be added concerning the peculiarities of the ſtyle and manner of the ſacred writers, particularly the hiſtorians. Theſe remarks extend to the Old Teſtament as well as to the New.—The *firſt* quality for which the ſacred hiſtory is remarkable is ſimplicity in the ſtructure of the ſentences. The firſt five verſes of Geneſis furniſh an example, which conſiſt of eleven ſentences. The ſubſtantives are not attended by adjectives, nor the verbs by adverbs, no ſynonymas, no ſuperlatives, no effort at expreſſing things in a bold, emphatical, or uncommon manner.

2. The ſecond quality is ſimplicity of ſentiment, particularly in the Pentateuch, ariſing from the very nature of the early and uncultivated ſtate of ſociety about which that book is converſant.

3. Simplicity of deſign. The ſubject of the narrative ſo engroſſes the attention of the writer, that he himſelf is as nobody. He introduces nothing as from himſelf, no remarks, doubts, conjectures, or reaſonings. Our Lord's biographers particularly excel in this quality. This quality of ſtyle we meet with in Xenophon and Cæſar.

The Evangeliſts may be ranked next to Geneſis for ſimplicity of compoſition in the ſentences. John and Matthew are diſtinguiſhed for it more than Mark and Luke. But the ſentiment is not ſo remarkable for ſimplicity in the Evangeliſt as the Pentateuch. The reaſons of this difference are, 1. The ſtate of the Jews was totally changed; their manners, cuſtoms, &c. ſplit into factions both in religion and politics. 2. The object of our Lord's miniſtry, which is the great ſubject of the goſpels, was *to inculcate a doctrine and morality* with which none of their ſyſtems perfectly coincided: beſides, being conſtantly oppoſed by all the great men, the greater part of his hiſtory conſiſts of inſtructions and diſputes. 3. As it is occupied with what our Saviour ſaid and what he did, this makes two diſtinctions of ſtyle and manner; that of our Saviour, and the ſacred penman's. In their own character, they neither explain nor command, promiſe nor threaten, praiſe nor blame. They generally omit the names of our Lord's enemies; thus directing our hatred at the vices they committed, not at the perſons. They never mention ſuch perſons without neceſſity; which is the caſe with the high prieſt, Pilate, Herod, and Judas: the three firſt for the chronology, the fourth to do juſtice to the eleven.

Herodias is, indeed, mentioned with diſhonour; but her crime was a public one. On the other hand, all perſons diſtinguiſhed for any thing virtuous are carefully mentioned, Joſeph of Arimathea, Nicodemus, Zaccheus, Bartimeus, Jairus, Lazarus, Mary, and Martha. They record their own faults (Peter's, Thomas's), nor do they make any merit of their confeſſion. In one uniform ſtrain they relate the moſt ſignal miracles and moſt ordinary facts.

From the narrative is excluded that quality of ſtyle which is called *animation*. Nothing that diſcovers paſſion in the writer, or is calculated to excite the paſſions of the reader. Every thing is directed to mend the heart.

But in the diſcourſes and dialogues of our Saviour, the expreſſion, without loſing any thing of its ſimplicity, is often remarkable for ſpirit and energy. Reſpecting harmony and ſmoothneſs, qualities which only add an external poliſh to language, they had not the leaſt ſolicitude.

As to elegance, there is an elegance which reſults from the uſe of ſuch words as are moſt in uſe with thoſe who are accounted fine writers, and from ſuch arrangements in the words and clauſes as have generally obtained their approbation. This is diſclaimed by the ſacred authors.

But there is an elegance of a ſuperior order more nearly connected with the ſentiment; and in this ſort of elegance they are not deficient. In all the oriental languages great uſe is made of tropes, eſpecially metaphors. When the metaphors employed bear a ſtrong reſemblance, they confer vivacity: if they be borrowed from objects which are naturally agreeable, beautiful, or attractive, they add alſo elegance. The Evangeliſts furniſh us with many examples of this kind of vivacity and elegance. Our Lord borrows tropes from cornfields, vineyards, gardens, &c.

127
Proper method of ſtudying the New Teſtament by analyſis and induction.

As a valuable appendage to this part of our ſubject, we ſhall ſubjoin Dr Campbell's method of ſtudying the books of the New Teſtament. This we offer to our readers as a beautiful inſtance of the judicious application of philoſophy to ſacred ſtudies. It is the ſame method of diſcovering truth by analyſis and induction, which was purſued by Sir Iſaac Newton with ſuch aſtoniſhing ſucceſs, which ſince his time has been uniformly practiſed in natural philoſophy, and has been alſo applied to chemiſtry, to medicine, to natural hiſtory, and to the philoſophy of mind, by the ingenious Dr Reid. This is the path of ſound philoſophy, which can alone lead to the diſcovery of truth. In following it, our progreſs may be ſlow, but it will be ſure. If all theologians would ſteadily adhere to it, we might then entertain the pleaſing hope of diſcarding for ever thoſe abſurd ſyſtems of religion which are founded on ſingle paſſages and detached fragments of ſcripture, and of eſtabliſhing opinions and doctrines on a ſolid foundation.

128
Dr Campbell's method. *Prel. Diſ. to the Goſpels.*

“ 1. To get acquainted with each writer's ſtyle; to obſerve his manner of compoſition, both in ſentences and paragraphs; to remark the words and phraſes peculiar to him, and the peculiar application that he may ſometimes make of ordinary words; for there are few of thoſe writers who have not their peculiarities in all the reſpects now mentioned. This acquaintance with each can be attained only by the frequent and attentive reading of his works in his own language.

“ 2. To inquire into the character, the ſituation, and the office of the writer, the time, the place, and the occaſion of his writing, and the people for whoſe immediate uſe he originally intended his work. Every one of theſe particulars will ſometimes ſerve to elucidate expreſſions otherwiſe obſcure or doubtful. This knowledge may in part be learned from a diligent and reiterated peruſal of the book itſelf, and in part be gathered from what authentic, or at leaſt probable, accounts have been tranſmitted to us concerning the compilement of the canon.

“ 3. The laſt general direction is, to conſider the principal ſcope of the book, and the particulars chiefly obſervable in the method, by which the writer has purpoſed to execute his deſign. This direction is particularly applicable to the epiſtolary writings, eſpecially thoſe of Paul.

“ 4. If a particular word or phraſe occur, which appears obſcure, perhaps unintelligible, the firſt thing we ought to do, if ſatisfied that the reading is genuine, is to conſult the context, to attend to the manner wherein the term is introduced, whether in a chain of reaſoning or in a hiſtorical narration, in a deſcription, or included in an exhortation or command. As the concluſion is inferred from the premiſſes, or as from two or more known truths a third unknown or unobſerved before may fairly be deduced; ſo from ſuch attention to the ſentence in connection, the import of an expreſſion, in itſelf obſcure or ambiguous, will ſometimes with moral certainty be diſcovered. This, however, will not always anſwer.

“ 5. If it do not, let the ſecond conſideration be, whether the term or phraſe be one of the writer's peculiarities. If ſo, it comes naturally to be inquired, what is the acceptation in which he employs it in other places? If the ſenſe cannot be preciſely the ſame in the paſſage under review, perhaps, by an eaſy and natural metaphor or other trope, the common acceptation may give riſe to one which perfectly ſuits the paſſage in queſtion.—Recourſe to the other places wherein the word or phraſe occurs in the ſame author is of conſiderable uſe, though the term ſhould not be peculiar to him.

“ 6. But thirdly, if there ſhould be nothing in the ſame writer that can enlighten the place, let recourſe be had to the parallel paſſages, if there be any ſuch, in the other ſacred writers. By parallel paſſages, I mean thoſe places, if the difficulty occur in hiſtory, wherein the ſame or a ſimilar ſtory, miracle, or event, is related; if in teaching or reaſoning, thoſe parts wherein the ſame argument or doctrine is treated, or the ſame parable propounded; and in moral leſſons, thoſe wherein the ſame claſs of duties is recommended: or, if the difficulty be found in a quotation from the Old Teſtament, let the parallel paſſage in the book referred to, both in the original Hebrew, and in the Greek verſion, be conſulted.

“ 7. But if in theſe there be found nothing that can throw light on the expreſſion of which we are in doubt, the fourth recourſe is to all the places wherein the word or phraſe occurs in the New Teſtament, and in the Septuagint verſion of the Old, adding to theſe the conſideration of the import of the Hebrew or Chaldaic word, whoſe place it occupies, and the extent of ſignification, of which in different occurrences ſuch Hebrew or Chaldaic term is ſuſceptible.

“ 8. Perhaps the term in queſtion is one of thoſe which very rarely occur in the New Teſtament, or thoſe called ἁπαξ λεγομενα, only once read in Scripture, and not found at all in the tranſlation of the Seventy. Several ſuch words there are. There is then a neceſſity, in the fifth place, for recurring to the ordinary acceptation of the term in claſſical authors. This is one of thoſe caſes wherein the interpretation given by the earlieſt Greek fathers deſerves particular notice. In this, however, I limit myſelf to thoſe comments wherein they give a literal expoſition of the ſacred text, and do not run into viſion and allegory.”

129
Manuſcripts of the New Teſtament.

The manuſcripts of the New Teſtament are the natural ſource from which the genuine readings of the Greek Teſtament are to be drawn. The printed editions are either copies of more ancient editions, or of manuſcripts; and they have no further authority than as they correſpond to the manuſcripts from which they were originally taken. By manuſcripts of the New Teſtament, we mean thoſe only which were written before the invention of printing. The moſt ancient of theſe are loſt, and there is no manuſcript now extant older than the ſixth century. Few contain the whole New Teſtament; ſome contain the four goſpels; ſome the Acts of the Apoſtles and Epiſtles; and others the book of Revelation. The greateſt number are thoſe which contain the firſt part; thoſe which have the ſecond, or the firſt and ſecond together, are likewiſe numerous; but thoſe of the third are extremely few. It muſt be added alſo, that in many manuſcripts thoſe epiſtles are omitted whoſe divine authority was formerly doubted.

There are many manuſcripts which have been examined only for a ſingle text, ſuch as 1 John v. 7. or at leaſt for a very ſmall number. Others have been examined from the beginning to the end, but not completely and in reſpect of all the readings. A third claſs conſiſts of ſuch as either have been, or are ſaid to have been, completely and accurately collated. But this requires ſuch phlegmatic patience, that we can hardly expect to find in critical catalogues all the various readings which have been only once collated. Wetſtein, in collating many manuſcripts anew, made diſcoveries which had entirely eſcaped the notice of his predeceſſors. The fourth claſs conſiſts of ſuch as have been completely and accurately collated more than once; but here alſo we are in danger of being led into error.—When various readings are transferred from one critical edition to another, as from that of Gregory to Mill's edition, and from the latter to thoſe of Bengel and Wetſtein, the manuſcripts muſt ſometimes be falſely named, and various readings muſt frequently be omitted. And as Wetſtein has marked by ciphers manuſcripts that in former editions had been denoted by their initial letters, he could ſcarcely avoid ſubſtituting, in ſome caſes, one figure inſtead of another. The fifth claſs, which is by far the moſt valuable, conſiſts of ſuch as have

have been printed word for word, and therefore form an original edition of the Greek Teſtament. We can boaſt but of a very few manuſcripts of this kind. Hearne printed at Oxford, in 1715, the Acts of the Apoſtles in Greek and Latin from the Codex Laudianus 3.; Knittel has annexed to his edition of Ulphilas, p. 53—118, a copy of two very ancient fragments preſerved in the library of Wolfenbuttle; the one of the four Goſpels in general, the other of St Luke and St John. Woide printed in 1786 the Codex Alexandrinus, a manuſcript of great antiquity, which ſhall afterwards be more fully deſcribed; and the univerſity of Cambridge has reſolved to publiſh, in a ſimilar manner, the Cod. Cant. I. or, as it is ſometimes called, the Codex Bezæ, the care of which is intruſted to Dr Kipling, a publication which will be thankfully received by every friend to ſacred criticiſm. It was the intention of the Abbé Spoletti, a few years ago, to publiſh the whole of the celebrated Codex Vaticanus; which would likewiſe have been a moſt valuable acceſſion, ſince a more important manuſcript is hardly to be found in all Europe. He delivered for this purpoſe a memorial to the pope; but the deſign was not put into execution, either becauſe the pope refuſed his aſſent or the abbé abandoned it himſelf. See the Oriental Bible, vol. xxii. N° 333. and vol. xxiii. N° 348.

130
Michaelis's propoſal of taking an impreſſion of ancient manuſcripts, vol. ii. p. 182.

"A very valuable library," ſays Michaelis, "might be compoſed of the impreſſions of ancient manuſcripts, which, though too expenſive for a private perſon, ſhould be admitted into every univerſity collection, eſpecially the Alexandrian and Cambridge manuſcripts, to which I would add, if it were now poſſible to procure it, Hearne's edition of the Codex Laudianus 3. A plan of this ſort could be executed only in England, by a private ſubſcription, where a zeal is frequently diſplayed in literary undertakings that is unknown in other countries; and it were to be wiſhed that the project were begun before length of time has rendered the manuſcripts illegible, and the attempt therefore fruitleſs. Ten thouſand pounds would go a great way towards the fulfilling of this requeſt, if the learned themſelves did not augment the difficulty of the undertaking, by adding their own critical remarks, and endeavouring thereby to recommend their publications, rather than by preſenting to the public a faithful copy of the original. Should poſterity be put in poſſeſſion of faithful impreſſions of important manuſcripts, an acquiſition which would render the higheſt ſervice to ſacred criticiſm, all theſe editions of the New Teſtament ſhould be regulated on the ſame plan as Hearne's edition of the Acts of the Apoſtles." It muſt be highly flattering to the patriotic ſpirit of an Engliſhman to hear the encomiums which learned foreigners have ſo profuſely beſtowed on our liberality in ſupporting works of genius and learning and public utility. The plan which Michaelis propoſes to us, in preference to all the other nations in Europe, is noble and magnificent, and would certainly confer immortality on thoſe men who would give it their patronage and aſſiſtance.

There are many ancient manuſcripts, eſpecially in Italy, which have never been collated, but lie ſtill unexplored. Here is a field where much remains to be done. See Marſh's Notes to Michaelis, vol. ii. p. 643.

Michaelis has given a catalogue of ancient manuſcripts, amounting in number to 292, to which he has added a ſhort account of each. In this place we ſhall confine our obſervations to the moſt celebrated, the Alexandrian and Vatican manuſcripts, which we have chiefly extracted from Michaelis.

131
Account of the Alexandrian manuſcript.

The *Alexandrian manuſcript* conſiſts of four volumes; the firſt three of which contain the Old Teſtament, the fourth the New Teſtament, together with the firſt Epiſtle of Clement to the Corinthians, and a fragment of the ſecond. In the New Teſtament, which alone is the object of our preſent inquiry, is wanting the beginning as far as Matthew xxv. 6. ὁ νυμφιος ερχεται; likewiſe from John vi. 50. to viii. 52. and from 2 Cor. iv. 13. to xii. 7. It muſt likewiſe be obſerved, that the Pſalms are preceded by the epiſtle of Athanaſius to Marcellinus, and followed by a catalogue, containing thoſe which are to be uſed in prayer for each hour, both of the day and of the night; alſo by 14 hymns, partly apocryphal, partly biblical, the 11th of which is an hymn in praiſe of the Virgin Mary, entitled προσευχη μαριας της θεοτοκȣ: further, the *Hypotheſes Euſebii* are annexed to the Pſalms, and his *Canones* to the Goſpels. It is true, that this has no immediate reference to the New Teſtament, but may have influence in determining the antiquity of the manuſcript itſelf.

It has neither accents nor marks of aſpiration; it is written with capital, or, as they are called, *uncial letters*, and has very few abbreviations. There are no intervals between the words; but the ſenſe of a paſſage is ſometimes terminated by a point, and ſometimes by a vacant ſpace. Here ariſes a ſuſpicion that the copyiſt did not underſtand Greek, becauſe theſe marks are ſometimes found even in the middle of a word, for inſtance Levit. v. 4. ανομος η for αν ομοση, and Numb. xiii. 29. μω Υσης.

This manuſcript was preſented to Charles I. in 1628, by Cyrillus Lucaris patriarch of Conſtantinople. Cyrillus himſelf has given the following account: "We know ſo much of this manuſcript of the holy writings of the Old and New Teſtament, that Thecla an Egyptian lady of diſtinction (*nobilis fæmina Ægyptia*) wrote it with her own hand 1300 years ago (A)." She lived ſoon after the council of Nice. Her name was formerly at the end of the book; but when Chriſtianity was ſubverted in Egypt by the errors of Mahomet, the books of the Chriſtians ſuffered the ſame fate, and the name of Thecla

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(A) He wrote this in the year 1628. According to this account, then, the manuſcript muſt have been written in 328; a date to which ſo many weighty objections may be made, that its moſt ſtrenuous advocates will hardly undertake to defend it. But this error has furniſhed Oudin with an opportunity of producing many arguments againſt the antiquity of the *Codex Alexandrinus*, which ſeem to imply, that Grabe and others, who have referred it to the fourth century, ſuppoſe it to have been written in the above-mentioned year. Now it is probable, that the inference which has been deduced from the account of Cyrillus is more than he himſelf intended to expreſs, as he relates that Thecla lived after the council of Nice.

Thecla was expunged. But oral tradition of no very ancient date (*memoria et traditio recens*) has preſerved the remembrance of it.

But the reader will ſee that this account is merely traditional. Dr Semler very properly obſerves, that there is no more reaſon to rely on a tradition reſpecting the tranſcriber of an ancient manuſcript, than on a tradition which relates to an ancient relic. The arguments which have been urged by Wetſtein, Semler, Oudin, and Woide, to fix the date of this manuſcript, are ſo many, that it would be tedious to repeat them. But, after all, its antiquity cannot be determined with certainty, though it appears from the formation of the letters, which reſemble thoſe of the fourth and fifth centuries, and the want of accents, that it was not written ſo late as the tenth century. In this century it was placed by Oudin, while Grabe and Schulze have referred it to the fourth, which is the very utmoſt period that can be allowed, becauſe it contains the epiſtles of Athanaſius. Wetſtein, with more probability, has choſen a mean between theſe two extremes, and referred it to the fifth century: but we are not juſtified in drawing this inference from the information of the letters alone, for it is well known that the ſame mode of forming the letters was retained longer in ſome countries and in ſome monaſteries than in others.

We are now in poſſeſſion of a perfect impreſſion of this manuſcript, which is accompanied with ſo complete and ſo critical a collection of various readings, as is hardly to be expected from the edition of any other manuſcript. Dr Woide publiſhed it in 1786, with types caſt for that purpoſe, line for line, without intervals between the words, as in the manuſcript itſelf: the copy is ſo perfect a reſemblance of the original, that it may ſupply its place. Its title is *Novum Teſtamentum Græcum è codice MS. Alexandrino qui Londini in Bibliotheca Muſei Britannici aſſervatur deſcriptum.* It is a very ſplendid folio; and the preface of the learned editor contains an accurate deſcription of the manuſcript, with an exact liſt of all its various readings, that takes up no leſs than 89 pages; and each reading is accompanied with a remark, in which is given an account of what his predeceſſors Juninus, Walton, Fell, Mill, Grabe, and Wetſtein, had performed or neglected.

132
Account of the Vatican manuſcript.

The *Vatican manuſcript* contained originally the whole Greek Bible, including both the Old and New Teſtament; and in this reſpect, as well as in regard to its antiquity, it reſembles none ſo much as the *Codex Alexandrinus*, but no two manuſcripts are more diſſimilar in their readings, in the New Teſtament as well as in the Old. After the Goſpels, which are placed in the uſual order, come the Acts of the Apoſtles, which are immediately followed by the ſeven catholic epiſtles. This muſt be particularly noted, becauſe ſome have contended that the ſecond Epiſtle of St Peter, with the ſecond and third of St John, were wanting. Profeſſor Hwiid, in a letter dated Rome, April 12. 1781, aſſured Michaelis that he had ſeen them with his own eyes, that the ſecond Epiſtle of St Peter is placed folio 1434, the ſecond of St John fol. 1442, the third fol. 1443: then follow the Epiſtles of St Paul, but not in the uſual order; for the Epiſtle to the Hebrews is placed immediately after thoſe to the Theſſalonians: and it is not improbable, that in the more ancient manuſcript, from which the *Codex Vaticanus* was copied, this Epiſtle was even placed before that to the Epheſians, and immediately after the Epiſtle to the Galatians (B); for the Epiſtles of St Paul are divided into 93 ſections by figures written in the margin with red ink; but the Epiſtle to the Galatians ends with 59, and that to the Epheſians begins with 70; the Epiſtle to the Hebrews, on the contrary, begins with 60, and ends with 69. With the words ἄμωμον τῷ Θεῷ, Heb. ix. 14. the manuſcript ceaſes, the remaining leaves being loſt. There is wanting, therefore, not only the latter part of this Epiſtle, but the Epiſtles to Timothy, Titus, and Philemon, with the Revelation of St John: but this laſt book, as well as the latter part of the Epiſtle to the Hebrews, has been ſupplied by a modern hand in the 15th century. In many places the faded letters have been alſo retouched by a modern, but careful hand; and when the perſon who made theſe amendments, who appears to have been a man of learning, found a reading in his own manuſcript which differed from that of the *Codex Vaticanus*, he has noted it in the margin, and has generally left the text itſelf untouched, though in ſome few examples he has ventured to eraſe it.

It is certain, that this manuſcript is of very high antiquity, though it has been diſputed which of the two in this reſpect is entitled to the preference, the *Vaticanus* or *Alexandrinus*. The editors of the Roman edition of the Septuagint, in 1587, referred the date of the Vatican manuſcript to the fourth century, the period to which the advocates for its great rival refer the *Codex Alexandrinus*. More moderate, and perhaps more accurate, are the ſentiments of that great judge of antiquity Montfaucon, who, in his *Bibliotheca Bibliothecarum*, p. 3. refers it to the fifth or ſixth century; and adds, that though he had ſeen other manuſcripts of equal antiquity, he had found none at the ſame time ſo complete.

The *Codex Vaticanus* has a great reſemblance to the manuſcripts noted by Wetſtein, C. D. L. 1. 13. 33. 69. 102. and to the Latin, Coptic, and Ethiopic verſions; but it is preferable to moſt of them, in being almoſt entirely free from thoſe undeniable interpolations and arbitrary corrections which are very frequently found in the above-mentioned manuſcripts, eſpecially in D. 1. and 69. It may be applied, therefore, as a mean not only of confirming their genuine readings, but of detecting and correcting thoſe that are ſpurious. It is written with great accuracy, and is evidently a faithful copy of the more ancient manuſcript from which it was tranſcribed. Peculiar readings, or ſuch as are found neither in other manuſcripts nor ancient verſions, are ſeldom diſcovered in the *Codex Vaticanus;* and of the few which have been actually found, the greateſt part are of little importance. But in proportion as the number of ſuch readings is ſmall, the number of thoſe is great; in ſupport of which few only, though ancient authorities,

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(B) Probably becauſe the Epiſtle to the Hebrews, as well as the Epiſtle to the Galatians, relates to the abolition of the Moſaic law.

authorities, have been hitherto produced: But this manuſcript has not throughout the whole New Teſtament the ſame uniform text.

As we have now a beautiful printed edition of the Alexandrian manuſcript by Dr Woide, it is much to be wiſhed that we had alſo an exact impreſſion of the Vatican manuſcript. From the ſuperſtitious fears and intolerant ſpirit of the inquiſition at Rome, all acceſs to this manuſcript was refuſed to the Abbé Spoletti, who preſented a memorial for that purpoſe. Unleſs the pope interpoſe his authority, we muſt therefore deſpair of having our wiſhes gratified; but from the liberality of ſentiment which the head of the Catholic church has ſhown on ſeveral occaſions, we hope that the period is not far diſtant when the Vatican library will be open to the learned, and when the pope will think it his greateſt honour to encourage their reſearches.

133 The beſt editions of the Greek New Teſtament are thoſe of Mill,

The moſt valuable editions of the Greek New Teſtament are thoſe of Mill, Bengel, and Wetſtein.

The edition of Mill, which was only finiſhed 14 days before his death, occupied the attention of the author for 30 years.

The collections of various readings which had been made before the time of Mill, the Veleſian, the Barberini, thoſe of Stephens, the London Polyglot, and Fell's edition, with thoſe which the biſhop had left in manuſcript, and whatever he was able to procure elſewhere, he brought together into one large collection. He made likewiſe very conſiderable additions to it. He collated ſeveral original editions more accurately than had been done before: he procured extracts from Greek manuſcripts which had never been collated; and of ſuch as had been before collated, but not with ſufficient attention, he obtained more complete extracts. It is ſaid that he has collected from manuſcripts, fathers, and verſions, not fewer than 30,000 various readings. This collection, notwithſtanding its many imperfections, and the ſuperiority of that of Wetſtein, is ſtill abſolutely neceſſary to every critic: for Wetſtein has omitted a great number of readings which are to be found in Mill, eſpecially thoſe which are either taken from the Vulgate, or confirm its readings. Mill was indeed too much attached to this verſion; yet he cannot be accuſed of partiality in producing its evidence, becauſe it is the duty of a critic to examine the witneſſes on both ſides of the queſtion: and Wetſtein, by too frequently neglecting the evidence in favour of the Vulgate, has rendered his collection leſs perfect than it would otherwiſe have been. He likewiſe added, as far as he was able, readings from the ancient verſions; and is much to be commended for the great attention which he paid to the quotations of the fathers; the importance of which he had ſagacity enough to diſcern.

It cannot, however, be denied, that Mill's Greek Teſtament has many imperfections, and ſome of real importance. His extracts from manuſcripts often are not only incomplete, but erroneous; and it is frequently neceſſary to correct his miſtakes from the edition of Wetſtein. His extracts from the oriental verſions are alſo imperfect, becauſe he was unacquainted with theſe languages; and in ſelecting readings from the Syriac, the Arabic, and Ethiopic, he was obliged to have recourſe to the Latin tranſlations, which are annexed to thoſe verſions in the London Polyglot.

The great diligence which Mill had ſhown in collecting ſo many various readings, alarmed the clergy as if the Chriſtian religion had been in danger of ſubverſion. It gave occaſion for a time to the triumphs of the deiſt, and expoſed the author to many attacks. But it is now univerſally known, that not a ſingle article of the Chriſtian religion would be altered though a deiſt were allowed to ſelect out of Mill's 30,000 readings whatever he ſhould think moſt inimical to the Chriſtian cauſe.

134 Bengel,

In 1734, Bengel abbot of Alpirſpach, in the duchy of Wurtemburg, publiſhed a new edition of the Greek Teſtament. The fears which Mill had excited began to ſubſide on this new publication; for Bengel was univerſally eſteemed a man of piety. Bengel was not only diligent in the examination of various readings, but in the ſtricteſt ſenſe of the word conſcientious; for he conſidered it as an offence againſt the Deity, if, through his own fault, that is, through levity or careleſſneſs, he introduced a falſe reading into the ſacred text. His object was not merely to make a collection of readings, and leave the choice of them to the judgement of the reader, but to examine the evidence on both ſides, and draw the inference; yet he has not given his own opinion ſo frequently as Mill, whom he reſembled in his reverence for the Latin verſion, and in the preference which he gave to harſh and difficult readings, before thoſe which were ſmooth and flowing. It may be obſerved in general, that he was a man of profound learning, and had a cool and ſound judgment, though it did not prevent him from thinking too highly of the Latin readings, and of the *Codex Alexandrinus*, with other Latinizing manuſcripts.

The imperfections of Bengel's edition ariſe chiefly from his diffidence and caution. He did not venture to inſert into the text any reading which had not already appeared in ſome printed edition, even though he believed it to be the genuine reading. In the book of Revelation indeed he took the liberty to inſert readings which had never been printed; becauſe few manuſcripts had been uſed in the printing of that book.

135 and of Wetſtein.

The celebrated edition of John James Wetſtein, which is the moſt important of all, and the moſt neceſſary to thoſe engaged in ſacred criticiſm, was publiſhed at Amſterdam in 1751 and 1752, in two volumes folio. No man will deny that Wetſtein's *Prolegomena* diſcover profound erudition, critical penetration, and an intimate acquaintance with the Greek manuſcripts. It is a work which in many reſpects has given a new turn to ſacred criticiſm, and no man engaged in that ſtudy can diſpenſe with it. Wherever Wetſtein has delivered his ſentiments reſpecting a Greek manuſcript, which he has done leſs frequently than Mill, and indeed leſs frequently than we could have wiſhed, he ſhows himſelf an experienced and ſagacious critic. He is likewiſe more conciſe than Mill in delivering his opinion, and does not ſupport it by producing ſo great a number of readings from the manuſcript in queſtion. This conciſeneſs is the conſequence of that warmth and haſte which were peculiar to Wetſtein's character, and which have ſometimes given birth to miſtakes. The fire of his diſpoſition was likewiſe the cauſe of his advancing conjectures, in regard to the hiſtory of his manuſcripts, which exceed the bounds of probability. But the critical

tical rules which he has delivered are perfectly juſt; and in this reſpect there is a remarkable agreement between him and his eminent predeceſſors Mill and Bengel. In regard to the Latin verſion alone they appear to differ: in Mill and Bengel it has powerful, and perhaps partial, advocates; but in Wetſtein a ſevere and ſagacious judge, who ſometimes condemns it without a cauſe. The Greek manuſcripts which confirm the readings of the Vulgate, and which he ſuppoſed had been corrupted from it, he of courſe condemned with equal ſeverity: and ſome collections of various readings which had been made by Catholics, he made no ſcruple to pronounce a forgery, ſaying, "*Timeo Danaos et dona ferentes.*" But in conſequence of his antipathy to the Vulgate, his collection of various readings is leſs perfect than it might have been.

It has been aſked, 1. Whether he has quoted his manuſcripts either falſely or imperfectly, in order to eſtabliſh his own religious opinions? or, 2. Whether his diligence and accuracy have been ſuch that we may at all times depend upon them? To the firſt of theſe queſtions there can be no other anſwer, than that Wetſtein, in his character of a critic, is perfectly honeſt. With reſpect to the ſecond, his diligence and accuracy, Michaelis thinks there is leſs reaſon to pronounce him faultleſs. But Mr Marſh has examined the examples on which Michaelis founds his aſſertion, and declares that Michaelis is miſtaken in every one of them.

The diligence of Wetſtein can ſcarcely be queſtioned by any who are acquainted with his hiſtory. He travelled into different countries, and examined with his own eyes a much greater number of manuſcripts than any of his predeceſſors. His collection of various reading amounts to *above a million;* and he has not only produced a much greater quantity of matter than his predeceſſors, but has likewiſe corrected their miſtakes. The extracts from manuſcripts, verſions, and printed editions of the Greek Teſtament, which had been quoted by Mill, are generally quoted by Wetſtein. Whenever Wetſtein had no new extracts from the manuſcripts quoted by Mill, or had no opportunity of examining them himſelf, he copied literally from Mill; but wherever Mill has quoted from printed editions, as from the margin of Robert Stephens's for inſtance, or from the London Polyglot, Wetſtein did not copy from Mill, but went to the original ſource, as appears from his having corrected many miſtakes in Mill's quotations.

In the opinion of Michaelis, there are many defects in the edition of Wetſtein, which require to be ſupplied, and many errors to be corrected. Yet ſtill it muſt be allowed to be a work of immenſe labour, and moſt valuable to thoſe engaged in ſacred criticiſm; and it is ſurpriſing, when we conſider the difficulties and labour which Wetſtein had to encounter, that his errors and imperfections are ſo few.

The propoſal of Michaelis, however, of a new collation of manuſcripts, in order to form a complete collection of various readings, is worthy the attention of the learned. In mentioning this propoſal, Michaelis turns a wiſhful eye towards Britain, the only country, he ſays, which poſſeſſes the will and the means to execute the taſk. Should a reſolution, he adds, be formed in this iſland, ſo happily ſituated for promoting the purpoſes of general knowledge, to make the undertaking a public concern, to enter into a ſubſcription, and to employ men of abilities in collating manuſcripts both at home and abroad, they would be able to do more in ten years than could otherwiſe be done in a century. And could this nation direct its attention to any object more glorious or more uſeful than in aſcertaining the text of the ſacred Scriptures, and giving to poſterity an accurate edition?

136
Punctuation of the New Teſtament.

As the ſenſe of Scripture, as well as all other books, is affected by the punctuation, it is of importance to determine whether the ſtops or points which we find in the ſacred books were uſed by the ſacred writers, or have been inſerted by modern tranſcribers.

We are told by Montfaucon, in his *Palæographia Græca*, p. 31. that the perſon who firſt diſtinguiſhed the ſeveral parts of a period in Greek writing, by the introduction of a point, was Ariſtophanes of Byzantium, who lived under Ptolemæus Epiphanes, in the 145th Olympiad. But though points were not uſed in books before this period, they were employed in inſcriptions above 400 years before the birth of Chriſt. See *Mont. Pal. Græc.* p. 135.

Under the article PUNCTUATION we mentioned, on authority which we reckoned unqueſtionable, that the ancient manuſcripts were written without any points. We have now, however, diſcovered, from Woide's edition of the *Codex Alexandrinus*, that points are uſed in that manuſcript, though omitted in the *fac ſimile* given by Montfaucon. That they are found too in the *Codex Vaticanus*, though not frequently, is related by Birch in his *Prolegomena*, p. 14.

As the fact has not been generally known, that the ancients pointed their manuſcripts, and as it is an important and intereſting fact, we ſhall preſent our readers with the firſt ſix lines of St John's Goſpel, as they are pointed in the Alexandrian manuſcript:

ΕΝΑΡΧΗΗΗΝΟΛΟΓΟΣΚΑΙΟΛΟΓΟΣΗΝ
ΠΡΟΣΤΟΝΘ̅Ν̅ ΚΑΙΘ̅Σ̅ΗΝΟΛΟΓΟΣ·
ΟΥΤΟΣΗΝΕΝΑΡΧΗΠΡΟΣΤΟΝΘ̅Ν̅
ΠΑΝΤΑΔΙΑΥΤΟΥΕΓΕΝΕΤΟ ΚΑΙΧΩ
ΡΕΙΣΑΥΤΟΥΕΓΕΝΕΤΟΟΥΔΕΕΝ·
ΟΓΕΓΟΝΕΝΕΝΑΥΤΩΖΩΗΗΝ·

Whether any points for marking the ſenſe were uſed by the apoſtles, cannot be determined; but the points now in uſe have been invented ſince.

In the fourth century, Jerome began to add the comma and colon to the Latin verſion; and they were then inſerted in many more ancient manuſcripts. In the fifth century, Euthalius a deacon of Alexandria divided the New Teſtament into lines. This diviſion was regulated by the ſenſe, ſo that each line ended where ſome pauſe was to be made in ſpeaking. And when a copyiſt was diſpoſed to contract his ſpace, and therefore crowded the lines into each other, he then placed a point where Euthalius had terminated the line. In the eighth century, the ſtroke was invented which we call a comma. In the Latin manuſcripts, Jerome's points were introduced by Paul Warnfried and Alcuin, at the command of Charlemagne. In the ninth century, the Greek note of interrogation (;) was firſt uſed. At the invention of printing the editors placed the points

points arbitrarily, probably without beſtowing the neceſſary attention; and Stephens, in particular, varied his points in every edition (D).

The meaning of many paſſages in the Scripture has been altered by falſe pointing. We ſhall produce one inſtance of this: Mat. v. 34. is commonly pointed in this manner, εγω δε λεγω υμιν, μη ομοσαι ολως· μητε εν τῳ ȣρανῳ, and conſequently tranſlated, "But I ſay unto you, ſwear not at all." But if, inſtead of the colon placed after ολως, we ſubſtitute a comma, the tranſlation will be, "But I ſay to you that you ought by no means to ſwear, either by heaven, for it is his throne, or by earth, for it is his footſtool." The command of Chriſt therefore applies particularly to the abuſe of oaths among the Phariſees, who on every trivial occaſion ſwore by the heaven, the earth, the temple, the head, &c. but it implies no prohibition to take an oath in the name of the Deity on ſolemn and important occaſions.

137 Diviſion into chapters.

The ancients divided the New Teſtament into two kinds of chapters, ſome longer and ſome ſhorter. This method appears to be more ancient than St Jerome, for he expunged a paſſage from the New Teſtament, which makes an entire chapter. The longer kind of chapters were called *breves*, the ſhorter *capitula*. St Matthew contained, according to Jerome, 68 breves; Mark contained 48; Luke 83; and John 18. All the evangeliſts together conſiſted of 217 breves and 1126 capitula. The inventor of our modern diviſion into chapters was Hugo de S. Caro, a French Dominican friar, who lived in the 13th century.

The ancients had two kinds of verſes, one of which they called ϛιχοι, and the other ῥηματα. The *remata* were lines which contained a certain number of letters, like our printed books, and therefore often broke off in the middle of a word. Joſephus's 20 books of Antiquities contained 60,000 of them, though in Ittiquis's edition there are only 40,000 broken lines.

Stichi were lines meaſured by the ſenſe: according to an ancient written liſt mentioned by Father Simin, there were in the New Teſtament 18,612 of theſe.

138 Diviſion into verſes.

The verſes into which the New Teſtament is now divided are more modern, and an imitation of the diviſion of the Old Teſtament. Robert Stephens, the firſt inventor, introduced them in his edition in the year 1551. He made this diviſion on a journey from Lyons to Paris; and, as his ſon Henry tells us in the preface to the Concordance of the New Teſtament, he made it *inter equitandum*. This phraſe probably means, that when he was weary of riding, he amuſed himſelf with this work at his inn.

139 Its diſadvantages.

This invention of the learned printer was ſoon introduced into all the editions of the New Teſtament; and it muſt be confeſſed, that in conſulting and quoting the Scriptures, and in framing concordances for them, a ſubdiviſion into minute parts is of the greateſt utility. But all the purpoſes of utility could ſurely have been gained, without adopting the haſty and indigeſted diviſion of Stephens, which often breaks the ſenſe in pieces, renders plain paſſages obſcure, and difficult paſſages unintelligible. To the injudicious diviſion of Stephens we may aſcribe a great part of the difficulties which attend the interpretation of the New Teſtament, and a great many of thoſe abſurd opinions which have diſgraced the ages of the Reformation. For as ſeparate verſes appear to the eyes of the learned, and to the minds of the unlearned, as ſo many detached ſentences, they have been ſuppoſed to contain complete ſenſe, and they have accordingly been explained without any regard to the context, and often in direct oppoſition to it. Were any modern hiſtory or continued diſcourſe divided into fragments with as little regard to the ſenſe, we ſhould ſoon find, that as many oppoſite meanings could be forced upon them as have been forced upon the books of the New Teſtament. The diviſion into verſes has been ſtill more injurious to the Epiſtles than to the Goſpels, for there is a cloſe connection between the different parts of the Epiſtles, which the verſes entirely diſſolve. It is therefore to be wiſhed that this diviſion into verſes were laid aſide. The Scriptures ought to be divided into paragraphs, according to the ſenſe; and the figures ought to be thrown into the margin. In this way, the figures will retain their utility without their diſadvantages. Dr Campbell, in his beautiful tranſlation of the Goſpels, has adopted this method with great judgment and ſucceſs; and he who will read that tranſlation, will perceive that this ſingle alteration renders the Goſpels much more intelligible, and, we may add, more entertaining (E).

140 Meaning of the word *Goſpel.*

The word ΕΥΑΓΓΕΛΙΟΝ ſignifies any joyful tidings, and

(D) The reader will perceive that the account of the origin of points is different from that given under PUNCTUATION. But the beſt authors differ upon this ſubject. We ſhall perhaps reconcile the difference, by ſuppoſing that points were invented at the time here mentioned, but were not in general uſe till the time mentioned under the article PUNCTUATION.

(E) We ſhall here ſubjoin, as a curioſity, what the anonymous author terms *the Old and New Teſtament diſſected*. It contains an enumeration of all the books, chapters, verſes, words, and letters, which occur in the Engliſh Bible and Apocrypha. It is ſaid to have occupied three years of the author's life, and is a ſingular inſtance of the trifling employments to which ſuperſtition has led mankind.

The OLD and NEW TESTAMENT diſſected.

Books in the Old	39	in the New	27	Total	66	Apocryph.	
Chapters	929		260		1189	Chapters	183
Verſes	23,214		7959		31,173	Verſes	6081
Words	592,439		181,253		773,692	Words	152,185
Letters	2,728,100		838,380		3,566,480		

and exactly correſponds to our Engliſh word GOSPEL. In the New Teſtament this term is confined to "The glad tidings of the coming of the Meſſiah." Thus, in Mat. xi. 5. our Lord ſays, "The poor have the Goſpel preached;" that is, The coming of the Meſſiah is preached to the poor. Hence the name of *Goſpel* was given to the hiſtories of Chriſt, in which the good news of the coming of the Meſſiah, with all its joyful circumſtances, are recorded.

141
Goſpel according to St Matthew.

That the Goſpel according to Matthew was compoſed, ſays Dr Campbell, by one born a Jew, familiarly acquainted with the opinions, ceremonies, and cuſtoms of his countrymen; that it was compoſed by one converſant in the ſacred writings, and habituated to their idiom; a man of plain ſenſe, but of little or no learning, except what he derived from the Scriptures of the Old Teſtament; and finally, that it was the production of a man who wrote from conviction, and had attended cloſely to the facts and ſpeeches which he related, but who in writing entertained not the moſt diſtant view of ſetting off himſelf—we have as ſtrong internal evidence as the nature of the thing will admit, and much ſtronger than that wherein the mind ninety-nine caſes out of a hundred acquieſces.

142
Its authenticity.

That the author of this hiſtory of our bleſſed Saviour was Matthew, appears from the teſtimony of the early Chriſtians. It is atteſted by Jerome, Auguſtin, Epiphanius, and Chryſoſtom, and in ſuch a manner as ſhews that they knew the fact to be uncontroverted, and judged it to be uncontrovertible. Origen, who flouriſhed in the former part of the 3d century, is alſo reſpectable authority. He is quoted by Euſebius in a chapter * wherein he ſpecially treats of Origen's account of the ſacred canon. "As I have learned (ſays Origen) *by tradition* concerning the four goſpels, which alone are received without diſpute by the whole church of God under heaven; the firſt was written by Matthew, once a publican, afterwards an apoſtle of Jeſus Chriſt, *who delivered it to the Jewiſh believers, compoſed in the Hebrew language.*" In another place he ſays, "Matthew writing for the Hebrews who expected him who was to deſcend from Abraham and David, ſays the lineage of Jeſus Chriſt, ſon of David, ſon of Abraham." It muſt be obſerved, that the Greek word παραδοσις does not exactly correſpond to the Engliſh word *tradition*, which ſignifies any thing delivered orally from age to age. Παραδοσις properly implies any thing tranſmitted from former ages, whether by oral or written teſtimony. In this acceptation we find it uſed in Scripture†: "Hold the traditions (τας παραδοσεις) which ye have been taught, *whether by word* or *our epiſtle.*" The next authority to which we ſhall have recourſe is that of Irenæus biſhop of Lyons, who had been a diſciple of Polycarp. He ſays in the only book of his extant, that "Matthew, among the Hebrews, wrote a goſpel in their own language, whilſt Peter and Paul were preaching the goſpel at Rome and founding the church there." *Euſeb. Hiſt. Eccl.* lib. v. cap. 8.

To the teſtimony of theſe writers it may be objected, that, except Irenæus, they all lived in the third and fourth centuries, and conſequently their evidence is of little importance. But there is ſuch unanimity in the teſtimony, that it muſt have been derived from ſome authentic ſource. And is it fair to queſtion the veracity of reſpectable men merely becauſe we knew not from what writings they received their information? Many books which were then extant are now loſt; and how do we know but theſe might have contained ſufficient evidence? Irenæus at leaſt had the beſt opportunities of information, having been well acquainted in his youth with Polycarp, the diſciple of John; no objection can therefore be made to his evidence. But we can quote an authority ſtill nearer the times of the apoſtles. Papias biſhop of Hierapolis, in Cæſarea, who flouriſhed about A. D. 116, affirms that Matthew wrote his goſpel in the Hebrew tongue, which every one interpreted as he was able §. Papias was the companion of Polycarp, and beſides muſt have been acquainted with many perſons who lived in the time of the apoſtles. The fact therefore is fully eſtabliſhed, that Matthew, the apoſtle of our Saviour, was the author of that goſpel which is placed firſt in our editions of the New Teſtament.

The next ſubject of inquiry reſpects the language in which

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* *Hiſt.* lib. vi. cap. 25.

† Theſſ. ii. 15.

§ *Euſeb. Hiſt. Eccl.* lib. iii. cap. 39.

The middle Chapter and the leaſt in the Bible is Pſalm 117.
The middle Verſe is the 8th of the 118th Pſalm.
The middle time is the 2d of Chronicles, 4th Chap. 16th Verſe.
The word *And* occurs in the Old Teſtament 35,543 times.
The ſame in the New Teſtament occurs 10,684 times.
The word *Jehovah* occurs 6855 times.

OLD TESTAMENT.

The middle Book is Proverbs.
The middle Chapter is Job 29th.
The middle Verſe is 2d Chron. 20th Chap. between 17th and 18th Verſes.
The leaſt Verſe is 1 Chron. 1ſt Chap. and 1ſt Verſe.

NEW TESTAMENT.

The middle Book is Theſſalonians 2d.
The middle Chapter is between the 13th and 14th Romans.
The middle Verſe is 17th Chap. Acts, 17th Verſe.
The leaſt Verſe is 11th Chap. John, Verſe 35.
The 21ſt Verſe of the 7th Chapter of Ezra has all the letters of the alphabet.
The 19th Chapter of 2d Kings and 37th of Iſaiah are alike.

143 Language in which it was written.

which it was written. This we are aſſured by Papias, by Irenæus, and Origen, was the Hebrew; but the truth of this fact has been diſputed by Eraſmus, Whitby, and others. Whitby urges the improbability that Providence would have ſuffered the original of this goſpel to be loſt, and nothing to remain but a tranſlation. This is an argument of no force againſt written teſtimony; indeed we are always in danger of drawing falſe concluſions when we argue from our own opinions of the conduct of Providence: *For His ways are not as our ways, nor His thoughts as our thoughts.* But though we are forced to acknowledge that the goſpel according to Matthew which we poſſeſs is a tranſlation, it is evidently a cloſe one; and the very circumſtance that it has ſuperſeded the original, is a clear proof that it was thought equally valuable by the ancient Chriſtians. It is neceſſary to remark, that the language in which the goſpel according to Matthew was originally compoſed, and which is called Hebrew by Papias, Irenæus, and Origen, is not the ſame with the Hebrew of the Old Teſtament: it was what Jerome very properly terms Syro-Chaldaic, having an affinity to both languages, but much more to the Chaldean than to the Syrian.

144 Date,

Lardner's Hiſt. of the Apoſtles.

The time when this goſpel was compoſed has not been preciſely aſcertained by the learned. Irenæus ſays that "Matthew publiſhed his goſpel when Peter and Paul were preaching at Rome." Now Paul arrived at Rome A. D. 60 or 61, and it is very probable ſuffered martyrdom in A. D. 65. This may be juſtly concluded from comparing the relation of Tacitus with that of Oroſius, a writer of the fifth century. Oroſius having given an account of Nero's perſecution of the Chriſtians, and of the death of the two apoſtles in it, adds, that it was followed by a peſtilence in the city, and other diſaſters. And Tacitus relates that a peſtilence prevailed in the city, and violent ſtorms took place in Italy, in the year of Chriſt 65. Matthew's goſpel was therefore written between the year 60 and 65.

145 and deſign of it.

Dr Campbell's Preface to Matthew's Goſpel.

That this hiſtory was primarily intended for the uſe of the Jews, we have, beſides hiſtorical evidence, very ſtrong preſumptions from the book itſelf. Every circumſtance is carefully pointed out which might conciliate the faith of that nation; every unneceſſary expreſſion is avoided, which might in any way ſerve to obſtruct it. To come to particulars, there was no ſentiment relating to the Meſſiah with which the Jews were more ſtrongly poſſeſſed, than that he muſt be of the race of Abraham, and of the family of David. Matthew, therefore, with great propriety, begins his narrative with the genealogy of Jeſus. That he ſhould be born at Bethlehem in Judea, is another circumſtance in which the learned among the Jews were univerſally agreed. His birth in that city, with ſome very memorable circumſtances that attended it, this hiſtorian has alſo taken the firſt opportunity to mention. Thoſe paſſages in the prophets, or other ſacred books, which either foretel any thing that ſhould happen to him, or admit an alluſive appellation, or were in that age generally underſtood to be applicable to events which reſpect the Meſſiah, are never paſſed over in ſilence by this Evangeliſt. The fulfilment of prophecy was always to the Jews, who were convinced of the inſpiration of their ſacred writings, ſtrong evidence. Accordingly none of the Evangeliſts has been more careful than Matthew, that nothing of this kind ſhould be overlooked.

146 Diſtinguiſhing character.

That which chiefly diſtinguiſhes Matthew's writings from thoſe of the other Evangeliſts, is the minute and diſtinct manner in which he has related many of our Lord's diſcourſes and moral inſtructions. Of theſe his ſermon on the mount, his charge to the apoſtles, his illuſtrations of the nature of his kingdom, and his prophecy on Mount Olivet, are examples. He has alſo wonderfully united ſimplicity and energy in relating the replies of his maſter to the cavils of his adverſaries. Being early called to the apoſtleſhip, he was an eye and ear witneſs of moſt of the things which he relates. And theſe are circumſtances which incline Dr Campbell to think that Matthew has approached as near the preciſe order of time in which the events happened as any of the Evangeliſts.

Concerning the life of the apoſtle Matthew we have nothing to add, as the principal circumſtances in his life have already been mentioned. See MATTHEW.

The Goſpel according to Matthew is cited ſeven times in the epiſtle of Barnabas, twice in the firſt epiſtle of Clemens Romanus to the Corinthians, eight times in the Shepherd of Hermas, ſix times in Polycarp's ſmall epiſtle to the Philippians, and ſeven times in the ſmaller epiſtles of Ignatius. Theſe citations may be ſeen at full length in *Jones's New and Full Method of ſettling the Canon*, with the parallel paſſages in the goſpel according to Matthew.

147 Goſpel according to St Mark.

148 Its authenticity,

Hiſt. Eccl. lib. iii. cap. 39.

That Mark was the author of the goſpel which bears his name, and that it was the ſecond in the order of time, is proved by the unanimous teſtimony of the ancient Chriſtians. Many authorities are therefore unneceſſary; we ſhall only mention thoſe of Papias and Irenæus. Euſebius has preſerved the following paſſage of Papias: "This is what was related by the elder that is, John, not the apoſtle, but a diſciple of Jeſus); Mark being Peter's interpreter wrote exactly whatever he remembered, not indeed in the order wherein things were ſpoken and done by the Lord; for he was not himſelf a hearer or follower of our Lord; but he afterwards, as I ſaid, followed Peter who gave inſtructions as ſuited the occaſions, but not as a regular hiſtory of our Lord's teaching. Mark, however, committed no miſtake in writing ſuch things as occurred to his memory: for of this one thing he was careful, to omit nothing which he had heard, and to inſert no falſehood into his narrative." Such is the teſtimony of Papias, which is the more to be regarded as he aſſigns his authority. He ſpake not from hearſay, but from the information which he had received from a moſt credible witneſs, John the elder, or preſbyter, a diſciple of Jeſus, and a companion of the apoſtles.

149 and date.

Adv. Har. lib. iii. cap. 1.

Irenæus, after telling us that Matthew publiſhed his goſpel whilſt Peter and Paul were preaching at Rome, adds: "After their departure (ἐξοδον), Mark alſo, the diſciple and interpreter of Peter, delivered to us in writing the things which had been preached by Peter." The Greek ἐξοδος, like the Engliſh word *departure*, may either denote death, which is a departure out of the world, or mean a departure out of the city. It is probably in the former of theſe ſenſes it is here uſed. Yet by the accounts given by ſome others, Mark's goſpel was publiſhed in Peter's lifetime, and had his approbation.

approbation. The goſpel of Mark is ſuppoſed to be but two years poſterior in date to that of Matthew. The preciſe year, however, cannot be determined with certainty; and it is a matter of no importance, ſince we have aſcertained the author and the time in which he lived.

Mark has generally been ſuppoſed to be the ſame perſon who is mentioned in the acts and ſome of Paul's epiſtles, who is called John, and was the nephew of Barnabas. But as this perſon was the attendant of Paul and Barnabas, and is nowhere in ſcripture ſaid to have accompanied Peter in his apoſtolical miſſion, which ancient writers inform us the author of the goſpel did, Dr Campbell has juſtly concluded that theſe were different perſons. The author of the goſpel is certainly meant by Peter when he ſays *Marcus my ſon ſaluteth you* *.

Preface to Mark.

150
Language in which it was written.

That Mark wrote his goſpel in Greek, is as evidently conformable to the teſtimony of antiquity, as that Matthew wrote his in Hebrew or Syro-Chaldaic. The cardinals Baronius and Bellarmine, anxious to exalt the language in which the vulgate was written, have maintained that this Evangeliſt publiſhed his work in Latin. The only appearance of teſtimony which has been produced in ſupport of this opinion is the inſcription ſubjoined to this goſpel in Syriac, and in ſome other oriental verſions. But theſe poſtſcripts are not the teſtimonies of the tranſlators: they proceed from the conjecture of ſome tranſcriber; but when written, or by whom, is equally unknown. Againſt poſitive teſtimony, therefore, they are entitled to no credit.

151
Deſign of it.

From the Hebraiſms in the ſtyle, we ſhould readily conclude that the author was by birth and education a Jew. There are alſo expreſſions which ſhow that he had lived for ſome time among the Latins, as κεντυριων, "centurion," and σπεκουλατωρ, "ſentinel;" words which do not occur in the other goſpels. There are other internal evidences that this goſpel was written beyond the confines of Judea. The firſt time the Jordan is mentioned, ποταμος, "river," is added to the name for explanation; for though no perſon in Judea needed to be informed that Jordan was a river, the caſe was different in diſtant countries. The word *Gehenna*, which is tranſlated *Hell* in the New Teſtament, originally ſignified the *Valley of Hinnom*, where infants had been ſacrificed by fire to Moloch, and where a continual fire was afterwards kept up to conſume the filth of Jeruſalem. As this word could not have been underſtood by a foreigner, the Evangeliſt adds, by way of explanation, πυρ το ασβεϛον, "the unquenchable fire." Inſtead of the word *Mammon*, he uſes the common term χρηματα, "riches." When he employs the oriental word *Corbon*, he ſubjoins the interpretation ὁ εϛι δωρον, that is, "a gift." Theſe peculiarities will corroborate the hiſtorical evidence that has been already mentioned, that Mark intended his goſpel for the uſe of the Gentiles.

Dr Campbell's Preface to Mark's Goſpel.

152
Mark not the abridger of Matthew,

It has been affirmed that this evangeliſt is the abridger of Matthew. It is true that Mark ſometimes copies the expreſſions uſed by Matthew; but he is not to be conſidered as a mere abridger, for he omits altogether ſeveral things related by Matthew, viz. our Lord's pedigree, his birth, the viſit of the Magians, Joſeph's flight into Egypt, and the cruelty of Herod. Dr Lardner has given a liſt of thirty-three paſſages, wherein circumſtances are related which are omitted by the other evangeliſts. There is one parable, and an account of two miracles peculiar to Mark. The parable or ſimilitude is mentioned in chap. iv. 26. One of theſe miracles was the curing of a deaf and dumb man, chap. vii. 31, 37. The other was the giving ſight to a blind man at Bethſaida, chap. viii. 22, 26. The ſtyle of Mark, inſtead of being more conciſe than that of Matthew, is more diffuſe. That he had read Matthew's goſpel cannot be doubted, but that he abridged it, is a miſtake.

153
but derived his information from Peter.

According to the teſtimony which has been already produced, Mark derived his information from the apoſtle Peter. It would be improper, therefore, not to remark, that this evangeliſt has omitted many things tending to Peter's honour, which are related in the other goſpels, and has given the moſt particular account of Peter's fall. This goſpel is ſeven times cited by Irenæus, and nine times by Tertullian.

154
Goſpel according to St Luke.

That the author of the goſpel which is the third in order was Luke, the companion of the apoſtle Paul, is evident from the teſtimonies of Irenæus, Clemens of Alexandria, Origen, Tertullian, and many ſucceeding writers. But it has been diſputed whether he was a Jew or a Gentile. That Luke was a Jew by birth, or at leaſt by religion, may be argued from his being a conſtant companion of Paul. If he had been an uncircumciſed Gentile, exceptions would have been made to him, eſpecially at Jeruſalem; but nothing of that kind appears. It is alſo rendered highly probable, from his mode of computing time by the Jewiſh feſtivals, and from his frequent uſe of the Hebrew idiom. It has been ſuppoſed that Luke was one of the 70 diſciples; but he does not pretend to have been a witneſs of our Lord's miracles and teaching; on the contrary, he tells us in his introduction, that he received his information from others.

155
Deſign of it.

The deſign of Luke in writing his goſpel was to ſuperſede ſome imperfect and inaccurate hiſtories of our Saviour, which had then been publiſhed. What theſe were, it is impoſſible now to determine, as they are not mentioned by any contemporary writer, and probably did not ſurvive the age in which they were compoſed.

156
From what ſource of information it was derived.

It has been ſuppoſed that Luke chiefly derived his information from the apoſtle Paul, whom he faithfully attended in his travels; but, from Luke's own words, we are led to conclude, that the principal ſource of his intelligence, as to the facts related in the goſpel, was from thoſe who had been eye and ear witneſſes of what our Lord both did and taught. Now Paul evidently was not of this number. It was from converſing with ſome of the twelve apoſtles or diſciples of our Lord, who heard his diſcourſes and ſaw his miracles, that he obtained his information.

As to the time when this goſpel was written, we have hardly any thing but conjecture to guide us. But as Origen, Euſebius, and Jerome, have ranged it after thoſe of Matthew and Mark, we have no reaſon to doubt but they were written in the ſame order.

157
Has ſupplied many omiſſions of the two former goſpels.

The goſpel by Luke has ſupplied us with many intereſting particulars which had been omitted both by Matthew and Mark. It has given a diſtinct narration of the circumſtances attending the birth of John the Baptiſt and the nativity of our Saviour. It has given an

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* 1 Pet. v. 13.

Dr Campbell's Preface to Luke's Gospel.

an account of ſeveral memorable incidents and cures which had been overlooked by the reſt; the converſion of Zaccheus the publican; the cure of the woman who had been bowed down for 18 years; the cure of the dropſical man; the cleanſing of the ten lepers; the inhoſpitable treatment of our Saviour by the Samaritans, and the inſtructive rebuke which he gave on that occaſion to two of his diſciples for their intemperate zeal; alſo the affecting interview which he had after his reſurrection with two of his diſciples. Luke has alſo added many edifying parables to thoſe which the other evangeliſts had recorded. Moſt of theſe are ſpecified by Irenæus as particularly belonging to this goſpel, and has thereby ſhown to us, without intending it, that the goſpel of Luke was the ſame in his time that it is at preſent.

158
Style and compoſition of it.

The ſtyle of this evangeliſt abounds as much with Hebraiſms as any of the ſacred writings, but it contains more of the Grecian idiom than any of them. It is alſo diſtinguiſhed by greater variety and copiouſneſs; qualities which may be juſtly aſcribed to the ſuperior learning of the author. His occupation as a phyſician would naturally induce him to employ ſome time in reading, and give him eaſier acceſs to the company of the great than any of the other evangeliſts. As an inſtance of Luke's copiouſneſs, Dr Campbell has remarked that each of the evangeliſts has a number of words which are uſed by none of the reſt; but in Luke's goſpel the number of ſuch peculiarities or words, uſed in none of the other goſpels, is greater than that of the peculiar words found in all the three other goſpels put together; and that the terms peculiar to Luke are for the moſt part long and compound words. The ſame judicious writer has alſo obſerved, that there is more of compoſition in Luke's ſentences than is found in the other three, and conſequently leſs ſimplicity. Of this the very firſt ſentence is an example, which occupies no leſs than four verſes. Luke, too, has a greater reſemblance to other hiſtorians, in giving what may be called his own verdict in the narrative part of this work; a freedom which the other evangeliſts have ſeldom or never ventured to uſe. He calls the Phariſees *lovers of money*; in diſtinguiſhing Judas Iſcariot from the other Judas, he uſes the phraſe, *he who proved a traitor*, (ος και εγενετο προδοτης). Matthew and Mark expreſs the ſame ſentiment in milder language, "he who delivered him up." In recording the moral inſtructions of our Lord, eſpecially his parables, this evangeliſt has united an affecting ſweetneſs of manner with genuine ſimplicity.

Chap. xvi. 14.

159
Cited by ancient Chriſtian authors.

This goſpel is frequently cited by Clemens Romanus, the contemporary of the Apoſtles, by Ignatius, and Juſtin Martyr. Irenæus has made above a hundred citations from it. In his lib. iii. *adv. Hæreſ.* c. 14. he vindicates the authority and perfection of Luke's goſpel, and has produced a collection of thoſe facts which are only recorded by this evangeliſt.

160
Goſpel according to John.

That the goſpel which is placed laſt in our editions of the New Teſtament was written by John, one of our Saviour's apoſtles, is confirmed by the unanimous teſtimony of the ancient Chriſtians. He was the ſon of Zebedee, a fiſherman of Bethſaida in Galilee, by his wife Salome, and the brother of James, ſurnamed the elder or greater. He was the beloved diſciple of our Saviour, and was honoured, along with Peter and James, with many marks of diſtinction which were not conferred on the other diſciples. He poſſeſſed a high degree of intrepidity and zeal, a warm and affectionate heart, and was ſtrongly attached to his maſter. His brother James and he were honoured with the title of Boanerges, or *Sons of Thunder*. He was anxious to reſtrain whatever he conſidered as a mark of diſreſpect againſt his maſter, and to puniſh his enemies with ſeverity. He was incenſed againſt ſome perſons for attempting to caſt out demons in the name of Jeſus; and required them to deſiſt becauſe they were not his diſciples. James and he propoſed to our Saviour to call down fire from heaven to puniſh the inhoſpitable Samaritans. Nor was the courage of John leſs ardent than his zeal. When Peter had diſowned his Lord, and all the other diſciples had fled, John continued to attend his maſter. He was preſent at his trial, and followed him to the croſs, where he was a ſpectator of his ſufferings and death. The interview between Jeſus and this diſciple at Calvary, though conciſely related, is an event which will ſtrongly affect every man of feeling, while it convinces him of the unalterable affection of Jeſus to his beloved diſciple, as well as diſcovers his reſpectful tenderneſs for his mother. See JOHN.

161
Motives for writing it.

The ancients inform us, that there were two motives which induced John to write his goſpel: the one, that he might refute the hereſies of Cerinthus and the Nicolaitans, who had attempted to corrupt the Chriſtian doctrine; the other motive was, that he might ſupply thoſe important events in the life of our Saviour which the other evangeliſts had omitted. Of the former of theſe motives Irenæus gives us the following account: "John, deſirous to extirpate the errors ſown in the minds of men by Cerinthus, and ſome time before by thoſe called Nicolaitans, publiſhed his goſpel; wherein he acquaints us that there is one God, who made all things by his word, and not, as they ſay, one who is the Creator of the world, and another who is the father of the Lord; one the ſon of the Creator, and another the Chriſt, from the ſuperceleſtial abodes who deſcended upon Jeſus, the ſon of the Creator, but remained impaſſible, and afterwards fled back into his own pleroma or fulneſs." As Irenæus is the moſt ancient author who has written upon this ſubject, many appeals have been made to his authority. The authority of Irenæus is certainly reſpectable, and we have often referred to his teſtimony with confidence; but we think it neceſſary to make a diſtinction between receiving his teſtimony to a matter of fact, and implicitly adopting his opinion. He does not tell us, that he derived his information from any preceding writer, or indeed from any perſon at all. Nay, he ſeems to have believed that John wrote againſt theſe hereſies by a prophetic ſpirit; for he ſays in another place, chap. xx. 30. "As John the diſciple of our Lord aſſures us, ſaying, But theſe are written, that ye might believe that Jeſus is the Chriſt, the Son of God, and that believing ye might have life through his name; *FORESEEING theſe blaſphemous notions that divide the Lord, ſo far as it is in their power.*"

162
Not to confute heretics.

Indeed it ſeems very improbable that an apoſtle ſhould write a hiſtory of our Lord on purpoſe to confute the wild opinions of Cerinthus or any other heretic. Had John conſidered ſuch a confutation neceſſary, it is more likely that he would have introduced it

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into an epiſtle than blended it with the actions of his venerable Maſter. But were the opinion of Irenæus well-founded, we ſhould ſurely diſcover ſome traces of it in the goſpel of John; yet except in the introduction, there is nothing that can with the leaſt ſhadow of probability be applied to the opinions of Cerinthus; and few, we preſume, will affirm, that the goſpel of John was compoſed merely for the ſake of the firſt eighteen verſes.

163 But to prove that Jeſus was the Meſſiah the Son of God.

The intention of John in writing his goſpel was far more extenſive and important than to refute the opinions of a few men who were to ſink into oblivion in the courſe of a few centuries. It was evidently (according to the opinion of Clemens of Alexandria) to ſupply the omiſſions of the other evangeliſts: It was to exhibit the evidences of the Chriſtian religion in a diſtinct and perſpicuous manner: It was, as he himſelf in the concluſion of his goſpel aſſures us, to convince his readers, *that Jeſus is the Meſſiah, the Son of God, and that believing they might have life through his name* *. Now it will appear to any perſon who reads this goſpel with attention, that he has executed his plan with aſtoniſhing ability, and has given the moſt circumſtantial and ſatisfactory evidence that Jeſus was the Meſſiah the Son of God. After declaring the pre-exiſtence of Jeſus, he proceeds to deliver the teſtimony of John the Baptiſt, and ſelects ſome of the greateſt miracles of Jeſus, to prove his divine miſſion. In the fifth chapter he preſents us with a diſcourſe which our Saviour delivered in the temple in the preſence of the Jews, wherein he ſtates in a very diſtinct manner the proofs of his miſſion from, 1. The teſtimony of John; 2. His own miracles; 3. The declaration of the Father at his baptiſm; 4. The Jewiſh Scriptures. Indeed the concluſion that Jeſus was the Meſſiah the Son of God, naturally ariſes from almoſt every miracle which our Saviour is ſaid to have performed, and from every diſcourſe that he delivered. This declaration is very often made by our Saviour himſelf; particularly to the woman of Samaria, to Nicodemus, and to the blind man whom he had cured.

* John xv. 31.

164 Is a ſupplement to the other three goſpels.

It muſt be evident to every reader, that John ſtudiouſly paſſes over thoſe paſſages in our Lord's hiſtory and teaching which had been treated at large by the other evangeliſts, or, if he mentions them at all, he mentions them ſlightly. This confirms the teſtimony of ancient writers, that the firſt three goſpels were written and publiſhed before John compoſed his goſpel. Except the relation of our Saviour's trial, death, and reſurrection, almoſt every thing which occurs in this book is new. The account of our Saviour's nativity, of his baptiſm, and of his temptation in the wilderneſs, is omitted; nor is any notice taken of the calling of the twelve apoſtles, or of their miſſion during our Saviour's life. It is remarkable, too, that not one parable is mentioned, nor any of the predictions relating to the deſtruction of Jeruſalem. All the miracles recorded by the other evangeliſts are paſſed over, except the miraculous ſupply of proviſion, by which five thouſand were fed: and it is probable that this miracle was related for the ſake of the diſcourſe to which it gave birth. The other miracles which are mentioned are few in number, but in general they are minutely detailed. They conſiſt of theſe: the turning of water into wine at Cana; the cure of the diſeaſed man at the pool of Betheſda; the cure of the man that had been blind from his birth; the reſtoring of Lazarus to life; and the healing of the ſervant's ear which Peter had cut off. But valuable would this goſpel be, though it had only recorded the conſolation of Jeſus to his diſciples previous to his departure; which exhibits a moſt admirable view of our Saviour's character, of his care and tender regard for his diſciples. Having opened every ſource of comfort to their deſponding minds; exhorted them to mutual love, and to the obedience of his Father's precepts; having warned them of the impending dangers and ſorrows—our Saviour concludes with a prayer, in the true ſpirit of piety and benevolence; ardent without enthuſiaſm, ſober and rational without lukewarmneſs.

Dr Campbell's Preface to John's Goſpel.

165 Time at which it was written.

The time in which this goſpel was written has not been fixed with any preciſion. Irenæus informs us, that it was written at Epheſus, but leaves us to conjecture whether it was written before or after John's return from Patmos. He was baniſhed to Patmos by Domitian, who reigned 15 years, and according to the beſt computation died A. D. 96. The perſecution which occaſioned the exile of John commenced in the 14th year of Domitian's reign. If John wrote his goſpel after his return to Epheſus, which is affirmed by Epiphanius to have been the caſe, we may fix the date of it about the year 97 (F).

166 Style of it.

This goſpel is evidently the production of an illiterate Jew, and its ſtyle is remarkable for ſimplicity. It abounds more with Hebraiſms than any of the other goſpels; and contains ſome ſtrong oriental figures which are not readily underſtood by an European.

167 Often quoted by ancient Chriſtians.

This goſpel is cited once by Clemens Romanus, by Barnabas three times, by Ignatius five times, by Juſtin Martyr ſix times, by Irenæus, and above forty times by Clemens Alexandrinus.

168 Acts of the apoſtles.

The book which we intitle the Acts of the Apoſtles connects the goſpels and the epiſtles. It is evidently a continuation of Luke's goſpel, which appears both from the introduction and from the atteſtations of ancient Chriſtians. Both are dedicated to Theophilus; and in the beginning of the Acts a reference is made to his goſpel, which he calls *a former treatiſe*, recording the actions and diſcourſes of Jeſus till his aſcenſion to heaven. Luke is mentioned as the author of the Acts of the Apoſtles by Irenæus, by Tertullian, by Origen, and Euſebius.

From the frequent uſe of the firſt perſon plural, it is manifeſt that Luke the author was preſent at many of the

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(F) It has been argued from a paſſage in this goſpel, that it muſt have been written before the deſtruction of Jeruſalem. In ſpeaking of the pool of Betheſda, John uſes the preſent tenſe: His words are, "There *is* at Jeruſalem." Now if theſe words had been written after the deſtruction of Jeruſalem, it is urged the paſt tenſe would have been uſed, and not the preſent. This argument is more ſpecious than forcible. Though Jeruſalem was demoliſhed, does it follow that the pool of Betheſdawas dried up?

the tranſactions which he relates. He appears to have accompanied Paul from Troas to Philippi. He attended him alſo to Jeruſalem, and afterwards to Rome, where he remained for two years. He is mentioned by Paul in ſeveral of thoſe epiſtles which were written from Rome, particularly in the 2d epiſtle to Timothy, and in the epiſtle to Philemon.

This book contains the hiſtory of the Chriſtian church for the ſpace of about 28 or 30 years, from the time of our Saviour's aſcenſion to Paul's arrival at Rome in the year 60 or 61. As it informs us that Paul reſided two years in Rome, it muſt have been written after the year 63; and as the death of Paul is not mentioned, it is probable it was compoſed before that event, which happened A. D. 65.

169
Contents of that book.

The Acts of the Apoſtles may be divided into ſeven parts. 1. The account of our Saviour's aſcenſion, and of the occurrences which happened on the firſt Pentecoſt after that event, contained in chap. i. ii. 2. The tranſactions of the Chriſtians of the circumciſion at Jeruſalem, in Judea, and Samaria, chap. iii.—ix. xi. 1—21. xii. 3. Tranſactions in Cæſarea, and the admiſſion of the Gentiles, chap. x. 4. The firſt circuit of Barnabas and Paul among the Gentiles, chap. xi. 22. xiii. xiv. 5. Embaſſy to Jeruſalem, and the firſt council held in that city, chap. xv. 6. Paul's ſecond journey, chap. xvi.—xxi. 7. His arreſtment, trial, appeal to Cæſar, and journey to Rome, chap. xxi. to the end of the book.

170
Often cited by the early Chriſtians.

The Acts of Apoſtles are cited by Clemens Romanus, by Polycarp, by Juſtin Martyr, thirty times by Irenæus, and ſeven times by Clemens Alexandrinus.

171
The epiſtles.

All the eſſential doctrines and precepts of the Chriſtian religion were certainly taught by our Saviour himſelf, and are contained in the goſpels. The epiſtles may be conſidered as commentaries on the doctrines of the goſpel, addreſſed to particular ſocieties, accommodated to their reſpective ſituations; intended to refute the errors and falſe notions which prevailed among them, and to inculcate thoſe virtues in which they were moſt deficient.

172
General plan of them.

The plan on which theſe LETTERS are written is, firſt, to decide the controverſy, or refute the erroneous notions which had ariſen in the ſociety to which the epiſtle was addreſſed: And, ſecondly, to recommend thoſe duties which their falſe doctrines might induce them to neglect; at the ſame time inculcating in general exhortations the moſt important precepts of Chriſtian morality.

173
Arranged in chronological order.

Of the epiſtles fourteen were written by St Paul. Theſe are not placed according to the order of time in which they were compoſed, but according to the ſuppoſed precedence of the ſocieties or perſons to whom they were addreſſed. It will be proper, therefore, to exhibit here their chronological order according to Dr Lardner.

A TABLE *of St* PAUL'S EPISTLES, *with the Places where, and times when, written, according to Dr Lardner.*

Epiſtles	Places.		A. D.
1 Theſſalonians	Corinth		52
2 Theſſalonians	Corinth		52
Galatians	Corinth or Epheſus	near the end of or beginning of	52 53
1 Corinthians	Epheſus	the beginning of	53
1 Timothy	Macedonia		56
Titus	Macedonia or near it	bef. the end of	56
2 Corinthians	Macedonia	about October	57
Romans	Corinth	about February	58
Epheſians	Rome	about April	61
2 Timothy	Rome	about May	61
Philippians	Rome	bef. the end of	62
Coloſſians	Rome	bef. the end of	62
Philemon	Rome	bef. the end of	62
Hebrews	Rome or Italy	in Spring of	63

A TABLE *of the* CATHOLIC EPISTLES, *and the* REVELATION, *according to Dr Lardner.*

Epiſtle.	Place.		A. D.
James	Judea	or beg. of	61 62
The two epiſtles of Peter	Rome		64
1 John	Epheſus	about	80
2d and 3d of John	Epheſus	between and	80 90
Jude	Unknown		64 or 65
Revelation	Patmos or Epheſus		95 or 96

174
Cauſes of their obſcurity.

It is more difficult to underſtand the epiſtolary writings than the goſpels; the cauſe of which is evident. Many things are omitted in a letter, or ſlightly mentioned, becauſe ſuppoſed to be known by the perſon to whom it is addreſſed. To a ſtranger this will create much difficulty. The buſineſs about which St Paul wrote was certainly well known to his correſpondents; but at this diſtance of time we can obtain no information concerning the occaſion of his writing, of the character and circumſtances of thoſe perſons for whom his letters were intended, except what can be gleaned from the writings themſelves. It is no wonder, therefore, though many alluſions ſhould be obſcure. Beſides, it is evident from many paſſages that he anſwers letters and queſtions which his correſpondents had ſent him. If theſe had been preſerved, they would have thrown more light upon many things than all the notes and conjectures of the commentators.

175
Cauſes of obſcurity peculiar to St Paul's epiſtles.

The cauſes of obſcurity which have been now mentioned are common to all the writers of the epiſtles; but there are ſome peculiar to St Paul. 1. As he had an acute and fertile mind, he ſeems to have written with great rapidity, and without attending much to the common rules of method and arrangement. To this cauſe we may aſcribe his numerous and long parentheſes. In the heat of argument he ſometimes breaks off abruptly to follow out ſome new thought; and when he has exhauſted it, he returns from his digreſſion without informing his readers; ſo that it requires great attention to retain the connection. 2. His frequent change of perſon, too, creates ambiguity: by the pronoun *I* he ſometimes means himſelf; ſometimes any Chriſtian; ſometimes a Jew, and ſometimes any man. In uſing the pronoun WE he ſometimes intends himſelf; ſometimes comprehends his companions; ſometimes the apoſ-

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tles; at one time he alludes to the converted Jews, at another time to the converted Gentiles. 3. There is a third cauſe of obſcurity; he frequently propoſes objections, and anſwers them without giving any formal intimation. There are other difficulties which ariſe from our uncertainty who are the perſons he is addreſſing, and what are the particular opinions and practices to which he refers. To theſe we may add two external cauſes, which have increaſed the difficulty of underſtanding the epiſtles. 1. The dividing them into chapters and verſes, which diſſolves the connection of the parts, and breaks them into fragments. If Cicero's epiſtles had been ſo disjointed, the reading of them would be attended with leſs pleaſure and advantage, and with a great deal more labour. 2. We are accuſtomed to the phraſeology of the epiſtles from our infancy; but we have either no idea at all when we uſe it, or our idea of it is derived from the articles or ſyſtem which we have eſpouſed. But as different ſects have arbitrary definitions for St Paul's phraſes, we ſhall never by following them diſcover the meaning of St Paul, who certainly did not adjuſt his phraſeology to any man's ſyſtem.

The beſt plan of ſtudying the epiſtles is that which was propoſed and executed by Mr Locke. This we ſhall preſent to our readers in the words of that acute and judicious author.

176
Mr Locke's plan of ſtudying the epiſtles.

“After I had found by long experience, that the reading of the text and comments in the ordinary way proved not ſo ſucceſsful as I wiſhed to the end propoſed, I began to ſuſpect that in reading a chapter as was uſual, and thereupon ſometimes conſulting expoſitors upon ſome hard places of it, which at that time moſt affected me, as relating to points then under conſideration in my own mind, or in debate againſt others, was not a right method to get into the true ſenſe of theſe epiſtles, I ſaw plainly, after I began once to reflect on it, that if any one ſhould write me a letter as long as St Paul's to the Romans, concerning ſuch a matter as that is, in a ſtyle as foreign, and expreſſions as dubious as his ſeem to be, if I ſhould divide it into fifteen or ſixteen chapters, and read one of them to-day, and another to-morrow, &c. it is ten to one I ſhould never come to a full and clear comprehenſion of it. The way to underſtand the mind of him that writ it, every one would agree, was to read the whole letter through from one end to the other all at once, to ſee what was the main ſubject and tendency of it: or if it had ſeveral views and purpoſes in it, not dependent one of another, nor in a ſubordination to one chief aim and end, to diſcover what thoſe different matters were, and where the author concluded one, and began another; and if there were any neceſſity of dividing the epiſtle into parts, to make the boundaries of them.

“In the proſecution of this thought, I concluded it neceſſary, for the underſtanding of any one of St Paul's epiſtles, to read it all through at one ſitting, and to obſerve as well as I could the drift and deſign of his writing it. If the firſt reading gave me ſome light, the ſecond gave me more; and ſo I perſiſted in reading conſtantly the whole epiſtle over at once till I came to have a good general view of the apoſtle's main purpoſe in writing the epiſtle, the chief branches of his diſcourſe wherein he proſecuted it, the arguments he uſed, and the diſpoſition of the whole.

“This, I confeſs, is not to be obtained by one or two haſty readings; it muſt be repeated again and again with a cloſe attention to the tenor of the diſcourſe, and a perfect neglect of the diviſions into chapters and verſes. On the contrary, the ſafeſt way is to ſuppoſe that the epiſtle has but one buſineſs and one aim, till by a frequent peruſal of it you are forced to ſee there are diſtinct independent matters in it, which will forwardly enough ſhow themſelves.

“It requires ſo much more pains, judgment, and application, to find the coherence of obſcure and abſtruſe writings, and makes them ſo much the more unfit to ſerve prejudice and preoccupation when found; that it is not to be wondered that St Paul's epiſtles have with many paſſed rather for disjointed, looſe, pious diſcourſes, full of warmth and zeal, and overflows of light, rather than for calm, ſtrong, coherent reaſonings, that carried a thread of argument and conſiſtency all through them.”

Mr Locke tells us he continued to read the ſame epiſtle over and over again till he diſcovered the ſcope of the whole, and the different ſteps and arguments by which the writer accompliſhes his purpoſe. For he was convinced before reading his epiſtles, that Paul was a man of learning, of ſound ſenſe, and knew all the doctrines of the goſpel by revelation. The ſpeeches recorded in the Acts of the Apoſtles convinced this judicious critic that Paul was a cloſe and accurate reaſoner: and therefore he concluded that his epiſtles would not be written in a looſe, confuſed, incoherent ſtyle. Mr Locke accordingly followed the chain of the apoſtle's diſcourſe, obſerved his inferences, and carefully examined from what premiſes they were drawn, till he obtained a general outline of any particular epiſtle. If every divine would follow this method, he would ſoon acquire ſuch a knowledge of Paul's ſtyle and manner, that he would peruſe his other Epiſtles with much greater eaſe.

177
Epiſtle to the Romans.

178
Its date.

That the Epiſtle to the Romans was written at Corinth by St Paul, is aſcertained by the teſtimony of the ancient Chriſtians. It was compoſed in the year 58, in the 24th year after Paul's converſion, and is the ſeventh epiſtle which he wrote. From the Acts of the Apoſtles we learn that it muſt have been written within the ſpace of three months; for that was the whole period of Paul's reſidence in Greece, (Acts xx. 1, 2, 3.).

The following analyſis of this epiſtle we have taken from a valuable little treatiſe, intitled A Key to the New Teſtament, which was written by Dr Percy biſhop of Dromore. It exhibits the intention of the apoſtle, and the arguments which he uſes to prove his different propoſitions, in the moſt conciſe, diſtinct, and connected manner, and affords the beſt view of this Epiſtle that we have ever ſeen.

179
General deſign

“The Chriſtian church at Rome appears not to have been planted by any apoſtle; wherefore St Paul, leſt it ſhould be corrupted by the Jews, who then ſwarmed in Rome, and of whom many were converted to Chriſtianity, ſends them an abſtract of the principal truths of the goſpel, and endeavours to guard them againſt thoſe erroneous notions which the Jews had of juſtification, and of the election of their own nation.

“Now the Jews aſſigned three grounds for juſtification. Firſt, ‘The extraordinary piety and merits of their anceſtors, and the covenant made by God with theſe holy men.’ They thought God could not hate the children

dren of ſuch meritorious parents; and as he had made a covenant with the patriarchs to bleſs their poſterity, he was obliged thereby to pardon their ſins.' Secondly, 'A perfect knowledge and diligent ſtudy of the law of Moſes.' They made this a plea for the remiſſion of all their ſins and vices. Thirdly, 'The works of the Levitical law,' which were to expiate ſin, eſpecially circumciſion and ſacrifices. Hence they inferred that the Gentiles muſt receive the whole law of Moſes, in order to be juſtified and ſaved.

“ The doctrine of the Jews concerning election was, 'That as God had promiſed to Abraham to bleſs his ſeed, to give him not only ſpiritual bleſſings, but alſo the land of Canaan, to ſuffer him to dwell there in proſperity, and to conſider him as his church upon earth:' That therefore this bleſſing extended to their whole nation, and that God was bound to fulfil theſe promiſes to them, whether they were righteous or wicked, faithful or unbelieving. They even believed that a prophet ought not to pronounce againſt their nation the prophecies with which he was inſpired; but was rather to beg of God to expunge his name out of the book of the living.

“ Theſe previous remarks will ſerve as a key to unlock this difficult Epiſtle, of which we ſhall now give a ſhort analyſis. See *Michaelis's Lectures on the New Teſtament*.

180 and analyſis of it.

“ I. The Epiſtle begins with the uſual ſalutation with which the Greeks began their letters, (chap. i. 1—7.).

“ II. St Paul profeſſes his joy at the flouriſhing ſtate of the church at Rome, and his deſire to come and preach the goſpel (ver. 8—19.): then he inſenſibly introduces the capital point he intended to prove, viz.

“ III. The ſubject of the goſpel (ver. 16, 17.), that it reveals a righteouſneſs unknown before, which is derived ſolely from faith, and to which Jews and Gentiles have an equal claim.

“ IV. In order to prove this, he ſhows (chap. i. 18—iii. 20.) that both Jews and Gentiles are 'under ſin,' i. e. that God will impute their ſins to Jews as well as to Gentiles.

“ His arguments may be reduced to theſe ſyllogiſms (chap. ii. 17—24.). 1. 'The wrath of God is revealed againſt thoſe who hold the truth in unrighteouſneſs; i. e. who acknowledge the truth, and yet ſin againſt it.' 2. The Gentiles acknowledged truths; but, partly by their idolatry, and partly by their other deteſtable vices, they ſinned againſt the truth they acknowledged. 3. Therefore the wrath of God is revealed againſt the Gentiles, and puniſheth them. 4. The Jews have acknowledged more truths than the Gentiles, and yet they ſin. 5. Conſequently the Jewiſh ſinners are yet more expoſed to the wrath of God (ch. ii. 1—12.). Having thus proved his point, he anſwers certain objections to it. *Obj.* 1. 'The Jews were well grounded in their knowledge, and ſtudied the law.' He anſwers, If the knowledge of the law, without obſerving it, could juſtify them, then God could not have condemned the Gentiles, who knew the law by nature (ch. ii. 13—16.). *Obj.* 2. 'The Jews were circumciſed.' *Anſ.* That is, ye are admitted by an outward ſign into the covenant with God. This ſign will not avail you when ye violate that covenant (ch. ii. 25. to the end). *Obj.* 3. 'According to this doctrine of St Paul, the Jews have no advantage before others.' *Anſ.* Yes, they ſtill have advantages; for unto them are committed the oracles of God. But their privileges do not extend to this, that God ſhould overlook their ſins, which, on the contrary, Scripture condemns even in the Jews (ch. iii. 1—19.). *Obj.* 4. 'They had the Levitical law and ſacrifices.' *Anſ.* From hence is no remiſſion, but only the knowledge of ſin, (ch. iii. 20.).

“ V. From all this St Paul concludes, that Jews and Gentiles may be juſtified by the ſame means, namely, without the Levitical law, through faith in Chriſt: And in oppoſition to the imaginary advantages of the Jews, he ſtates the declaration of Zechariah, that God is the God of the Gentiles as well as of the Jews, (ch. iii. 21. to the end.

“ VI. As the whole bleſſing was promiſed to the faithful deſcendants of Abraham, which both Scripture and the Jews call his children, he proves his former aſſertion from the example of Abraham; who was an idolater before his call, but was declared juſt by God, on account of his faith, long before the circumciſion. Hence he takes occaſion to explain the nature and fruits of faith, (ch. iv. 1. v. 11.).

“ VII. He goes on to prove from God's juſtice, that the Jews had no advantages over the Gentiles with reſpect to juſtification. Both Jews and Gentiles had forfeited life and immortality, by the means of one common father of their race, whom they themſelves had not choſen. Now as God was willing to reſtore immortality by a new ſpiritual head of a covenant, viz. Chriſt, it was juſt that both Jews and Gentiles ſhould ſhare in this new repreſentative of the whole race (ch. v. 12. to the end).—Chap. v. ver. 15, 16. amounts to this negative queſtion, 'Is it not fitted that the free gift ſhould extend as far as the offence?'

“ VIII. He ſhows that the doctrine of juſtification, as ſtated by him, lays us under the ſtrongeſt obligations of holineſs, (ch. vi. 1. to the end).

“ IX. He ſhows that the law of Moſes no longer concerns us at all; for our juſtification ariſes from our appearing in God's ſight, as if actually dead with Chriſt on account of our ſins; but the law of Moſes was not given to the dead. On this occaſion he proves at large, that the eternal power of God over us is not affected by this; and that whilſt we are under the law of Moſes we perpetually become ſubject to death, even by ſins of inadvertency, (ch. vii. 1. to the end).

“ X. Hence he concludes, that all thoſe, and thoſe only, who are united with Chriſt, and for the ſake of his union, do not live according to the fleſh, are free from all condemnation of the law, and have an undoubted ſhare in eternal life, (ch. viii. 1.—17.).

“ XI. Having deſcribed their bleſſedneſs, he is aware that the Jews, who expected a temporal happineſs, ſhould object to him, that Chriſtians notwithſtanding endure much ſuffering in this world. He anſwers this objection at large, (ch. viii. 18. to the end).

“ XII. He ſhows that God is not the leſs true and faithful, becauſe he doth not juſtify, but rather rejects and puniſhes, thoſe Jews who would not believe the Meſſiah, (ch. ix. x. xi.). In diſcuſſing this point, we may obſerve the cautious manner in which, on account of the Jewiſh prejudices, he introduces it (ch. ix. 1.—5.), as well as in the diſcuſſion itſelf.

“ He ſhows that the promiſes of God were never made to all the poſterity of Abraham, and that God always reſerved to himſelf the power of chooſing thoſe ſons of Abraham whom, for Abraham's ſake, he intended to bleſs, and of puniſhing the wicked ſons of Abraham; and that with reſpect to temporal happineſs or miſery, he was not even determined in his choice by their works. Thus he rejected Iſhmael, Eſau, the Iſraelites in the deſert in the time of Moſes, and the greater part of that people in the time of Iſaiah, making them a ſacrifice to his juſtice, (ch. ix. 6.—29.).

“ He then proceeds to ſhow, that God had reaſon to reject moſt of the Jews then living, becauſe they would not believe in the Meſſiah, though the goſpel had been preached to them plainly enough, (ch. ix. 30. x. to the end). However, that God had not rejected all the people, but was ſtill fulfilling his promiſe upon many thouſand natural deſcendants of Abraham, who believed in the Meſſiah, and would in a future period fulfil them upon more; for that all Iſrael would be converted, (ch. xi. 1—32.). And he concluded with admiring the wiſe counſels of God, (ver. 33. to the end).

“ XIII. From the doctrine hitherto laid down, and particularly from this, that God has in mercy accepted the Gentiles; he argues, that the Romans ſhould conſecrate and offer themſelves up wholly to God. This leads him to mention in particular ſome Chriſtian duties, (ch. xii.), viz.

“ XIV. He exhorts them to be ſubject to magiſtrates (ch. xiii. 1—7.); the Jews at that time being given to ſedition.

“ XV. To love one another heartily (ver. 2—10.). And,

“ XVI. To abſtain from thoſe vices which were conſidered as things indifferent among the Gentiles, (ver. 11. to the end).

“ XVII. He exhorts the Jews and Gentiles in the Chriſtian church to brotherly unity, (ch. xiv. 2. xv. 13.).

“ XVIII. He concludes his Epiſtle with an excuſe for having ventured to admoniſh the Romans, whom he had not converted; with an account of the journey to Jeruſalem; and with ſome ſalutations to thoſe perſons whom he meant to recommend to the church at Rome.” See *Michaelis's Lectures on the New Teſtament*.

181
First Epiſtle to the Corinthians.

Corinth was a wealthy and luxurious city, built upon the iſthmus which joins the Morea to the northern parts of Greece. In this city Paul had ſpent two years founding a Chriſtian church, which conſiſted of a mixture of Jews and Gentiles, but the greater part Gentiles.

182
Its date.

About three years after the apoſtles had left Corinth, he wrote this Epiſtle from Epheſus in the year 56 or 57, and in the beginning of Nero's reign. That it was written from Epheſus, appears from the ſalutation with which the Epiſtle cloſes, (chap. xvi. 19.). “The churches of Aſia ſalute you. Aquila and Priſcilla ſalute you much in the Lord.” From theſe words it is evident, in the 1ſt place, that the Epiſtle was written in Aſia. 2dly, It appears from Acts xviii. 18, 19. that Aquila and Priſcilla accompanied Paul from Corinth to Epheſus, where they ſeem to have continued till Paul's departure.

St Paul had certainly kept up a conſtant intercourſe with the churches which he had founded; for he was evidently acquainted with all their revolutions. They ſeem to have applied to him for advice in thoſe difficult caſes which their own underſtanding could not ſolve; and he was ready on all occaſions to correct their miſtakes.

183
General deſign of it.

This Epiſtle conſiſts of two parts. 1. A reproof for thoſe vices to which they were moſt propenſe; 2. An anſwer to ſome queries which they had propoſed to him.

184
The apoſtle reproves the Corinthians for their vices;

The Corinthians, like the other Greeks, had been accuſtomed to ſee their philoſophers divide themſelves into different ſects; and as they brought along with them into the Chriſtian church their former opinions and cuſtoms, they wiſhed, as before, to arrange themſelves under different leaders. In this Epiſtle Paul condemns theſe diviſions as inconſiſtent with the ſpirit of Chriſtianity, which inculcates benevolence and unanimity, and as oppoſite to the conduct of Chriſtian teachers, who did not, like the philoſophers, aſpire after the praiſe of eloquence and wiſdom. They laid no claim to theſe nor to any honour that cometh from men. The apoſtle declares, that the Chriſtian truths were revealed from heaven; that they were taught with great plainneſs and ſimplicity, and proved by the evidence of miracles, (chap. i. 1.). He diſſuades them from their diviſions and animoſities, by reminding them of the great trial which every man's work muſt undergo; of the guilt they incurred by polluting the temple or church of God; of the vanity of human wiſdom; and of glorying in men. He admoniſhes them to eſteem the teachers of the goſpel only as the ſervants of Chriſt; and to remember that every ſuperior advantage which they enjoyed was to be aſcribed to the goodneſs of God, (chap. iii. 4.).

2. In the fifth chapter the apoſtle conſiders the caſe of a notorious offender, who had married his ſtepmother; and tells them, that he ought to be excommunicated. He alſo exhorts the Chriſtians not to aſſociate with any perſon who led ſuch an openly profane life.

3. He cenſures the Corinthians for their litigious diſpoſition, which cauſed them to proſecute their Chriſtian brethren before the Heathen courts. He expreſſes much warmth and ſurpriſe that they did not refer their differences to their brethren; and concludes his exhortations on this ſubject, by aſſuring them that they ought rather to allow themſelves to be defrauded than to ſeek redreſs from Heathens (chap. v. 1—9.).

4. He inveighs againſt thoſe vices to which the Corinthians had been addicted before their converſion, and eſpecially againſt fornication, the criminality of which they did not fully perceive, as this vice was generally overlooked in the ſyſtems of the philoſophers, (chap. vi. 10. to the end).

185
And anſwers certain queſtions which they had propoſed to him.

Having thus pointed out the public irregularities with which they were chargeable, he next replies to certain queſtions which the Corinthians had propoſed to him by letter. He, 1. Determines ſome queſtions relating to the marriage ſtate; as, 1ſt, Whether it was good to marry under the exiſting circumſtances of the church? And, 2d, Whether they ſhould withdraw from their partners if they continued unbelievers? (chap. vii.).

2. He inſtructs them how to act with reſpect to idol offerings. It could not be unlawful in itſelf to eat the food which had been offered to idols; for the conſecration of fleſh or wine to an idol did not make it the property of the idol, an idol being nothing, and therefore incapable

incapable of property. But ſome Corinthians thought it lawful to go to a feaſt in the idol temples, which at the ſame time were places of reſort for lewdneſs, and to eat the ſacrifices whilſt praiſes were ſung to the idol. This was publicly joining in the idolatry. He even adviſes to abſtain from ſuch participation as was lawful, rather than give offence to a weak brother; which he enforces by his own example, who had abſtained from many lawful things, rather than prove a ſcandal to the goſpel, (chap. viii. ix. x.).

3. He anſwers a third query concerning the manner in which women ſhould deliver any thing in public, when called to it by a divine impulſe. And here he cenſures the unuſual dreſs of both ſexes in propheſying, which expoſed them to the contempt of the Greeks, among whom the men uſually went uncovered, and the women veiled.

Being thus led to the conſideration of the abuſes that prevailed in their public worſhip, he goes on to cenſure the irregularities which were committed at their love-feaſts, or, as we term them, the *Lord's Supper*. It was a common practice with the Greeks at their ſocial ſuppers for every man to bring his own proviſions along with him, not, however, to ſhare them with the company, but to feaſt on them in a ſolitary manner. Thus the rich ate and drank to exceſs, whilſt the poor were totally neglected. The Corinthians introduced the ſame practice in the celebration of the Lord's Supper, thus confounding it with their ordinary meals, and without ever examining into the end of the inſtitution. It was this groſs abuſe that Paul reproves in the 11th chapter. He alſo cenſures their conduct in the exerciſe of the extraordinary gifts of the Holy Ghoſt; he ſhows them they all proceeded from the ſame ſpirit, and were intended for the inſtruction of Chriſtian ſocieties; that all Chriſtians ought to be united in mutual love; and that tenderneſs ought to be ſhown to the moſt inconſiderable member, as every one is ſubſervient to the good of the whole (chap. xii.). In the 13th chapter he gives a beautiful deſcription of benevolence, which has been much and juſtly admired. He repreſents it as ſuperior to the ſupernatural gifts of the ſpirit, to the moſt exalted genius, to univerſal knowledge, and even to faith. In the 14th chapter he cautions the Corinthians againſt oſtentation in the exerciſe of the gift of languages, and gives them proper advices.

4. He aſſerts the reſurrection of the dead, in oppoſition to ſome of the Corinthians who denied it, founding it on the reſurrection of Jeſus Chriſt, which he conſiders as one of the moſt eſſential doctrines of Chriſtianity. He then anſwers ſome objections to the reſurrection, drawn from our not being capable of underſtanding how it will be accompliſhed (chap. xv.). He then concludes with ſome directions to the Corinthian church concerning the manner of collecting alms; promiſes them a viſit, and ſalutes ſome of the members.

186 The ſecond Epiſtle to the Corinthians.

The ſecond Epiſtle to the Corinthians was written from Macedonia in the year 57, about a year after the former. See 2 Cor. ix. 1.—5. viii. and xiii. 1.

187 State of the Corinthian church.

St Paul's firſt Epiſtle had wrought different effects among the Corinthians: many of them examined their conduct; they excommunicated the inceſtuous man; requeſted St Paul's return with tears; and vindicated him and his office againſt the falſe teacher and his adherents. Others of them ſtill adhered to that adverſary of St Paul, expreſsly denied his apoſtolic office, and even furniſhed themſelves with pretended arguments from that Epiſtle. He had formerly promiſed to take a journey from Epheſus to Corinth, thence to viſit the Macedonians, and return from them to Corinth (2 Cor. i. 15, 16.). But the unhappy ſtate of the Corinthian church made him alter his intention (verſe 23.), ſince he found he muſt have treated them with ſeverity. Hence his adverſaries partly argued, 1. That St Paul was irreſolute and unſteady, and therefore could not be a prophet: 2. The improbability of his ever coming to Corinth again, ſince he was afraid of them. Such was the ſtate of the Corinthian church when St Paul, after his departure from Epheſus, having viſited Macedonia (Acts xx. 1.), received an account of the above particulars from Titus (2 Cor. vii. 5, 6.), and therefore wrote them his ſecond Epiſtle about the end of the ſame year, or the beginning of 58.

188 View of the contents of this Epiſtle.

But to give a more diſtinct view of the contents of this Epiſtle:

1. The apoſtle, after a general ſalutation, expreſſes his grateful ſenſe of the divine goodneſs; profeſſing his confidence in God, ſupported by a ſenſe of his own integrity; makes an apology for not having viſited the Corinthians as he had intended, and vindicates himſelf from the charge of fickleneſs, (chap. i.).

2. He forgives the inceſtuous man, whoſe conduct had made ſo deep an impreſſion on the apoſtle's mind, that one reaſon why he had deferred his journey to Corinth was, that he might not meet them in grief, nor till he had received advice of the effect of his apoſtolical admonitions. He mentions his anxiety to meet Titus at Troas, in order to hear of their welfare; expreſſes his thankfulneſs to God for the ſucceſs attending his miniſtry, and ſpeaks of the Corinthians as his credentials, written by the finger of God, (chap. ii. iii. 1.—6.).

3. He treats of the office committed to him of preaching the redemption; and highly prefers it to preaching the law: to which probably his adverſaries had made great pretences. They had ridiculed his ſufferings; which he ſhows to be no diſgrace to the goſpel or its miniſters; and here he gives a ſhort abſtract of the doctrine he preaches, chap. iii. 6. v. to the end).

He expatiates with great copiouſneſs on the temper with which, in the midſt of afflictions and perſecutions, he and his brethren executed their important embaſſy; and with great affection and tenderneſs he exhorts them to avoid the pollution of idolatry, (chap. vi.). He endeavours to win their confidence, by telling them how much he rejoiced in their amendment and welfare, and how ſorry he had been for the diſtreſs which his neceſſary reproofs had occaſioned, (chap. vii.). He then exhorts them to make liberal contributions for the Chriſtians in Judea. He recommends to them the example of the Macedonians, and reminds them of the benevolence of the Lord Jeſus. He expreſſes his joy for the readineſs of Titus to aſſiſt in making the collection; and makes alſo honourable mention of other Chriſtian brethren, whom he had joined with Titus in the ſame commiſſion, chap. viii.). He then, with admirable addreſs, urges a liberal contribution, and recommends them to the divine bleſſing, (chap. ix.).

4. Next he obviates ſome reflections which had been

thrown

thrown on him for the mildneſs of his conduct, as if it had proceeded from fear. He aſſerts his apoſtolical power and authority, cautioning his opponents againſt urging him to give too ſenſible demonſtrations of it, (chap. x.). He vindicates himſelf againſt the inſinuations of ſome of the Corinthians, particularly for having declined pecuniary ſupport from the church; an action which had been ungenerouſly turned to his diſadvantage. To ſhow his ſuperiority over thoſe deſigning men who had oppoſed his preaching, he enumerates his ſufferings; gives a detail of ſome extraordinary revelations which he had received; and vindicates himſelf from the charge of boaſting, by declaring that he had been forced to it by the deſire of ſupporting his apoſtolical character, (chap. xi. xii.). He cloſes the Epiſtle, by aſſuring them with great tenderneſs how much it would grieve him to demonſtrate his divine commiſſion by ſeverer methods.

189 Epiſtle to the Galatians.

190 The date

The Galatians were deſcended from thoſe Gauls who had formerly invaded Greece, and afterwards ſettled in Lower Aſia. St Paul had preached the goſpel among them in the year 51, ſoon after the council held at Jeruſalem, (Acts xvi. 6.). Aſia ſwarmed at that time with zealots for the law of Moſes, who wanted to impoſe it on the Gentiles, (Acts xv. 1.). Soon after St Paul had left the Galatians, theſe falſe teachers had got among them, and wanted them to be circumciſed, &c. This occaſioned the following Epiſtle, which Michaelis thinks was written in the ſame year, before St Paul left Theſſalonica. Dr Lardner dates it about the end of the year 52, or in the very beginning of 53, before St Paul ſet out to go to Jeruſalem by way of Epheſus.

191 and contents of it.

The ſubject of this Epiſtle is much the ſame with that of the Epiſtle to the Romans; only this queſtion is more fully conſidered here, "Whether circumciſion, and an obſervance of the Levitical law, be neceſſary to the ſalvation of a Chriſtian convert?" It appears, theſe Judaizing Chriſtians, whoſe indirect views St Paul expoſes (Acts xv. 1. Gal. v. 3, 9.), at firſt only repreſented circumciſion as neceſſary to ſalvation; but afterwards they inſiſted upon the Chriſtians receiving the Jewiſh feſtivals, (Gal. iv. 10.).

As St Paul had founded the churches of Galatia, and inſtructed them in the Chriſtian religion, he does not ſet before them its principal doctrines, as he had done in the Epiſtle to the Romans; but referring them to what he had already taught (chap. i, 8, 9.), he proceeds at once to the ſubject of the Epiſtle.

As it appears from ſeveral paſſages of this Epiſtle, particularly chapter i. 7, 8, 10. and chapter v. 11. that the Judaizing Chriſtians had endeavoured to perſuade the Galatians that Paul himſelf had changed his opinion, and now preached up the Levitical law; he denies that charge, and affirms that the doctrines which he had taught were true, for he had received them from God by immediate revelation. He relates his miraculous converſion; aſſerts his apoſtolical authority, which had been acknowledged by the diſciples of Jeſus; and, as a proof that he had never inculcated a compliance with the Moſaic law, he declares that he had oppoſed Peter at Antioch for yielding to the prejudices of the Jews.

192 Arguments by which the apoſtle proves that the law of Moſes was not obligatory on the Galatians.

Locke on the Epiſtles.

Having now vindicated his character from the ſuſpicion of fickleneſs, and ſhown that his commiſſion was divine, he argues that the Galatians ought not to ſubmit to the law of Moſes: 1. Becauſe they had received the Holy Ghoſt and the gift of miracles, not by the law, but by the goſpel, (chap. iii. 1—5.). 2. Becauſe the promiſes which God made to Abraham were not reſtricted to his circumciſed deſcendants, but extended to all who are his children by faith, (chap. iii. 6—18.). In anſwer to the objection, *To what then ſerveth the law?* he replies, That it was given becauſe of tranſgreſſion; that is, to preſerve them from idolatry till the Meſſiah himſelf ſhould come. 3. Becauſe all men, whether Jews or Gentiles, are made the children of God by faith, or by receiving the Chriſtian religion, and therefore do not ſtand in need of circumciſion, (chap. iii. 26—29.). From the 1ſt verſe of chap. iv. to the 11th, he argues that the law was temporary, being only fitted for a ſtate of infancy; but that the world, having attained a ſtate of manhood under the Meſſiah, the law was of no farther uſe. In the remaining part of chapter iv. he reminds them of their former affection to him, and aſſures them that he was ſtill their ſincere friend. He exhorts them to ſtand faſt in the liberty with which Chriſt had made them free; for the ſons of Agar, that is, thoſe under the law given at Mount Sinai, are in bondage, and to be caſt out; the inheritance being deſigned for thoſe only who are the free-born ſons of God under the ſpiritual covenant of the goſpel.

193 How he vindicates his own character from falſe aſperſions.

The apoſtle next confutes the falſe report which had been ſpread abroad among the Galatians, that Paul himſelf preached up circumciſion. He had already indirectly refuted this calumny by the particular account which he gave of his life; but he now directly and openly contradicts it in the following manner:

1. By aſſuring them, that all who thought circumciſion neceſſary to ſalvation could receive no benefit from the Chriſtian religion, (chap. v. 2—4.).

2. By declaring, that he expected juſtification only by faith, (verſe 5, 6.).

3. By teſtifying, that they had once received the truth, and had never been taught ſuch falſe doctrines by him, (verſe 7, 8.).

4. By inſinuating that they ſhould paſs ſome cenſure on thoſe who miſled them (verſe 9, 10.), by declaring that he was perſecuted for oppoſing the circumciſion of the Chriſtians, (verſe 11.).

5. By expreſſing a wiſh that thoſe perſons ſhould be cut off who troubled them with his doctrine.

This Epiſtle affords a fine inſtance of Paul's ſkill in managing an argument. The chief objection which the advocates for the Moſaic law had urged againſt him was, that he himſelf preached circumciſion. In the beginning of the Epiſtle he overturns this ſlander by a ſtatement of facts, without taking any expreſs notice of it; but at the end fully refutes it, that it might leave a ſtrong and laſting impreſſion on their minds.

He next cautions them againſt an idea which his arguments for Chriſtian liberty might excite, that it conſiſted in licentiouſneſs. He ſhows them it does not conſiſt in gratifying vicious deſires; for none are under ſtronger obligations to moral duties than the Chriſtian. He recommends gentleneſs and meekneſs to the weak (chap vi. 1—5.), and exhorts them to be liberal to their teachers, and to all men (ver. 6—10.). He concludes with expoſing the falſe pretences of the Judaizing teachers, and aſſerting the integrity of his own conduct.

194 Epiſtle to the Epheſians.

Epheſus was the chief city of all Aſia on this ſide Mount Taurus. St Paul had paſſed through it in the year 54, but without making any ſtay, (Acts xviii. 19—21.). The following year he returned to Epheſus again, and ſtaid there three years, (chap. xix.). During his abode there he completed a very flouriſhing church of Chriſtians, the firſt foundations of which had been laid by ſome inferior teachers. As Epheſus was frequented by perſons of diſtinction from all parts of Aſia Minor, St Paul took the opportunity of preaching in the ancient countries (ver. 10.); and the other churches of Aſia were conſidered as the daughters of the church of Epheſus; ſo that an Epiſtle to the Epheſians was, in effect, an epiſtle to the other churches of Aſia at the ſame time.

195 The date

Dr Lardner ſhows it to be highly probable that this epiſtle was written in the year 61, ſoon after Paul's arrival at Rome.

196 and deſign of it.

As Paul was in a peculiar manner the apoſtle of the Gentiles, and was now a priſoner at Rome in conſequence of having provoked the Jews, by aſſerting that an obſervance of the Moſaic law was not neceſſary to obtain the favour of God, he was afraid leaſt an advantage ſhould be taken of his confinement to unſettle the minds of thoſe whom he had converted. Hearing that the Epheſians ſtood firm in the faith of Chriſt, without ſubmitting to the law of Moſes, he writes this Epiſtle to give them more exalted views of the love of God, and of the excellence and dignity of Chriſt. This epiſtle is not compoſed in an argumentative or didactic ſtyle: The firſt three chapters conſiſt almoſt entirely of thankſgivings and prayers, or glowing deſcriptions of the bleſſings of the Chriſtian religion. This circumſtance renders them a little obſcure; but by the aſſiſtance of the two following epiſtles, which were written on the ſame occaſion, and with the ſame deſign, the meaning of the apoſtle may be eaſily diſcovered. The laſt three chapters contain practical exhortations. He firſt inculcates unity, love, and concord, from the conſideration that all Chriſtians are members of the ſame body, of which Chriſt is the head. He then adviſes them to forſake the vices to which they had been addicted while they remained heathens. He recommends juſtice and charity; ſtrenuouſly condemns lewdneſs, obſcenity, and intemperance, vices which ſeem to have been too common among the Epheſians. In the 6th chapter he points out the duties which ariſe from the relations of huſbands and wives, parents and children, maſters and ſervants; and concludes with ſtrong exhortations to fortitude, which he deſcribes in an allegorical manner.

197 Epiſtle to the Philippians.

The church at Philippi had been founded by Paul, Silas, and Timothy (Acts xvi.), in the year 51, and had continued to ſhow a ſtrong and manly attachment to the Chriſtian religion, and a tender affection for the apoſtle. Hearing of his impriſonment at Rome, they ſent Epaphroditus, one of their paſtors, to ſupply him with money. It appears from this epiſtle that he was in great want of neceſſaries before this contribution arrived; for as he had not converted the Romans, he did not conſider himſelf as intitled to receive ſupplies from them. Being a priſoner, he could not work as formerly; and it was a maxim of his never to accept any pecuniary aſſiſtance from thoſe churches where a faction had been raiſed againſt him. From the Philippians he was not averſe to receive a preſent in the time of want, becauſe he conſidered it as a mark of their affection, and becauſe he was aſſured that they had conducted themſelves as ſincere Chriſtians.

198 The date

It appears from the apoſtle's own words, that this letter was written while he was a priſoner at Rome, (chap. i. 7, 13. iv. 22.); and from the expectation which he diſcovers (chap. ii. 24.) of being ſoon releaſed and reſtored to them, compared with Philemon, v. 22. and Heb. xiii. 13. where he expreſſes a like expectation in ſtronger terms, it is probable that this epiſtle was written towards the end of his firſt impriſonment in the year 62.

199 and deſign of it.

The apoſtle's deſign in this epiſtle, which is quite of the practical kind, ſeems to be, "to comfort the Philippians under the concern they had expreſſed at the news of his impriſonment; to check a party-ſpirit that appears to have broken out among them, and to promote, on the contrary, an entire union and harmony of affection; to guard them againſt being ſeduced from the purity of the Chriſtian faith by Judaizing teachers; to ſupport them under the trials with which they ſtruggled; and, above all, to inſpire them with a concern to adorn their profeſſion by the moſt eminent attainments in the divine life." After ſome particular admonitions in the beginning of the 4th chapter, he proceeds in the 8th verſe to recommend virtue in the moſt extenſive ſenſe, mentioning all the different foundations in which it had been placed by the Grecian philoſophers. Towards the cloſe of the epiſtle, he makes his acknowledgments to the Philippians for the ſeaſonable and liberal ſupply which they had ſent him, as it was ſo convincing a proof of their affection for him, and their concern for the ſupport of the goſpel, which he preferred far above any private ſecular intereſt of his own; expreſsly diſclaiming all ſelfiſh, merecnary views, and aſſuring them with a noble ſimplicity, that he was able upon all occaſions to accommodate his temper to his circumſtances; and had learned, under the teachings of Divine grace, in whatever ſtation Providence might ſee fit to place him, therewith to be content. After which, the apoſtle, having encouraged them to expect a rich ſupply of all their wants from their God and Father, to whom he devoutly aſcribes the honour of all, concludes with ſalutations from himſelf and his friends at Rome to the whole church, and a ſolemn benediction, (verſe 10. to the end); and declares, that he rejoiced in their liberality chiefly on their own account.

200 Epiſtle to the Coloſſians.—Date and deſign of it.

The epiſtle to the Coloſſians was written while Paul was in priſon (chap. iv. 3.), and was therefore probably compoſed in the year 62. The intention of the apoſtle, as far as can be gathered from the epiſtle itſelf, was to ſecure the Coloſſians from the influence of ſome doctrines that were ſubverſive of Chriſtianity, and to excite them to a temper and behaviour worthy of their ſacred character. A new ſect had ariſen, which had blended the oriental philoſophy with the ſuperſtitious opinions of the Jews.

201 To guard the Coloſſians againſt the dangerous doctrines of the Jews.

They held, 1. That God was ſurrounded by demons or angels, who were mediators with God, and therefore to be worſhipped. 2. That the ſoul is defiled by the body; that all bodily enjoyments hurt the ſoul, which they believed to be immortal, though they ſeem to have denied

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denied the reſurrection of the body, as it would only render the ſoul ſinful by being reunited to it. 3. That there was a great myſtery in numbers, particularly in the number ſeven; they therefore attributed a natural holineſs to the ſeventh or Sabbath day, which they obſerved more ſtrictly than the other Jews. They ſpent their time moſtly in contemplation; abſtained from marriage, and every gratification of the ſenſes; uſed waſhings, and thought it ſinful to touch certain things; regarded wine as poiſon, &c.

202
The arguments which the apoſtle employs.

The arguments againſt theſe doctrines are managed with great ſkill and addreſs. He begins with expreſſing great joy for the favourable character which he had heard of them, and aſſures them that he daily prayed for their farther improvement. Then he makes a ſhort digreſſion, in order to deſcribe the dignity of Jeſus Chriſt; declares that he had created all things, whether thrones or dominions, principalities and powers; that he alone was the head of the church, and had reconciled men to the Father. The inference from this deſcription is evident, that Jeſus was ſuperior to angels; that they were created beings, and ought not to be worſhipped. Thus he indirectly confutes one doctrine before he formally oppoſes it. Paul now returns from his digreſſion in the 21ſt verſe to the ſentiments with which he had introduced it in the 13th and 14th verſes, and again expreſſes his joy that the Philippians remained attached to the goſpel, which was to be preached to the Gentiles, without the reſtraints of the ceremonial law. Here again he ſtates a general doctrine, which was inconſiſtent with the opinions of thoſe who were zealous for the law of Moſes; but he leaves the Coloſſians to draw the inference, (chap. i.).

Having again aſſured them of his tender concern for their welfare, for their advancement in virtue, and that they might acknowledge the myſtery of God, that is, that the goſpel was to ſuperſede the law of Moſes, he proceeds directly to caution them againſt the philoſophy of the new teachers, and their ſuperſtitious adherence to the law; ſhows the ſuperiority of Chriſt to the angels, and warns Chriſtians againſt worſhipping them. He cenſures the obſervation of Sabbaths, and rebukes thoſe who required abſtinence from certain kinds of food, and cautions them againſt perſons who aſſume a great appearance of wiſdom and virtue, (chap. ii.).

203
Exhortations.

In the 3d chapter he exhorts them, that, inſtead of being occupied about external ceremonies, they ought to cultivate pure morality. He particularly guards them againſt impurity, to which they had before their converſion been much addicted. He admoniſhes them againſt indulging the iraſcible paſſions, and againſt committing falſehood. He exhorts them to cultivate the benevolent affections, and humility, and patience. He recommends alſo the relative duties between huſbands and wives, parents and children, maſters and ſervants. He enjoins the duties of prayer and thankſgiving (chap. iv. 2.), and requeſts them to remember him in their petitions. He enjoins affability and mild behaviour to the unconverted heathens (verſe 6th); and concludes the epiſtle with matters which are all of a private nature, except the directions for reading this epiſtle in the church of Laodicea, as well as in the church of Coloſſe.

204
Firſt Epiſtle to the Theſſalonians.

This epiſtle is addreſſed to the inhabitants of Theſſalonica, the capital of Macedonia, a large and populous city. It appears from the Acts, chapter xvii. 1. that the Chriſtian religion was introduced into this city by Paul and Silas, ſoon after they had left Philippi. At firſt they made many converts; but at length the Jews, ever jealous of the admiſſion of the Gentiles to the ſame privileges with themſelves, ſtirred up the rabble, which aſſaulted the houſe where the apoſtle and his friends lodged; ſo that Paul and Silas were obliged to flee to Berea, where their ſucceſs was ſoon interrupted by the ſame reſtleſs and implacable enemies. The apoſtle then withdrew to Athens; and Timothy, at his deſire, returned to Theſſalonica (1 Theſſ. iii. 2.), to ſee what were the ſentiments and behaviour of the inhabitants after the perſecution of the Jews. From Athens Paul went to Corinth, where he ſtayed a year and ſix months; during which, Timothy returned with the joyful tidings, that the Theſſalonians remained ſtedfaſt to the faith, and firmly attached to the apoſtle, notwithſtanding his flight. Upon this he ſent them this epiſtle, A. D. 52, in the 12th year of Claudius.

205
The date

This is generally reckoned the firſt epiſtle which Paul wrote; and we find he was anxious that it ſhould be read to all the Chriſtians. In chap. v. 27. he uſes theſe words; "I adjure you by the Lord, that this epiſtle be read unto all the holy brethren." This direction is very properly inſerted in his firſt epiſtle.

206
and deſign of it.

The intention of Paul in writing this epiſtle was evidently to encourage the Theſſalonians to adhere to the Chriſtian religion. This church being ſtill in its infancy, and oppreſſed by the powerful Jews, required to be eſtabliſhed in the faith. St Paul, therefore, in the three firſt chapters, endeavours to convince the Theſſalonians of the truth and divinity of his goſpel, both by the miraculous gifts of the Holy Ghoſt which had been imparted, and by his own conduct when among them.

While he appeals, in the firſt chapter, to the miraculous gifts of the Holy Spirit, he is very liberal in his commendations. He vindicates himſelf from the charge of timidity, probably to prevent the Theſſalonians from forming an unfavourable opinion of his fortitude, which his flight might have excited. He aſſerts, that he was not influenced by ſelfiſh or diſhonourable motives, but that he was anxious to pleaſe God and not man. He expreſſes a ſtrong affection for them, and how anxious he was to impart the bleſſings of the goſpel. He congratulates himſelf upon his ſucceſs; mentions it to their honour that they received the goſpel as the word of God and not of man, and therefore did not renounce it when perſecution was raiſed by the Jews. He expreſſes a ſtrong deſire to viſit the Theſſalonians; and aſſures them he had been hitherto retained againſt his will.

As a farther proof of his regard, the apoſtle informs them, that when he came to Athens, he was ſo much concerned, leaſt, being diſcouraged by his ſufferings, they ſhould be tempted to caſt off their profeſſion, that he could not forbear ſending Timothy to comfort and ſtrengthen them; and expreſſes, in very ſtrong terms, the ſenſible pleaſure he felt, in the midſt of all his afflictions, from the favourable account he received of their faith and love; to which he adds, that he was continually praying for their farther eſtabliſhment in religion, and for an opportunity of making them another viſit, in order to promote their edification, which lay ſo near his heart, (chap. iii. throughout).

Having now ſhown his paternal affection for them, with great addreſs he improves all that influence which his zeal and fidelity in their ſervice muſt naturally have given him to inculcate upon them the precepts of the goſpel. He recommends chaſtity, in oppoſition to the prevailing practice of the heathens; juſtice, in oppoſition to fraud. He praiſes their benevolence, and encourages them to cultivate higher degrees of it. He recommends induſtry and prudent behaviour to their heathen neighbours. In order to comfort them under the loſs of their friends, he aſſures them that thoſe who were fallen aſleep in Jeſus ſhould be raiſed again at the laſt day, and ſhould, together with thoſe who remained alive, be caught up to meet their Lord, and ſhare his triumph, (chap. iv.). He admoniſhes them to prepare for this ſolemn event, that it might not come upon them unawares; and then concludes the epiſtle with various exhortations.

207 Second Epiſtle to the Theſſalonians.

The ſecond epiſtle to the Theſſalonians appears to have been written ſoon after the firſt, and from the ſame place; for Silvanus or Silas, and Timothy, are joined together with the apoſtle in the inſcriptions of this epiſtle, as well as the former.

208 Contents of it.

The apoſtle begins with commending the faith and charity of the Theſſalonians, of which he had heard a favourable report. He expreſſes great joy on account of the patience with which they ſupported perſecution; and obſerves that their perſecution was a proof of a righteous judgment to come, where their perſecutors would meet with their proper recompenſe, and the righteous be delivered out of all their afflictions. He aſſures them of his conſtant prayers for their farther improvement, in order to attain the felicity that was promiſed, (chap. i.).

From miſunderſtanding a paſſage in his former letter, it appears that the Theſſalonians believed the day of judgment was at hand. To rectify this miſtake, he informs them that the day of the Lord will not come till a great apoſtaſy has overſpread the Chriſtian world, the nature of which he deſcribes (G). Symptoms of this myſtery of iniquity had then appeared; but the apoſtle expreſſes his thankfulneſs to God that the Theſſalonians had eſcaped this corruption. He exhorts them to ſtedfaſtneſs, and prays that God would comfort and ſtrengthen them, (chap. ii.).

He requeſts the prayers of the Theſſalonians for him and his two aſſiſtants, at the ſame time expreſſing his confidence that they would pay due regard to the inſtructions which he had given them. He then proceeds to correct ſome irregularities. Many of the Theſſalonians ſeem to have led an idle diſorderly life; theſe he ſeverely reproves, and commands the faithful to ſhun their company if they ſtill remained incorrigible.

209 Firſt Epiſtle to Timothy, when written.

When the firſt Epiſtle to Timothy was written, it is difficult to aſcertain. Lardner dates it in 56; Mill, Whitby, and Macknight, place it in 64: but the arguments on which each party founds their opinion are too long to inſert here.

210 Intention and contents of it.

Timothy was the intimate friend and companion of Paul, and is always mentioned by that apoſtle with much affection and eſteem. Having appointed him to ſuperintend the church of Epheſus during a journey which he made to Macedonia, he wrote this letter, in order to direct him how to diſcharge the important truſt which was committed to him. This was the more neceſſary, as Timothy was young and inexperienced, (1 Tim. iv. 12.). In the beginning of the epiſtle he reminds him of the charge with which he had intruſted him, to wit, to preſerve the purity of the goſpel againſt the pernicious doctrines of the Judaizing teachers, whoſe opinions led to frivolous controverſies, and not to a good life. He ſhows the uſe of the law of Moſes, of which theſe teachers were ignorant. This account of the law, he aſſures Timothy, was agreeable to the repreſentation of it in the goſpel, with the preaching of which he was intruſted. He then makes a digreſſion, in the fulneſs of his heart, to expreſs the ſenſe which he felt of the goodneſs of God towards him.

In the ſecond chapter, the apoſtle preſcribes the manner in which the worſhip of God was to be performed in the church of Epheſus; and in the third explains the qualifications of the perſons whom he was to ordain as biſhops and deacons. In the fourth chapter he foretels the great corruptions of the church which were to prevail in future times, and inſtructs him how to ſupport the ſacred character. In the fifth chapter he teaches Timothy how to admoniſh the old and young of both ſexes; mentions the age and character of ſuch widows as were to be employed by the ſociety in ſome peculiar office; and ſubjoins ſome things concerning the reſpect due to elders. In the ſixth chapter he deſcribes the duties which Timothy was to inculcate on ſlaves; condemns trifling controverſies and pernicious diſputes; cenſures the exceſſive love of money, and charges the rich to be rich in good words.

211 Second Epiſtle to Timothy.

That the ſecond Epiſtle to Timothy was written from Rome is univerſally agreed; but whether it was during his firſt or ſecond impriſonment has been much diſputed. That Timothy was at Epheſus or in Aſia Minor when this Epiſtle was ſent to him, appears from the frequent mention in it of perſons reſiding at Epheſus.

212 Deſign and contents of it.

The apoſtle ſeems to have intended to prepare Timothy for thoſe ſufferings which he foreſaw he would be expoſed to. He exorts him to conſtancy and perſeverance, and to perform with a good conſcience the duties of the ſacred function.

The falſe teachers, who had before thrown this church into confuſion, grew every day worſe: inſomuch that not only Hymenæus, but Philetus, another Epheſian heretic, now denied the reſurrection of the dead. They were led into this error by a diſpute about words. At firſt they only annexed various improper ſignifications to the word *reſurrection*, but at laſt they denied it altogether (H); pretending that the reſurrection of the dead was only a reſurrection from the death of ſin, and ſo

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(G) For an explanation of this prophecy, Dr Hurd's ſermons may be conſulted. He applies it to the papal power, to which it correſponds with aſtoniſhing exactneſs.

(H) This is by no means uncommon among men; to begin to diſpute about the ſignification of words, and to ſo was already paſt. This error was probably derived from the eaſtern philoſophy, which placed the origin of ſin in the body (chapter ii.). He then forewarns him of the fatal apoſtaſy and declenſion that was beginning to appear in the church; and at the ſame time animates him from his own example and the great motives of Chriſtianity, to the moſt vigorous and reſolute diſcharge of every part of the miniſterial office.

213 Epiſtle to Titus.

This Epiſtle is addreſſed to Titus, whom Paul had appointed to preſide over the church of Crete. It is difficult to determine either its date or the place from which it was ſent. The apoſtle begins with reminding Titus of the reaſons for which he had left him at Crete; and directs him on what principles he was to act in ordaining Chriſtian paſtors: the qualifications of whom he particularly deſcribes. To ſhow him how cautious he ought to be in ſelecting men for the ſacred office, he reminds him of the arts of the Judaizing teachers, and the bad character of the Cretans (chapter i.).

214 Deſigns and contents of it.

He adviſes him to accommodate his exhortations to the reſpective ages, ſexes, and circumſtances, of thoſe whom it was his duty to inſtruct; and to give the greater weight to his inſtructions, he admoniſhes him to be an example of what he taught (chap. ii.). He exhorts him alſo to teach obedience to the civil magiſtrate, becauſe the Judaizing Chriſtians affirmed that no obedience was due from the worſhippers of the true God to magiſtrates who were idolaters. He cautions againſt cenſoriouſneſs and contention, and recommends meekneſs; for even the beſt Chriſtians had formerly been wicked, and all the bleſſings which they enjoyed they derived from the goodneſs of God. He then enjoins Titus ſtrenuouſly to inculcate good works, and to avoid uſeleſs controverſies; and concludes with directing him how to proceed with thoſe heretics who attempted to ſow diſſenſion in the church.

215 Epiſtle to Philemon.—Date and deſign of it.

The Epiſtle to Philemon was written from Rome at the ſame time with the Epiſtles to the Coloſſians and Philippians, about A. D. 62 or 63. The occaſion of the letter was this: Oneſimus, Philemon's ſlave, had robbed his maſter and fled to Rome; where, happily for him, he met with the apoſtle, who was at that time a priſoner at large, and by his inſtructions and admonitions was converted to Chriſtianity; and reclaimed to a ſenſe of his duty. St Paul ſeems to have kept him for ſome conſiderable time under his eye, that he might be ſatisfied of the reality of the change; and, when he had made a ſufficient trial of him, and found that his behaviour was entirely agreeable to his profeſſion, he would not detain him any longer for his own private convenience, though in a ſituation that rendered ſuch an aſſiſtant peculiarly deſirable (compare ver. 13, 14.), but ſent him back to his maſter; and, as a mark of his eſteem, entruſted him, together with Tychicus, with the charge of delivering his Epiſtle to the church at Coloſſe, and giving them a particular account of the ſtate of things at Rome, recommending him to them, at the ſame time, as a faithful and beloved brother (Col. iv. 9.). And as Philemon might well be ſuppoſed to be ſtrongly prejudiced againſt one who had left his ſervice in ſo infamous a manner, he ſends him this letter, in which he employs all his influence to remove his ſuſpicions, and reconcile him to the thoughts of taking Oneſimus into his family again. And whereas St Paul might have exerted that authority which his character as an apoſtle, and the relation in which he ſtood to Philemon as a ſpiritual father, would naturally give him, he chooſes to entreat him as a friend; and with the ſofteſt and moſt inſinuating addreſs urges his ſuit, conjuring him by all the ties of Chriſtian friendſhip that he would not deny him his requeſt: and the more effectually to prevail upon him, he repreſents his own peace and happineſs as deeply intereſted in the event; and ſpeaks of Oneſimus in ſuch terms as were beſt adapted to ſoften his prejudices, and diſpoſe him to receive one who was ſo dear to himſelf, not merely as a ſervant, but as a fellow Chriſtian and a friend.

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216 The ſkill and addreſs which the apoſtle diſcovers in this Epiſtle.

It is impoſſible to read over this admirable Epiſtle, without being touched with the delicacy of ſentiment, and the maſterly addreſs that appear in every part of it. We ſee here, in a moſt ſtriking light, how perfectly conſiſtent true politeneſs is, not only with all the warmth and ſincerity of the friend, but even with the dignity of the Chriſtian and the apoſtle. And if this letter were to be conſidered in no other view than as a mere human compoſition, it muſt be allowed a maſter-piece in its kind. As an illuſtration of this remark, it may not be improper to compare it with an epiſtle of Pliny, that ſeems to have been written upon a ſimilar occaſion, (lib. ix. lit. 21); which, though penned by one that was reckoned to excel in the epiſtolary ſtyle, and though it has undoubtedly many beauties, yet muſt be acknowledged, by every impartial reader, vaſtly inferior to this animated compoſition of the apoſtle.

217 Epiſtle to the Hebrews was compoſed by Paul.

The Epiſtle to the Hebrews has been generally aſcribed to Paul; but the truth of this opinion has been ſuſpected by others, for three reaſons: 1. The name of the writer is nowhere mentioned, neither in the beginning nor in any other part of the Epiſtle. 2. The ſtyle is ſaid to be more elegant than Paul's. 3. There are expreſſions in the Epiſtle which have been thought unſuitable to an apoſtle's character. 1. In anſwer to the firſt objection, Clemens Alexandrinus has aſſigned a very good reaſon: "Writing to the Hebrews (ſays he), who had conceived a prejudice againſt him, and were ſuſpicious of him, he wiſely declined ſetting his name at the beginning, leſt he ſhould offend them." 2. Origen and Jerome admired the elegance of the ſtyle, and reckoned it ſuperior to that which Paul had exhibited in his Epiſtles: but as ancient teſtimony had aſſigned it to Paul, they endeavoured to anſwer the objection, by ſuppoſing that the ſentiments were the apoſtle's, but the language and compoſition the work of ſome other perſon. If the Epiſtle, however, be a tranſlation, which we believe it to be, the elegance of the language may belong to the tranſlator. As to the compoſition and arrangement, it cannot be denied that there are many ſpecimens in the writings of this apoſtle not inferior

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to be led gradually to deny the thing ſignified. This appears to have been the cauſe of moſt diſputes and the general beginning of ſcepticiſm and infidelity.

ferior in theſe qualities to the Epiſtle to the Hebrews. 3. It is objected, that in Heb. ii. 3. the writer of this Epiſtle joins himſelf with thoſe who had received the goſpel from Chriſt's apoſtles. Now Paul had it from Chriſt himſelf. But Paul often appeals to the teſtimony of the apoſtles in ſupport of thoſe truths which he had received from Revelation. We may inſtance 1 Cor. xv. 5, 6, 7, 8.; 2 Tim. ii. 2.

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Quoted as his by ancient writers.

This Epiſtle is not quoted till the end of the ſecond century, and even then does not ſeem to have been univerſally received. This ſilence might be owing to the Hebrews themſelves, who ſuppoſing this letter had no relation to the Gentiles, might be at pains to diffuſe copies of it. The authors, however, on whoſe teſtimony we receive it as authentic, are entitled to credit; for they lived ſo near the age of the apoſtles, that they were in no danger of being impoſed on; and from the numerous liſt of books which they rejected as ſpurious, we are aſſured that they were very careful to guard againſt impoſition. It is often quoted as Paul's by Clemens Alexandrinus, about the year 194. It is received and quoted as Paul's by Origen, about 230; by Dionyſius biſhop of Alexandria in 247; and by a numerous liſt of ſucceeding writers.

219
Written in the Syro-Chaldaic language.

The Epiſtle to the Hebrews was originally written in Hebrew, or rather Syro-Chaldaic; a fact which we believe on the teſtimony of Clemens Alexandrinus, Jerome, and Euſebius. To this it has been objected, that as theſe writers have not referred to any authority, we ought to conſider what they ſay on this ſubject merely as an opinion. But as they ſtate no reaſons for adopting this opinion, but only mention as a fact that Paul wrote to the Hebrews in their native language, we muſt allow that it is their teſtimony which they produce, and not their opinion. Euſebius informs us, that ſome ſuppoſed Luke the Evangeliſt, and others Clemens Romanus, to have been the tranſlator.

According to the opinion of ancient writers, particularly Clemens Alexandrinus, Jerome, and Euthalius, this Epiſtle was addreſſed to the Jews in Paleſtine.—The ſcope of the Epiſtle confirms this opinion.

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Date of it.

Having now given ſufficient evidence that this Epiſtle was written by Paul, the time when it was written may be eaſily determined: For the ſalutation from the ſaints of Italy (chap. iv. 24.), together with the apoſtle's promiſe to ſee the Hebrews (ver. 23.), plainly intimate, that his confinement was then either ended or on the eve of being ended. It muſt therefore have been written ſoon after the Epiſtles to the Coloſſians, Epheſians, and Philemon, and not long before Paul left Italy, that is, in the year 61 or 62.

Percy's Key to the New Teſtament.

As the zealous defenders of the Moſaic law would naturally inſiſt on the divine authority of Moſes, on the majeſty and glory attending its promulgation by the miniſtry of angels, and the great privileges it afforded thoſe who adhered to it; the apoſtle ſhows,

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Deſign of it to prove to the Jews the truth of the Chriſtian religion and its ſuperiority to the law of Moſes;

I. That in all theſe ſeveral articles Chriſtianity had an infinite ſuperiority to the law.

This topic he purſues from chap. i. to xi. wherein he reminds the believing Hebrews of the extraordinary favour ſhown them by God, in ſending them a revelation by his own ſon, whoſe glory was far ſuperior to that of angels (chap. i. throughout); very naturally inferring from hence the danger of deſpiſing Chriſt on account of his humiliation, which, in perfect conſiſtence with his dominion over the world to come, was voluntarily ſubmitted to by him for wiſe and important reaſons; particularly to deliver us from the fear of death, and to encourage the freedom of our acceſs to God (chap. ii. throughout). With the ſame view he magnifies Chriſt as ſuperior to Moſes, their great legiſlator; and from the puniſhment inflicted on thoſe who rebelled againſt the authority of Moſes, infers the danger of contemning the promiſes of the goſpel (chap. iii. 2—13.). And as it was an eaſy tranſition to call to mind on this occaſion that reſt in Canaan to which the authority inveſted in Moſes was intended to lead them; the apoſtle hence cautions them againſt unbelief, as what would prevent their entering into a ſuperior ſtate of reſt to what the Jews ever enjoyed (chap. iii. 14. iv. 11.). This caution is ſtill farther enforced by awful views of God's omniſcience, and a lively repreſentation of the high-prieſthood of Chriſt (chap. iv. to the end; and chap. v. throughout). In the next place, he intimates the very hopeleſs ſituation of thoſe who apoſtatiſe from Chriſtianity (chap. vi. 1—9.); and then, for the comfort and confirmation of ſincere believers, diſplays to them the goodneſs of God, and his faithful adherence to his holy engagements; the performance of which is ſealed by the entrance of Chriſt into heaven as our forerunner (chap. vi. 9. to the end). Still farther to illuſtrate the character of our Lord, he enters into a parallel between him and Melchizedec as to their title and deſcent; and, from inſtances wherein the prieſthood of Melchizedec excelled the Levitical, infers, that the glory of the prieſthood of Chriſt ſurpaſſed that under the law (chap. vii. 1—17.). From theſe premiſes the apoſtle argues, that the Aaronical prieſthood was not only excelled, but conſummated by that of Chriſt, to which it was only introductory and ſubſervient; and of courſe, that the obligation of the law was henceforth diſſolved (chap. vii. 18. to the end). Then recapitulating what he had already demonſtrated concerning the ſuperior dignity of Chriſt's prieſthood, he thence illuſtrates the diſtinguiſhed excellence of the new covenant, as not only foretold by Jeremiah, but evidently enriched with much better promiſes than the old (ch. viii. throughout): Explaining farther the doctrine of the prieſthood and interceſſion of Chriſt, by comparing it with what the Jewiſh high-prieſt did on the great day of atonement (chap. ix. 1—14.). Afterwards he enlarges on the neceſſity of ſhedding Chriſt's blood, and the ſufficiency of the atonement made by it (chap. ix. 15. to the end); and proves that the legal ceremonies could not by any means purify the conſcience: whence he infers the inſufficiency of the Moſaic law, and the neceſſity of looking beyond it (chap. x. 1—15.). He then urges the Hebrews to improve the privileges which ſuch an high-prieſt and covenant conferred on them, to the purpoſes of approaching God with confidence, to a conſtant attendance on his worſhip, and moſt benevolent regards to each other (chap. x. 15—25.).

The apoſtle having thus obviated the inſinuations and objections of the Jews, for the ſatisfaction and eſtabliſhment of the believing Hebrews, proceeds,

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and to animate them to bear perſecution with fortitude.

II. To prepare and fortify their minds againſt the ſtorm of perſecution which in part had already befallen them, which was likely to continue and be often renewed, he reminds them of thoſe extremities they had endured, and of the fatal effects which would attend their apoſtaſy (chap. x. 26. to the end); calling to their remembrance the eminent examples of faith and fortitude exhibited by holy men, and recorded in the Old Teſtament (chap. xi. 1—29.). He concludes his diſcourſe with glancing at many other illuſtrious worthies; and, beſides thoſe recorded in Scripture, refers to the caſe of ſeveral who ſuffered under the perſecution of Antiochus Epiphanes (2 Maccab. chap. viii. &c. chap. xi. 30. xii. 2.).

Having thus finiſhed the argumentative part of the Epiſtle, the apoſtle proceeds to a general application; in which he exhorts the Hebrew Chriſtians to patience, peace, and holineſs (chap. xii. 3—14.); cautions them againſt ſecular views and ſenſual gratifications, by laying before them the incomparable excellence of the bleſſings introduced by the goſpel, which even the Jewiſh economy, glorious and magnificent as it was, did by no means equal; exhorts them to brotherly affection, purity, compaſſion, dependence on the divine care, ſtedfaſtneſs in the profeſſion of truth, a life of thankfulneſs to God, and benevolence to man: and concludes the whole with recommending their pious miniſters to their particular regard, intreating their prayers, ſaluting and granting them his uſual benediction.

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The ſeven Catholic epiſtles.

The ſeven following Epiſtles, one of James, two of Peter, three of John, and one of Jude, have been diſtinguiſhed by the appellation of *catholic* or *general* epiſtles, becauſe moſt of them are inſcribed, not to particular churches or perſons, but to the body of Jewiſh or Gentile converts over the world. The authenticity of ſome of theſe has been frequently queſtioned, viz. The Epiſtle of James, the ſecond of Peter, the Epiſtle of Jude, and the ſecond and third of John. The ancient Chriſtians were very cautious in admitting any books into their canon whoſe authenticity they had any reaſon to ſuſpect. They rejected all the writings forged by heretics in the name of the apoſtles, and certainly, therefore, would not receive any without firſt ſubjecting them to a ſevere ſcrutiny. Now, though theſe five epiſtles were not immediately acknowledged as the writings of the apoſtles, this only ſhows that the perſons who doubted had not received complete and inconteſtable evidence of their authenticity. But as they were afterwards univerſally received, we have every reaſon to conclude, that upon a ſtrict examination they were found to be the genuine productions of the apoſtles. The truth is, ſo good an opportunity had the ancient Chriſtians of examining this matter, ſo careful were they to guard aagainſt impoſition, and ſo well founded was their judgment concerning the books of the New Teſtament, that, as Dr Lardner obſerves, no writing which they pronounced genuine has yet been proved ſpurious, nor have we at this day the leaſt reaſon to believe any book genuine which they rejected.

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Epiſtle of James the Leſs.

That the Epiſtle of James was written in the apoſtolical age is proved by the quotations of ancient authors. Clemens Romanus and Ignatius ſeem to have made references to it. Origen quotes it once or twice.—There are ſeveral reaſons why it was not more generally quoted by the firſt Chriſtian writers. Being written to correct the errors and vices which prevailed among the Jews, the Gentiles might think it of leſs importance to them, and therefore take no pains to procure copies of it. As the author was ſometimes denominated James the Juſt, and often called biſhop of Jeruſalem, it might be doubted whether he was one of the apoſtles. But its authenticity does not ſeem to have been ſuſpected on account of the doctrines which it contains. In modern times, indeed, Luther called it a ſtrawy epiſtle (*epiſtola ſtraminea*), and excluded it from the ſacred writings, on account of its apparent oppoſition to the apoſtle Paul concerning juſtification by faith.

225
The date

This Epiſtle could not be written by James the Elder, the ſon of Zebedee, and brother of John, who was beheaded by Herod in the year 44, for it contains paſſages which refer to a later period. It muſt, therefore, have been the compoſition of James the Leſs, the ſon of Alpheus, who was called *the Lord's brother*, becauſe he was the ſon of Mary, the ſiſter of our Lord's mother. As to the date of this Epiſtle, Lardner fixes it in the year 61 or 62.

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and deſign of it.

James the Leſs ſtatedly reſided at Jeruſalem, whence he hath been ſtyled by ſome ancient fathers biſhop of that city, though without ſufficient foundation. Now James being one of the apoſtles of the circumciſion, while he confined his perſonal labours to the inhabitants of Judea, it was very natural for him to endeavour by his writings to extend his ſervices to the Jewiſh Chriſtians who were diſperſed abroad in more diſtant regions. For this purpoſe, there are two points which the apoſtle ſeems to have principally aimed at, though he hath not purſued them in an orderly and logical method, but in the free epiſtolary manner, handling them jointly or diſtinctly as occaſions naturally offered. And theſe were, "to correct thoſe errors both in doctrine and practice into which the Jewiſh Chriſtians had fallen, which might otherwiſe have produced fatal conſequences; and then to eſtabliſh the faith and animate the hope of ſincere believers, both under their preſent and their approaching ſufferings."

The opinions which he is moſt anxious to refute are theſe, that God is the author of ſin, (ch. i. 13.); that the belief of the doctrines of the goſpel was ſufficient to procure the favour of God for them, however deficient they were in good works, (ch. ii.). He diſſuades the Jews from aſpiring to the office of teachers in the third chapter, becauſe their prejudices in favour of the law of Moſes might induce them to pervert the doctrines of the goſpel. He therefore guards them againſt the ſins of the tongue, by repreſenting their pernicious effects; and as they thought themſelves wiſe and intelligent, and were ambitious of becoming teachers, he adviſes them to make good their pretenſions, by ſhowing themſelves poſſeſſed of that wiſdom which is from above, (ch. iii.).

The deſtruction of Jeruſalem was now approaching; the Jews were ſplit into factions, and often ſlaughtered one another; the apoſtle, therefore, in the fourth chapter, admoniſhes them to purify themſelves from thoſe vices which produced tumults and bloodſhed. To rouſe them to repentance, he foretels the miſeries that were coming upon them. Laſtly, he checks an irreligious ſpirit that ſeems to have prevailed, and concludes the Epiſtle with ſeveral exhortations.

227
Firſt Epiſtle of Peter.

The authenticity of the firſt Epiſtle of Peter has never been denied. It is referred to by Clemens Romanus, by Polycarp, and is quoted by Papias, Irenæus, Clemens Alexandrinus, and Tertullian. It is addreſſed to the ſtrangers ſcattered through Pontus, &c. who are evidently Chriſtians in general, as appears from chap.

chap. ii. 10. "In time paſt they were not a people, but are now the people of God." From Peter's ſending the ſalutation of the church at Babylon to the Chriſtians in Pontus, &c. it is generally believed that he wrote it in Babylon. There was a Babylon in Egypt and another in Aſſyria. It could not be the former, for it was an obſcure place, which ſeems to have had no church for the firſt four centuries. We have no authority to affirm that Peter ever was in Aſſyria. The moſt probable opinion is that of Grotius, Whitby, Lardner, as well as of Euſebius, Jerome, and others, that by Babylon Peter figuratively means Rome. Lardner dates it in 63 or 64, or at the lateſt 65.

228 The date
229 and deſign of it.

St Peter's chief deſign is to confirm the doctrine of St Paul, which the falſe teachers pretended he was oppoſing; and to aſſure the proſelytes that they ſtood in the true grace of God, (ch. v. 12.). With this view he calls them elect; and mentions, that they had been declared ſuch by the effuſion of the Holy Ghoſt upon them, (ch. i. 1, 2.). He aſſures them that they were regenerate without circumciſion, merely through the goſpel and reſurrection of Chriſt, (ver. 3, 4, 21—25.); and that their ſufferings were no argument of their being under the diſpleaſure of God, as the Jews imagined, (ver. 6—12.). He recommends it to them to hope for grace to the end, (ver. 13.). He teſtifies, that they were not redeemed by the Paſchal lamb, but through Chriſt, whom God had preordained for this purpoſe before the foundation of the world, (ver. 18—20.).

230 Second Epiſtle of Peter. The authenticity of it proved

The ſecond Epiſtle of Peter is not mentioned by any ancient writer extant till the fourth century, from which time it has been received by all Chriſtians except the Syrians. Jerome acquaints us, that its authenticity was diſputed, on account of a remarkable difference between the ſtyle of it and the former Epiſtle. But this remarkable difference in ſtyle is confined to the 2d chapter of the 2d Epiſtle. No objection, however, can be drawn from this circumſtance; for the ſubject of that chapter is different from the reſt of Peter's writings, and nothing is ſo well known than that different ſubjects ſuggeſt different ſtyles. Peter, in deſcribing the character of ſome flagitious impoſtors, feels an indignation which he cannot ſuppreſs: it breaks out, therefore, in the bold and animated figures of an oriental writer. Such a diverſity of ſtyle is not uncommon in the beſt writers, eſpecially when warmed with their ſubject.

231 from internal evidence.

This objection being removed, we contend that this Epiſtle was written by Peter, from the inſcription, *Simon Peter, a ſervant and an apoſtle of Jeſus Chriſt.* It appears from chap. i. 16, 17, 18. that the writer was one of the diſciples who ſaw the transfiguration of our Saviour. Since it has never been aſcribed to James or John, it muſt therefore have been Peter. It is evident, from chap. iii. 1. that the author had written an Epiſtle before to the ſame perſons, which is another circumſtance that proves Peter to be the author.

It is acknowledged, however, that all this evidence is merely internal; for we have not been able to find any external evidence upon the ſubject. If, therefore, the credit which we give to any fact is to be in proportion to the degree of evidence with which it is accompanied, we ſhall allow more authority due to the goſpels than to the epiſtles; more to thoſe epiſtles which have been generally acknowledged than to thoſe which have been controverted; and therefore no doctrine of Chriſtianity ought to be founded ſolely upon them. It may alſo be added, that perhaps the beſt way of determining what are the eſſential doctrines of Chriſtianity would be to examine what are the doctrines which occur ofteneſt in the goſpels; for the goſpels are the plaineſt parts of the New Teſtament; and their authenticity is moſt completely proved. They are therefore beſt fitted for common readers. Nor will it be denied, we preſume, that our Saviour taught all the doctrines of the Chriſtian religion himſelf; that he repeated them on different occaſions, and inculcated them with an earneſtneſs proportionable to their importance. The Epiſtles are to be conſidered as a commentary on the eſſential doctrines of the goſpel, adapted to the ſituation and circumſtances of particular churches, and perhaps ſometimes explaining doctrines of inferior importance. 1. The eſſential doctrines are therefore firſt to be ſought for in the goſpels, and to be determined by the number of times they occur. 2. They are to be ſought for, in the next place, in the uncontroverted Epiſtles, in the ſame manner. 3. No eſſential doctrine ought to be founded on a ſingle paſſage, nor on the authority of a controverted Epiſtle.

That Peter was old, and near his end, when he wrote this Epiſtle, may be inferred from chap. i. 14. "Knowing that ſhortly I muſt put off this tabernacle, even as our Lord Jeſus has ſhewn me." Lardner thinks it was written ſoon after the former. Others, perhaps with more accuracy, date it in 67.

232 Deſign of it.

The general deſign of this Epiſtle is, to confirm the doctrines and inſtructions delivered in the former; "to excite the Chriſtian converts to adorn, and ſtedfaſtly adhere to their holy religion, as a religion proceeding from God, notwithſtanding the artifices of falſe teachers, whoſe character is at large deſcribed; or the perſecution of their bitter and inveterate enemies."

233 Firſt Epiſtle of John. Its authenticity and ſtyle.

The firſt Epiſtle of John is aſcribed by the unanimous ſuffrage of the ancients to the beloved diſciple of our Lord. It is referred to by Polycarp, is quoted by Papias, by Irenæus, and was received as genuine by Clemens Alexandrinus, by Dionyſius of Alexandria, by Cyprian, by Origen, and Euſebius. There is ſuch a reſemblance between the ſtyle and ſentiments of this Epiſtle and thoſe of the goſpel according to John, as to afford the higheſt degree of internal evidence that they are the compoſition of the ſame author. In the ſtyle of this apoſtle there is a remarkable peculiarity, and eſpecially in this Epiſtle. His ſentences, conſidered ſeparately, are exceeding clear and intelligible; but when we ſearch for their connection, we frequently meet with greater difficulties than we do even in the Epiſtles of St Paul. The principal ſignature and characteriſtic of his manner is an artleſs and amiable ſimplicity, and a ſingular modeſty and candour, in conjunction with a wonderful ſublimity of ſentiment. His conceptions are apparently delivered to us in the order in which they aroſe to his own mind, and are not the product of artificial reaſoning or laboured inveſtigation.

It is impoſſible to fix with any preciſion the *date* of this Epiſtle, nor can we determine to what perſons it was addreſſed.

234 Deſign of it.

The leading deſign of the apoſtle is to ſhow the inſufficiency of faith, and the external profeſſion of religion, ſeparate from morality; to guard the Chriſtians to whom he writes againſt the deluſive arts of the corrupters

rupters of Chriſtianity, whom he calls Antichriſt; and to inculcate univerſal benevolence. His admonitions concerning the neceſſity of good morals, and the ineſficacy of external profeſſions, are ſcattered over the Epiſtle, but are moſt frequent in the 1ſt, 2d, and 3d chapters. The enemies or corrupters of Chriſtianity, againſt whom he contends, ſeem to have denied that Jeſus was the Meſſiah the Son of God (chapter ii. 22. v. 1.), and had actually come into the world in a human form, (chap. iv. 2, 3.). The earneſtneſs and frequency with which this apoſtle recommends the duty of benevolence is remarkable. He makes it the diſtinguiſhing characteriſtic of the diſciples of Jeſus, the only ſure pledge of our love to God, and the only aſſurance of eternal life, (chap. iii. 34, 15.). Benevolence was his favourite theme, which he affectionately preſſed upon others, and conſtantly practiſed himſelf. It was conſpicuous in his conduct to his great Maſter, and in the reciprocal affection which it inſpired in his ſacred breaſt. He continued to recommend it in his laſt words. When his extreme age and infirmities had ſo waſted his ſtrength that he was incapable to exerciſe the duties of his office, the venerable old man, anxious to exert in the ſervice of his Maſter the little ſtrength which ſtill remained, cauſed himſelf to be carried to church, and, in the midſt of the congregation, he repeated theſe words, "Little children love one another."

235 Second and third Epiſtles of John.

It has been obſerved by Dr Mill that the ſecond and third Epiſtles of John are ſo ſhort, and reſemble the firſt ſo much in ſentiment and ſtyle, that it is not worth while to contend about them. The ſecond Epiſtle conſiſts only of 13 verſes; and of theſe eight may be found in the 1ſt Epiſtle, in which the ſenſe or language is preciſely the ſame.

The ſecond Epiſtle is quoted by Irenæus, and was received by Clemens Alexandrinns. Both were admitted by Athanaſius, by Cyril of Jeruſalem, and by Jerome. The ſecond is addreſſed to a woman of diſtinction whoſe name is by ſome ſuppoſed to be *Cyria* (taking κυρια for a proper name), by others *Electa.* The third is inſcribed to Gaius, or Caius according to the Latin orthography, who, in the opinion of Lardner, was an eminent Chriſtian, that lived in ſome city of Aſia not far from Epheſus, where St John chiefly reſided after his leaving Judea. The time of writing theſe two Epiſtles cannot be determined with any certainty. They are ſo ſhort that an analyſis of them is not neceſſary.

236 Epiſtle of Jude. Its authenticity

The Epiſtle of Jude is cited by no ancient Chriſtian writer extant before Clemens Alexandrinus about the year 194; but this author has tranſcribed eight or ten verſes in his Stromata and Pedagogue. It is quoted once by Tertullian about the year 200; by Origen frequently about 230. It was not however received by many of the ancient Chriſtians, on account of a ſuppoſed quotation from a book of Enoch. But it is not certain that Jude quotes any book. He only ſays that *Enoch propheſied, ſaying, The Lord cometh with ten thouſand of his ſaints.* Theſe might be words of a prophecy preſerved by tradition, and inſerted occaſionally in different writings. Nor is there any evidence that there was ſuch a book as Enoch's prophecies in the time of Jude, though a book of that name was extant in the ſecond and third centuries. As to the date of this Epiſtle nothing beyond conjecture can be produced.

237 and deſign.

The deſign of it is, by deſcribing the character of the falſe teachers, and the puniſhments to which they were liable, to caution Chriſtians againſt liſtening to their ſuggeſtions, and being thereby perverted from the faith and purity of the goſpel.

238 The Apocalypſe. Its authenticity proved.

The Apocalypſe or Revelation has not always been unanimouſly received as the genuine production of the apoſtle John. Its authenticity is proved, however, by the teſtimony of many reſpectable authors of the firſt centuries. It is referred to by the martyrs of Lyons: it was admitted by Juſtin Martyr as the work of the apoſtle John. It is often quoted by Irenæus, by Theophilus biſhop of Antioch, by Clement of Alexandria, by Tertullian, by Origen, and by Cyprian of Carthage. It was alſo received by heretics, by Novatus and his followers, by the Donatiſts, and by the Arians. For the firſt two centuries no part of the New Teſtament was more univerſally acknowledged, or mentioned with higher reſpect. But a diſpute having ariſen about the millennium, Caius with ſome others, about the year 212, to end the controverſy as ſpeedily and effectually as poſſible, ventured to deny the authority of the book which had given occaſion to it.

239 The date of it.

The book of Revelation, as we learn from Rev. i. 9. was written in the iſle of Patmos. According to the general teſtimony of ancient authors, John was baniſhed into Patmos in the reign of Domitian, and reſtored by his ſucceſſor Nerva. But the book could not be publiſhed till after John's releaſe, when he returned to Epheſus. As Domitian died in 96, and his perſecution did not commence till near the end of his reign, the Revelation might therefore be publiſhed in 96 or 97.

Percy's Key to the New Teſtament.

Here we ſhould conclude; but as the curious reader may deſire to be informed how the predictions revealed in this book of St John have uſually been interpreted and applied, we ſhall conſiſtently with our ſubject ſubjoin *a key to the prophecies contained in the Revelation.* This is extracted from the learned diſſertations of Dr Newton, biſhop of Briſtol (1): to which the reader is referred for a more full illuſtration of the ſeveral parts, as the conciſeneſs of our plan only admits a ſhort analyſis or abridgment of them.

240 Dr Newton's explication of the prophecies which have been already accompliſhed.

Nothing of a prophetical nature occurs in the firſt three chapters, except, 1. What is ſaid concerning the church of Epheſus, that her "candleſtick ſhall be removed out of its place," which is now verified, not only in this, but in all the other Aſiatic churches which exiſted at that time; the light of the goſpel having been taken from them, not only by their hereſies and diviſions from within, but by the arms of the Saracens from without: And, 2. Concerning the church of Smyrna, that ſhe ſhall "have tribulation ten days;" that is, in prophetic language,

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(1) Diſſertations on the prophecies which have remarkably been fulfilled, and at this time are fulfilling, in the world, vol. iii. 8vo.

guage, "ten years;" referring to the perſecution of Diocleſian, which alone of all the general perſecutions laſted ſo long.

The next five chapters relate to the opening of the *Seven Seals;* and by theſe ſeals are intimated ſo many different periods of the prophecy. Six of theſe ſeals are opened in the ſixth and ſeventh chapters.

The *firſt ſeal* or period is memorable for conqueſts. It commences with Veſpaſian, and terminates in Nerva; and during this time Judea was ſubjugated. The *ſecond ſeal* is noted for war and ſlaughter. It commences with Trajan, and continues through his reign, and that of his ſucceſſors. In this period, the Jews were entirely routed and diſperſed; and great was the ſlaughter and devaſtation occaſioned by the contending parties. The *third ſeal* is characteriſed by a rigorous execution of juſtice, and an abundant proviſion of corn, wine, and oil. It commences with Septimius Severus. He and Alexander Severus were juſt and ſevere emperors, and at the ſame time highly celebrated for the regard they paid to the felicity of their people, by procuring them plenty of every thing, and particularly corn, wine, and oil. This period laſted during the reigns of the Septimian family. The *fourth ſeal* is diſtinguiſhed by a concurrence of evils, ſuch as war, famine, peſtilence, and wild beaſts; by all which the Roman empire was remarkably infeſted from the reign of Maximin to that of Diocleſian. The *fifth ſeal* begins at Diocleſian, and is ſignalized by the great perſecution, from whence aroſe that memorable era, the Era of Martyrs. With Conſtantine begins the *ſixth ſeal*, a period of revolutions, pictured forth by great commotions in earth and in heaven, alluding to the ſubverſion of Paganiſm and the eſtabliſhment of Chriſtianity. This period laſted from the reign of Conſtantine the Great to that of Theodoſius the Firſt. The *ſeventh ſeal* includes under it the remaining parts of the prophecy, and comprehends ſeven periods diſtinguiſhed by the ſounding of ſeven trumpets.

As the ſeals foretold the ſtate of the Roman empire before and till it became Chriſtian, ſo the trumpets foreſhow the fate of it afterwards; each trumpet being an alarm to one nation or other, rouſing them up to overthrow that empire.

Four of theſe trumpets are ſounded in the eighth chapter.

At the ſounding of the firſt, Alaric and his Goths invade the Roman empire, beſiege Rome twice, and ſet it on fire in ſeveral places. At the ſounding of the ſecond, Attila and his Huns waſte the Roman provinces, and compel the eaſtern emperor Theodoſius the Second, and the weſtern emperor Valentinian the Third, to ſubmit to ſhameful terms. At the ſounding of the third, Genſeric and his Vandals arrive from Africa; ſpoil and plunder Rome, and ſet ſail again with immenſe wealth and innumerable captives. At the ſounding of the fourth, Odoacer and the Heruli put an end to the very name of the weſtern empire; Theodoric founds the kingdom of the Oſtrogoths in Italy; and at laſt Italy becomes a province of the eaſtern empire, Rome being governed by a duke under the exarch of Ravenna. As the foregoing trumpets relate chiefly to the downfal of the weſtern empire, ſo do the following to that of the eaſtern. They are ſounded in the ninth, tenth, and part of the eleventh chapters. At the ſounding of the fifth trumpet, Mahomet, that blazing ſtar, appears, opens the bottomleſs pit, and with his locuſts the Arabians darkens the ſun and air. And at the ſounding of the ſixth, a period not yet finiſhed, the four angels, that is, the four ſultans, or leaders of the Turks and Othmans, are looſed from the river Euphrates. The Greek or Eaſtern empire was cruelly "hurt and tormented" under the fifth trumpet; but under the ſixth, was "ſlain," and utterly deſtroyed.

The Latin or Weſtern Church not being reclaimed by the ruin of the Greek or Eaſtern, but ſtill perſiſting in their idolatry and wickedneſs; at the beginning of the tenth chapter, and under the ſound of this ſixth trumpet, is introduced a viſion preparative to the prophecies reſpecting the Weſtern Church, wherein an angel is repreſented, having in his hand a little book, or codicil, deſcribing the calamities that ſhould overtake that church. The meaſuring of the temple ſhows, that during all this period there will be ſome true Chriſtians, who will conform themſelves to the rule of God's word, even whilſt the outer court, that is, the external and more extenſive part of this temple or church, is trodden under foot by Gentiles, *i. e.* ſuch Chriſtians as, in their idolatrous worſhip and perſecuting practice, reſemble and outdo the Gentiles themſelves. Yet againſt theſe corrupters of religion there will always be ſome true witneſſes to proteſt, who, however they may be overborne at times, and in appearance reduced to death, yet will ariſe again from time to time, till at laſt they triumph and glorioſly aſcend. The eleventh chapter concludes with the ſounding of the ſeventh trumpet.

In the twelfth chapter, by the woman bearing a man-child is to be underſtood the Chriſtian church; by the great red dragon, the heathen Roman empire; by the man-child whom the woman bore, Conſtantine the Great; and by the war in heaven, the conteſts between the Chriſtian and Heathen religions.

In the thirteenth chapter, by the beaſt with ſeven heads and ten horns, unto whom the dragon gave his power, ſeat, and great authority, is to be underſtood, not Pagan but Chriſtian, not imperial but papal Rome; in ſubmitting to whoſe religion, the world did in effect ſubmit again to the religion of the dragon. The ten-horned beaſt therefore repreſents the Romiſh church and ſtate in general: but the beaſt with two horns like a lamb is the Roman clergy; and that image of the ten-horned beaſt, which the two-horned beaſt cauſed to be made, and inſpired with life, is the pope; whoſe number is 666, according to the numerical powers of the letters conſtituting the Roman name Λατεινος, *Latinus*, or its equivalent in *Hebrew*, רומיית *Romith.*

Λ	30	200	ר
Α	1	6	ו
Τ	300	40	מ
Ε	5	10	י
Ι	10	10	י
Ν	50	400	ת
Ο	70		
Σ	200		
	666	666	

Chapter xiv. By the lamb on Mount Sion is meant Jeſus; by the hundred forty and four thouſand, his church and followers; by the angel preaching the everlaſting

laſting goſpel, the firſt principal effort made towards a reformation by that public oppoſition formed againſt the worſhip of ſaints and images by emperors and biſhops in the eighth and ninth centuries; by the angel crying, "Babylon is fallen," the Waldenſes and Albigenſes, who pronounced the church of Rome to be the Apocalyptic Babylon, and denounced her deſtruction; and by the third angel Martin Luther and his fellow reformers, who proteſted againſt all the corruptions of the church of Rome as deſtructive to ſalvation. For an account of the doctrines and precepts contained in the Scriptures, ſee THEOLOGY. For proofs of their divine origin, ſee RELIGION, PROPHECY, and MIRACLES.

SCRIVENER, one who draws contracts, or whoſe buſineſs it is to place money at intereſt. If a ſcrivener be entruſted with a bond, he may receive the intereſt; and if he fail, the obligee ſhall bear the loſs: and ſo it is if he receive the principal and deliver up the bond; for being entruſted with the ſecurity itſelf, it muſt be preſumed that he is truſted with power to receive intereſt or principal; and the giving up the bond on payment of the money ſhall be a diſcharge thereof. But if a ſcrivener ſhall be entruſted with a mortgage-deed, he hath only authority to receive the intereſt, not the principal; the giving up the deed in this caſe not being ſufficient to reſtore the eſtate, but there muſt be a reconveyance, &c. It is held, where a ſcrivener puts out his client's money on a bad ſecurity, which upon inquiry might have been eaſily found ſo, yet he cannot in equity be charged to anſwer for the money; for it is here ſaid, no one would venture to put out money of another upon a ſecurity, if he were obliged to warrant and make it good in caſe a loſs ſhould happen, without any fraud in him.

SCROBICULUS CORDIS, the ſame as ANTICARDIUM.

SCROFANELLO, in *Ichthyology*, a name by which ſome have called a ſmall fiſh of the Mediterranean, more uſually known by the name of the *ſcorpæna*.

SCROLL, in *Heraldry*. See that article, chap. iv. ſect. 9. When the motto relates to the creſt, the ſcroll is properly placed above the achievement; otherwiſe it ſhould be annexed to the eſcutcheon. Thoſe of the order of knighthood are generally placed round ſhields.

SCROPHULA, the KING'S EVIL. See MEDICINE, Nº 349.

SCROPHULARIA, FIGWORT, a genus of plants belonging to the didynamia claſs, and in the natural method ranking under the 40th order, *Perſonatæ*. See BOTANY *Index*.

SCROTUM. See ANATOMY, Nº 220.

SCRUPLE, SCRUPULUS, or *Scrupulum*, the leaſt of the weights uſed by the ancients, which amongſt the Romans was the 24th part of an ounce, or the 3d part of a dram. The ſcruple is ſtill a weight among us, containing the 3d part of a dram, or 20 grains. Among goldſmiths it is 24 grains.

SCRUPLE, in *Chaldean Chronology*, is $\frac{1}{1080}$ part of an hour, called by the Hebrews *helakin*. Theſe ſcruples are much uſed by the Jews, Arabs, and other eaſtern people, in computations of time.

SCRUPLES of half Duration, an arch of the moon's orbit, which the moon's centre deſcribes from the beginning of an eclipſe to its middle.

SCRUPLES of Immerſion or *Incidence*, an arch of the moon's orbit, which her centre deſcribes from the beginning of the eclipſe to the time when its centre falls into the ſhadow.

SCRUPLES of Emerſion, an arch of the moon's orbit, which her centre deſcribes in the time from the firſt emerſion of the moon's limb to the end of the eclipſe.

SCRUTINY, (*Scrutinium*), in the primitive church, an examination or probation practiſed in the laſt week of Lent, on the catechumens, who were to receive baptiſm on the Eaſter-day. The ſcrutiny was performed with a great many ceremonies. Exorciſms and prayers were made over the heads of the catechumens; and on Palm Sunday, the Lord's Prayer and Creed were given them, which they were afterwards made to rehearſe. This cuſtom was more in uſe in the church of Rome than anywhere elſe; though it appears, by ſome miſſals, to have been likewiſe uſed, though much later, in the Gallican church. It is ſuppoſed to have ceaſed about the year 860. Some traces of this practice ſtill remain at Vienne in Dauphiné, and at Liege.

SCRUTINY, is alſo uſed, in the *Canon Law*, for a ticket or little paper billet, wherein at elections the electors write their votes privately, ſo as it may not be known for whom they vote. Among us the term *ſcrutiny* is chiefly uſed for a ſtrict peruſal and examination of the ſeveral votes haſtily taken at an election; in order to find out any irregularities committed therein, by unqualified voters, &c.

SCRUTORE, or SCRUTOIR (from the French *eſcritoire*), a kind of cabinet, with a door or lid opening downwards, for conveniency of writing on, &c.

SCRY, in falconry, denotes a large flock of fowl.

SCUDDING, the movement by which a ſhip is carried precipitately before a tempeſt. As a ſhip flies with amazing rapidity through the water whenever this expedient is put in practice, it is never attempted in a contrary wind, unleſs when her condition renders her incapable of ſuſtaining the mutual effort of the wind and waves any longer on her ſide, without being expoſed to the moſt imminent danger of being overſet.

A ſhip either ſcuds with a ſail extended on her foremaſt, or, if the ſtorm is exceſſive, without any ſail: which, in the ſea-phraſe, is called *ſcudding under bare poles*. In ſloops and ſchooners, and other ſmall veſſels, the ſail employed for this purpoſe is called the *ſquare ſail*. In large ſhips, it is either the foreſail at large, reefed, or with its gooſe-wings extended, according to the degree of the tempeſt; or it is the fore-top ſail, cloſe reefed, and lowered on the cap; which laſt is particularly uſed when the ſea runs ſo high as to becalm the foreſail occaſionally, a circumſtance which expoſes the ſhip to the danger of broaching to. The principal hazards incident to ſcudding are generally, a pooping ſea; the difficulty of ſteering, which expoſes the veſſel perpetually to the riſk of broaching to; and the want of ſufficient ſea-room. A ſea ſtriking the ſhip violently on the ſtern may daſh it inwards, by which ſhe muſt inevitably founder. In broaching to (that is, inclining ſuddenly to windward), ſhe is threatened with being immediately overturned; and, for want of ſea-room, ſhe is endangered

dangered by ſhipwreck on a lee-ſhore, a circumſtance too dreadful to require explanation.

SCULPONEÆ, among the Romans, a kind of ſhoes worn by ſlaves of both ſexes. Theſe ſhoes were only blocks of wood made hollow, like the French ſabots.

SCULPTURE,

1 Definition of ſculpture. Origin of it,

IS the art of carving wood or hewing ſtone into images. It is an art of the moſt remote antiquity, being practiſed, as there is reaſon to believe, before the general deluge. We are induced to aſſign to it this early origin, by conſidering the expedients by which, in the firſt ſtages of ſociety, men have every where ſupplied the place of alphabetic characters. Theſe, it is univerſally known, have been picture-writing, ſuch as that of the Mexicans, which, in the progreſs of refinement and knowledge, was gradually improved into the hieroglyphics of the Egyptians and other ancient nations. See HIEROGLYPHICS.

That mankind ſhould have lived near 1700 years, from the creation of the world to the flood of Noah, without falling upon any method to make their conceptions permanent, or to communicate them to a diſtance, is extremely improbable; eſpecially when we call to mind that ſuch methods of writing have been found, in modern times, among people much leſs enlightened than thoſe muſt have been who were capable of building ſuch a veſſel as the ark. But if the antediluvians were acquainted with any kind of writing, there can be little doubt of its being hieroglyphical writing. Mr Bryant has proved that the Chaldeans were poſſeſſed of that art before the Egyptians; and Beroſus * informs us, that a delineation of all the monſtrous forms which inhabited the chaos, when this earth was in that ſtate, was to be ſeen in the temple of Belus in Babylon. This delineation, as he deſcribes it, muſt have been a hiſtory in hieroglyphical characters; for it conſiſted of human figures with wings, with two heads, and ſome with the horns and legs of goats. This is exactly ſimilar to the hieroglyphical writing of the Egyptians; and it was preſerved, our author ſays, both in drawings and *engravings* in the temple of the god of Babylon. As Chaldea was the firſt peopled region of the earth after the flood, and as it appears from Pliny †, as well as from Beroſus, that the art of engraving on bricks baked in the ſun was there carried to a conſiderable degree of perfection at a very early period, the probability certainly is, that the Chaldeans derived the art of hieroglyphical writing, and conſequently the rudiments of the art of ſculpture, from their antediluvian anceſtors.

2 not ſolely from idolatry;

It is generally thought that ſculpture had its origin from idolatry, as it was found neceſſary to place before the people the images of their gods to enliven the fervour of their devotion: but this is probably a miſtake. The worſhip of the heavenly bodies, as the only gods of the heathen nations, prevailed ſo long before the deification of dead men was thought of (ſee POLYTHEISM), that we cannot ſuppoſe mankind to have been, during all that time, ignorant of the art of hieroglyphical writing. But the deification of departed heroes undoubtedly gave riſe to the almoſt univerſal practice of repreſenting the gods by images of a human form; and therefore we muſt conclude, that the elements of ſculpture were known before that art was employed to enliven the devotion of idolatrous worſhippers. The pyramids and obeliſks of Egypt, which were probably temples, or rather altars, dedicated to the ſun (ſee PYRAMID), were covered from top to bottom with hieroglyphical emblems of men, beaſts, birds, fiſhes, and reptiles, at a period prior to that in which there is any unexceptionable evidence that mere ſtatue-worſhip prevailed even in that nurſery of idolatry.

3 though it probably contributed to carry the art to perfection.

But though it appears thus evident that picture-writing was the firſt employment of the ſculptor, we are far from imagining that idolatrous worſhip did not contribute to carry his art to that perfection which it attained in ſome of the nations of antiquity. Even in the dark ages of Europe, when the other fine arts were almoſt extinguiſhed, the mummery of the church of Rome, and the veneration which ſhe taught for her ſaints and martyrs, preſerved among the Italians ſome veſtiges of the ſiſter-arts of ſculpture and painting; and therefore, as human nature is every where the ſame, it is reaſonable to believe that a ſimilar veneration for heroes and demigods would, among the ancient nations, have a ſimilar effect. But if this be ſo, the preſumption is, that the Chaldeans were the firſt who invented the art of hewing blocks of wood and ſtone into the figures of men and other animals; for the Chaldeans were unqueſtionably the firſt idolaters, and their early progreſs in ſculpture is confirmed by the united teſtimonies of Beroſus, Alexander Polyhiſtor, Apollodorus, and Pliny; not to mention the eaſtern tradition, that the father of Abraham was a ſtatuary.

4 Mr Bromley's theory, that ſculpture was invented by the Scythians,

Againſt this concluſion Mr Bromley, in his late Hiſtory of the Fine Arts, has urged ſome plauſible arguments. In ſtating theſe he profeſſes not to be original, or to derive his information from the fountain-head of antiquity. He adopts, as he tells us, the theory of a French writer, who maintains, that in the year of the world 1949, about 300 years after the deluge, the Scythians under Brouma, a deſcendant of Magog the ſon of Japhet, extended their conqueſts over the greater part of Aſia. According to this ſyſtem, Brouma was not only the civilizer of India, and the author of the braminical doctrines, but alſo diffuſed the principles of the Scythian mythology over Egypt, Phœnicia, Greece, and the continent of Aſia.

Of theſe principles Mr Bromley has given us no diſtinct enumeration; the account which he gives of them is not to be found in one place, but to be collected from a variety of diſtant paſſages. In attempting therefore to preſent the ſubſtance of his ſcattered hints in one view, we will not be confident that we have omitted none of them. The ox, ſays he, was the Scythian emblem of the generator of animal life, and hence it became the principal divinity of the Arabians. The ſerpent was the ſymbol of the ſource of intelligent nature. Theſe were the common points of union in all the firſt religions

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* *Apud Syncellum*, p. 37.

† *Hiſt. Nat.* lib. vii. cap. 56.

religions of the earth. From Egypt the Iſraelites carried with them a religious veneration for the ox and the ſerpent. Their veneration for the ox appeared ſoon after they marched into the wilderneſs, when in the abſence of Moſes they called upon Aaron to make them gods which ſhould go before them. The idea of having an idol to go before them, ſays our author, was completely Scythian; for ſo the Scythians acted in all their progreſs through Aſia, with this difference, that their idol was a living animal. The Iſraelites having gained their favourite god, which was an ox (not a calf as it is rendered in the book of Exodus), next proceeded to hold a feſtival, which was to be accompanied with dancing; a ſpecies of gaiety common in the feſtivals which were held in adoration of the emblematic *Urotal* or ox in that very part of Arabia near Mount Sinai where this event took place. It is mentioned too as a curious and important fact, that the ox which was revered in Arabia was called *Adonai*. Accordingly Aaron announcing the feaſt to the ox or golden calf, ſpeaks thus, *to-morrow is a feaſt to Adonai*, which is in our tranſlation rendered *to the lord*. In the time of Jeroboam we read of the golden calves ſet up as objects of worſhip at Bethel and Dan. Nor was the reverence paid to the ox confined to Scythia, to Egypt, and to Aſia; it extended much farther. The ancient Cimbri, as the Scythians did, carried an ox of bronze before them on all their expeditions. Mr Bromley alſo informs us, that as great reſpect was paid to the living ox among the Greeks as was offered to its ſymbol among other nations.

The emblem of the ſerpent, continues Mr Bromley, was marked yet more decidedly by the expreſs direction of the Almighty. That animal had ever been conſidered as emblematic of the ſupreme generating power of intelligent life: And was that idea, ſays he, diſcouraged, ſo far as it went to be a ſign or ſymbol of life? when God ſaid to Moſes, "Make thee a brazen ſerpent, and ſet it on a pole, and it ſhall come to paſs that every one who is bitten, when he looketh on it, ſhall live." In Egypt the ſerpent ſurrounded their Iſis and Oſiris, the diadems of their princes, and the bonnets of their prieſts. The ſerpents made a diſtinguiſhed figure in Grecian ſculpture. The fable of Echidne, the mother of the Scythians, gave her figure terminating as a ſerpent to all the founders of ſtates in Greece; from which their earlieſt ſculptors repreſented in that form the Titan princes, Cecrops, Draco, and even Ericthonius. Beſides the ſpear of the image of Minerva, which Phidias made for the citadel of Athens, he placed a ſerpent, which was ſuppoſed to guard that goddeſs.

The ſerpent was combined with many other figures. It ſometimes was coiled round an egg as an emblem of the creation; ſometimes round a trident, to ſhow its power over the ſea; ſometimes it encircled a flambeau, to repreſent life and death.

In Egypt, as well as in Scythia and India, the divinity was repreſented on the leaves of the tamara or lotus. Pan was worſhipped as a god in that country, as well as over the eaſt. Their ſphinxes, and all their combined figures of animal creation, took their origin from the mother of the Scythians, who brought forth an offspring that was half a woman and half a ſerpent. Their pyramids and obeliſks aroſe from the idea of flame; the firſt emblem of the ſupreme principle, introduced by the Scythians, and which even the influence of Zoroaſter and the Magi could not remove.

We are told that the Bacchus of the Greeks is derived from the Brouma of the Indians; that both are repreſented as ſeated on a ſwan ſwimming over the waves, to indicate that each was the god of humid nature, not the god of wine, but the god of waters. The mitre of Bacchus was ſhaped like half an egg; an emblem taken from this circumſtance, that at the creation the egg from which all things ſprung was divided in the middle. Pan alſo was revered among the Scythians; and from that people were derived all the emblems by which the Greeks repreſented this divinity.

It would be tedious to follow our author through the whole of this ſubject; and were we to ſubmit to the labour of collecting and arranging his ſcattered materials, we ſhould ſtill view his ſyſtem with ſome degree of ſuſpicion. It is drawn, as he informs us, from the work of M. D'Ancarville, intitled, *Recherches ſur l'Origine, l'Eſprit, et les Progres, des Arts de la Grece.*

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ill founded.

To form concluſions concerning the origin of nations, the riſe and progreſs of the arts and ſciences, without the aid of hiſtorical evidence, by analogies which are ſometimes accidental, and often fanciful, is a mode of reaſoning which cannot readily be admitted. There may indeed, we acknowledge, be reſemblances in the religion, language, manners, and cuſtoms, of different nations, ſo ſtriking and ſo numerous, that to doubt of their being deſcended from the ſame ſtock would ſavour of ſcepticiſm. But hiſtorical theories muſt not be adopted raſhly. We muſt be certain that the evidence is credible and ſatisfactory before we proceed to deduce any concluſions. We muſt firſt know whether the Scythian hiſtory itſelf be authentic, before we make any compariſon with the hiſtory of other nations. But what is called the Scythian hiſtory, every man of learning knows to be a collection of fables. Herodotus and Juſtin are the two ancient writers from whom we have the fulleſt account of that warlike nation; but theſe two hiſtorians contradict each other, and both write what cannot be believed of the ſame people at the ſame period of their progreſs. Juſtin tells us, that there was a long and violent conteſt between the Scythians and Egyptians about the antiquity of their reſpective nations; and after ſtating the arguments on each ſide of the queſtion, which, as he gives them *, are nothing to the purpoſe, he decides in favour of the claim of the Scythians. Herodotus was too partial to the Egyptians, not to give them the palm of antiquity: and he was probably in the right; for Juſtin deſcribes his moſt ancient of nations, even in the time of Darius Hyſtaſpes, as ignorant of all the arts of civil life. "They occupied their land in common (ſays he), and cultivated none of it. They had no houſes nor ſettled habitations, but wandered with their cattle from deſert to deſert. In theſe rambles they carried their wives and children in tumbrels covered with the ſkins of beaſts, which ſerved as houſes to protect them from the ſtorms of winter. They were without laws, governed by the dictates of natural equity. They coveted not gold or ſilver like the reſt of mankind, and lived upon milk and honey. Though they were expoſed to extreme cold, and had abundance of flocks, they knew not how to make garments of wool, but clothed themſelves in the ſkins of

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* Lib. ii. cap. i.

wild beaſts [†]." This is the moſt favourable account which any ancient writer gives of the Scythians. By Strabo [‡] and Herodotus [§] they are repreſented as the moſt ſavage of mortals, delighting in war and bloodſhed, cutting the throats of all ſtrangers who came among them, eating their fleſh, and making cups and pots of their ſkulls. Is it conceivable that ſuch ſavages could be ſculptors; or that, even ſuppoſing their manners to have been ſuch as Juſtin repreſents them, a people ſo ſimple and ignorant could have impoſed their mythology upon the Chaldeans, Phenicians, and Egyptians, whom we know by the moſt incontrovertible evidence to have been great and poliſhed nations ſo early as in the days of Abraham? No! We could as ſoon admit other novelties of more importance, with which the French of the preſent age pretend to enlighten the world, as this origin aſſigned by Mr Bromley to the art of ſculpture, unleſs ſupported by better authority than that of D'Ancarville.

The inference of our author from the name of the ſacred ox in Arabia, and from the dancing and gaiety which were common in the religious feſtivals of the Arabians, appears to us to be very haſtily drawn. At the early period of the departure of the Iſraelites from Egypt, the language of the Hebrews, Egyptians, and Arabians, differed not more from each other than do the different dialects of the Greek tongue which are found in the poems of Homer (ſee PHILOLOGY, Sect. III.); and it is certain, that for many years after the formation of the golden-calf, the Hebrews were ſtrangers to every ſpecies of idolatry but that which they had brought with them from their houſe of bondage. See REMPHAN.

Taking for granted, therefore, that the Scythians did not impoſe their mythology on the eaſtern nations, and that the art of ſculpture, as well as hieroglyphic writing and idolatrous worſhip, prevailed firſt among the Chaldeans, we ſhall endeavour to trace the progreſs of this art through ſome other nations of antiquity, till we bring it to Greece, where it was carried to the higheſt perfection to which it has yet attained.

The firſt intimation that we have of the art of ſculpture is in the book of Geneſis, where we are informed, that when Jacob, by the divine command, was returning to Canaan, his wife Rachel carried along with her the teraphim or idols of her father. Theſe we are aſſured were ſmall, ſince Rachel found it ſo eaſy to conceal them from her father, notwithſtanding his anxious ſearch. We are ignorant, however, how theſe images were made, or of what materials they were compoſed. The firſt perſon mentioned as an artiſt of eminence is Bezaleel, who formed the cherubims which covered the mercy-ſeat.

6 Egyptian ſculpture.

The Egyptians alſo cultivated the art of ſculpture; but there were two circumſtances which obſtructed its progreſs. 1. The perſons of the Egyptians were not poſſeſſed of the graces of form, of elegance, or of ſymmetry; and of conſequence they had no perfect ſtandard to model their taſte. They reſembled the Chineſe in the caſt of their face, in their great bellies, and in the clumſy rounding of their contours. 2. They were reſtrained by their laws to the principles and practices of their anceſtors, and were not permitted to introduce any innovations. Their ſtatues were always formed in the ſame ſtiff attitude, with the arms hanging perpendicularly down the ſides. What perfection were they capable of who knew no other attitude than that of chairmen? So far were they from attempting any improvements, that in the time of Adrian the art continued in the ſame rude ſtate as at firſt; and when their ſlaviſh adulation for that emperor induced them to place the ſtatue of his favourite Antinous among the objects of their worſhip, the ſame inanimate ſtiffneſs in the attitude of the body and poſition of the arms was obſerved. We believe it will ſcarcely be neceſſary to inform our readers that the Egyptian ſtatue juſt now mentioned is very different from the celebrated ſtatue of Antinous, of which ſo many moulds have been taken that imitations of it are now to be met with almoſt in every cabinet in Europe.

Notwithſtanding the attachment of the Egyptians to ancient uſages, Winkelman thinks he has diſcovered two different ſtyles of ſculpture which prevailed at different periods. The firſt of theſe ends with the conqueſt of Egypt by Cambyſes. The ſecond begins at that time, and extends beyond the reign of Alexander the Great.

7 Firſt ſtyle.

In the firſt ſtyle, the lines which form the contour are ſtraight and projecting a little; the poſition is ſtiff and unnatural: In ſitting figures the legs are parallel, the feet ſqueezed together, and the arms fixed to the ſides; but in the figures of women the left arm is folded acroſs the breaſt; the bones and muſcles are faintly diſcernible; the eyes are flat and looking obliquely, and the eyebrows ſunk—features which deſtroy entirely the beauty of the head; the cheek-bones are high, the chin ſmall and piked; the ears are generally placed higher than in nature, and the feet are too large and flat. In ſhort, if we are to look for any model in the ſtatues of Egypt, it is not for the model of beauty but of deformity. The ſtatues of men are naked, only they have a ſhort apron, and a few folds of drapery ſurrounding their waiſt: The veſtments of women are only diſtinguiſhable by the border, which riſes a little above the ſurface of the ſtatue. In this age it is evident the Egyptians knew little of drapery.

8 Second ſtyle.

Of the ſecond ſtyle of ſculpture practiſed among the Egyptians, Winkelman thinks he has found ſpecimens in the two figures of baſaltes in the Capitol, and in another figure at Villa Albani, the head of which has been renewed. The firſt two of theſe, he remarks, bear viſible traces of the former ſtyle, which appear eſpecially in the form of the mouth and ſhortneſs of the chin. The hands poſſeſs more elegance; and the feet are placed at a greater diſtance from each other, than was cuſtomary in more ancient times. In the firſt and third figures the arms hang down cloſe to the ſides. In the ſecond they hang more freely. Winkelman ſuſpects that theſe three ſtatues have been made after the conqueſt of Egypt by the Greeks. They are clothed with a tunic, a robe, and a mantle. The tunic, which is puckered into many folds, deſcends from the neck to the ground. The robe in the firſt and third ſtatues ſeems cloſe to the body, and is only perceptible by ſome little folds. It is tied under the breaſt, and covered by the mantle, the two buttons of which are placed under the epaulet.

The Antinous of the Capitol is compoſed of two pieces, which are joined under the haunches. But as all the Egyptian ſtatues which now remain have been hewn out of one block, we muſt believe that Diodorus,

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[†] Lib. ii. cap. 2.

[‡] Lib. vi.

[§] Lib. iv. cap. 62.

in ſaying the ſtone was divided, and each half finiſhed by a ſeparate artizan, ſpoke only of a coloſſus. The ſame author informs us, that the Egyptians divided the human body into 24¼ parts; but it is to be regretted that he has not given a more minute detail of that diviſion.

The Egyptian ſtatues were not only formed by the chiſel, they were alſo poliſhed with great care. Even thoſe on the ſummit of an obeliſk, which could only be viewed at a diſtance, were finiſhed with as much labour and care as if they had admitted a cloſe inſpection. As they are generally executed in granite or baſaltes, ſtones of a very hard texture, it is impoſſible not to admire the indefatigable patience of the artiſts.

The eye was often of different materials from the reſt of the ſtatue; ſometimes it was compoſed of a precious ſtone or metal. We are aſſured that the valuable diamond of the empreſs of Ruſſia, the largeſt and moſt beautiful hitherto known, formed one of the eyes of the famous ſtatue of Scheringham in the temple of Brama.

Thoſe Egyptian ſtatues which ſtill remain are compoſed of wood or baked earth: and the ſtatues of earth are covered with green enamel.

9 Phenician ſculpture.

The Phenicians poſſeſſed both a character and ſituation highly favourable to the cultivation of ſtatuary. They had beautiful models in their own perſons, and their induſtrious character qualified them to attain perfection in every art for which they had a taſte. Their ſituation raiſed a ſpirit of commerce, and commerce induced them to cultivate the arts. Their temples ſhone with ſtatues and columns of gold, and a profuſion of emeralds was every where ſcattered. All the great works of the Phenicians have been unfortunately deſtroyed; but many of the Carthaginian medals are ſtill preſerved, ten of which are depoſited in the cabinet of the grand duke of Florence. But though the Carthaginians were a colony of Phenicians, we cannot from their works judge of the merit of their anceſtors.

10 This art not cultivated among the Perſians.

The Perſians made no diſtinguiſhed figure in the arts of deſign. They were indeed ſenſible to the charms of beauty, but they did not ſtudy to imitate them. Their dreſs, which conſiſted of long flowing robes concealing the whole perſon, prevented them from attending to the beauties of form. Their religion, too, which taught them to worſhip the divinity in the emblem of fire, and that it was impious to repreſent him under a human form, ſeemed almoſt to prohibit the exerciſe of this art, by taking away thoſe motives which alone could give it dignity and value; and as it was not cuſtomary among them to raiſe ſtatues to great men, it was impoſſible that ſtatuary could flouriſh in Perſia.

11 Etrurian ſculpture.

The Etrurians or ancient Tuſcans, in the opinion of Winkelman, carried this art to ſome degree of perfection at an earlier period than the Greeks. It is ſaid to have been introduced before the ſiege of Troy by Dedalus, who, in order to eſcape the reſentment of Minos king of Crete, took refuge in Sicily, from whence he paſſed into Italy, where he left many monuments of his art. Pauſanias and Diodorus Siculus informs us, that ſome works aſcribed by him were to be ſeen when they wrote, and that theſe poſſeſſed that character of majeſty which afterwards diſtinguiſhed the labours of Etruria.

A character ſtrongly marked forms the chief diſtinction in thoſe productions of Etruria which have deſcended to us. Their ſtyle was indeed harſh and overcharged; a fault alſo committed by Michael Angelo, the celebrated painter of modern Etruria; for it is not to be ſuppoſed that a people of ſuch rude manners as the Etrurians could communicate to their works that vividneſs and beauty which the elegance of Grecian manners inſpired. On the other hand, there are many of the Tuſcan ſtatues which bear ſo cloſe a reſemblance to thoſe of Greece, that antiquarians have thought it probable that they were conveyed from that country, or Magna Græcia, into Etruria, about the time of the Roman conqueſt, when Italy was adorned with the ſpoils of Greece.

12 Firſt ſtyle.

Among the monuments of Etrurian art two different ſtyles have been obſerved. In the firſt the lines are ſtraight, the attitude ſtiff, and no idea of beauty appears in the formation of the head. The contour is not well rounded, and the figure is too ſlender. The head is oval, the chin piked, the eyes flat, and looking aſquint.

Theſe are the defects of an art in a ſtate of infancy, which an accompliſhed maſter could never fall into, and are equally conſpicuous in Gothic ſtatues as in the productions of the ancient natives of Florence. They reſemble the ſtyle of the Egyptians ſo much, that one is almoſt induced to ſuppoſe that there had once been a communication between theſe two nations; but others think that this ſtyle was introduced by Dedalus.

13 Second ſtyle.

Winkelman ſuppoſes that the ſecond epoch of this art commenced in Etruria, about the time at which it had reached its greateſt perfection in Greece, in the age of Phidias; but this conjecture is not ſupported by any proofs. To deſcribe the ſecond ſtyle of ſculpture among the Etrurians, is almoſt the ſame as to deſcribe the ſtyle of Michael Angelo and his numerous imitators. The joints are ſtrongly marked, the muſcles raiſed, the bones diſtinguiſhable; but the whole mien harſh. In deſigning the bone of the leg, and the ſeparation of the muſcles of the calf, there is an elevation and ſtrength above life. The ſtatues of the gods are deſigned with more delicacy. In forming them, the artiſts were anxious to ſhow that they could exerciſe their power without that violent diſtenſion of the muſcles which is neceſſary in the exertions of beings merely human; but in general their attitudes are unnatural, and the actions ſtrained. If a ſtatue, for inſtance, hold any thing with its fore fingers, the reſt are ſtretched out in a ſtiff poſition.

According to ancient hiſtory, the Greeks did not emerge from the ſavage ſtate till a long time after the Egyptians, Chaldeans, and Indians, had arrived at a conſiderable degree of civilization. The original rude inhabitants of Greece were civilized by colonies which arrived among them, at different times, from Egypt and Phenicia. Theſe brought along with them the religion, the letters, and the arts of their parent countries: and if ſculpture had its origin from the worſhip of idols, there is reaſon to believe that it was one of the arts which were thus imported; for that the gods of Greece were of Egyptian and Phenician extraction is a fact incontrovertible; (ſee MYSTERIES, MYTHOLOGY, PHILOLOGY, Sect. VII. PHILOSOPHY, N° 19, and TITAN). The original ſtatues of the gods, however, were very rude. The earlieſt objects of idolatrous worſhip

worſhip have everywhere been the heavenly bodies; and the ſymbols conſecrated to them were generally pillars of a conical or pyramidal figure. It was not till hero-worſhip was engrafted on the planetary, that the ſculptor thought of giving to the ſacred ſtatue any part of the human form (ſee POLYTHEISM, N° 19, 23.); and it appears to have been about the era of their revolution in idolatry that the art of ſculpture was introduced among the Greeks. The firſt repreſentations of their gods were round ſtones placed upon cubes or pillars; and theſe ſtones they afterwards formed roughly, ſo as to give them ſomething of the appearance of a head. Agreeable to this deſcription was a Jupiter, which Pauſanias ſaw in Tegeum, in Arcadia. Theſe repreſentations were called *Hermes;* not that they repreſented Mercury, but from the word *Herma,* which ſignified a rough ſtone. It is the name which Homer gives to the ſtones which were uſed to fix veſſels to the ſhore. Pauſanias ſaw at Pheres 30 deities made of unformed blocks or cubical ſtones. The Lacedæmonians repreſented Caſtor and Pollux by two parallel poſts; and a tranſverſe beam was added, to expreſs their mutual affection.

If the Greeks derived from foreign nations the rudiments of the arts, it muſt redound much to their honour, that in a few centuries they carried them to ſuch wonderful perfection as entirely to eclipſe the fame of their maſters. It is by tracing the progreſs of ſculpture among them that we are to ſtudy the hiſtory of this art; and we ſhall ſee its origin and ſucceſſive improvements correſpond with nature, which always operates ſlowly and gradually.

View of Grecian Sculpture.

14 Cauſes which promoted the art of ſculpture in Greece.

THE great ſuperiority of the Greeks in the art of ſculpture may be aſcribed to a variety of cauſes. The influence of climate over the human body is ſo ſtriking, that it muſt have fixed the attention of every thinking man who has reflected on the ſubject. The violent heats of the torrid zone, and the exceſſive cold of the polar regions, are unfavourable to beauty. It is only in the mild climates of the temperate regions that it appears in its moſt attractive charms. Perhaps no country in the world enjoys a more ſerene air, leſs tainted with miſt and vapours, or poſſeſſes in a higher degree that mild and genial warmth which can unfold and expand the human body into all the ſymmetry of muſcular ſtrength, and all the delicacies of female beauty in greater perfection, than the happy climate of Greece; and never was there any people that had a greater taſte for beauty, or were more anxious to improve it. Of the four wiſhes of Simonides, the ſecond was to have a handſome figure. The love of beauty was ſo great among the Lacedæmonian women, that they kept in their chambers the ſtatues of Nereus, of Narciſſus, of Hyacinthus, and of Caſtor and Pollux; hoping that by often contemplating them they might have beautiful children.

There was a variety of circumſtances in the noble and virtuous freedom of the Grecian manners that rendered theſe models of beauty peculiarly ſubſervient to the cultivation of the fine arts. There were no tyrannical laws, as among the Egyptians, to check their progreſs. They had the beſt opportunities to ſtudy them in the public places, where the youth, who needed no other veil than chaſtity and purity of manners, performed their various exerciſes quite naked. They had the ſtrongeſt motives to cultivate ſculpture, for a ſtatue was the higheſt honour which public merit could attain. It was an honour ambitiouſly ſought, and granted only to thoſe who had diſtinguiſhed themſelves in the eyes of their fellow citizens. As the Greeks preferred natural qualities to acquired accompliſhments, they decreed the firſt rewards to thoſe who excelled in agility and ſtrength of body. Statues were often raiſed to wreſtlers. Even the moſt eminent men of Greece, in their youth, ſought renown in gymnaſtic exerciſes. Chryſippus and Cleanthes diſtinguiſhed themſelves in the public games before they were known as philoſophers. Plato appeared as a wreſtler both at the Iſthmian and Pythian games; and Pythagoras carried off the prize at Elis, (ſee PYTHAGORAS). The paſſion by which they were inſpired was the ambition of having their ſtatues erected in the moſt ſacred place of Greece, to be ſeen and admired by the whole people. The number of ſtatues erected on different occaſions was immenſe; of courſe the number of artiſts muſt have been great, their emulation ardent, and their progreſs rapid.

As moſt of their ſtatues were decreed for thoſe who vanquiſhed in the public games, the artiſts had the opportunity of ſeeing excellent models; for thoſe who ſurpaſſed in running, boxing, and wreſtling, muſt in general have been well formed, yet would exhibit different kinds of beauty.

The high eſtimation in which ſculptors were held was very favourable to their art. Socrates declared the artiſts the only wiſe men. An artiſt could be a legiſlator, a commander of armies, and might hope to have his ſtatue placed beſide thoſe of Miltiades and Themiſtocles, or thoſe of the gods themſelves. Beſides, the honour and ſucceſs of an artiſt did not depend on the caprice of pride or of ignorance. The productions of art were eſtimated and rewarded by the greateſt ſages in the general aſſembly of Greece, and the ſculptor who had executed his work with ability and taſte was confident of obtaining immortality.

It was the opinion of Winkelman, that liberty was highly favourable to this art; but, though liberty is abſolutely neceſſary to the advancement of ſcience, it may be doubted whether the fine arts owe their improvement to it. Sculpture flouriſhed moſt in Greece, when Pericles exerciſed the power of a king; and in the reign of Alexander, when Greece was conquered. It attained no perfection in Rome till Auguſtus had enſlaved the Romans. It revived in Italy under the patronage of the family of Medici, and in France under the deſpotic rule of Louis XIV. It is the love of beauty, luxury, wealth, or the patronage of a powerful individual, that promotes the progreſs of this art.

15 Grecian ideas of beauty.

16 The profile.

It will now be proper to give a particular account of the ideas which the Greeks entertained concerning the ſtandard of beauty in the different parts of the human body. And with reſpect to the head, the profile which they chiefly admired is peculiar to dignified beauty. It conſiſts in a line almoſt ſtraight, or marked by ſuch ſlight and gentle inflections as are ſcarcely diſtinguiſhable from a ſtraight line. In the figures of women and young perſons, the forehead and noſe form a line approaching to a perpendicular.

17 The forehead. Ancient writers, as well as artiſts, aſſure us that the Greeks reckoned a ſmall forehead a mark of beauty, and a high forehead a deformity. From the ſame idea, the Circaſſians wore their hair hanging down over their foreheads almoſt to their eyebrows. To give an oval form to the countenance, it is neceſſary that the hair ſhould cover the forehead, and thus make a curve about the temples; otherwiſe the face, which terminates in an oval form in the inferior part, will be angular in the higher part, and the proportion will be deſtroyed. This rounding of the forehead may be ſeen in all handſome perſons, in all the heads of ideal beauty in ancient ſtatues, and eſpecially in thoſe of youth. It has been overlooked, however, by modern ſtatuaries. Bernini, who modelled a ſtatue of Louis XIV. in his youth, turned back the hair from the forehead.

18 The eyes. It is generally agreed that large eyes are beautiful; but their ſize is of leſs importance in ſculpture than their form, and the manner in which they are enchaſed. In ideal beauty, the eyes are always ſunk deeper than they are in nature, and conſequently the eyebrows have a greater projection. But in large ſtatues, placed at a certain diſtance, the eyes, which are of the ſame colour with the reſt of the head, would have little effect if they were not ſunk. By deepening the cavity of the eye, the ſtatuary increaſes the light and ſhade, and thus gives the head more life and expreſſion. The ſame practice is uſed in ſmall ſtatues. The eye is a characteriſtic feature in the heads of the different deities. In the ſtatues of Apollo, Jupiter, and Juno, the eye is large and round. In thoſe of Pallas they are alſo large; but by lowering the eyelids, the virgin air and expreſſion of modeſty are delicately marked. Venus has ſmall eyes, and the lower eyelid being raiſed a little, gives them a languiſhing look and enchanting ſweetneſs. It is only neceſſary to ſee the Venus de Medicis to be convinced that large eyes are not eſſential to beauty, eſpecially if we compare her ſmall eyes with thoſe which reſemble them in nature. The beauty of the eyebrows conſiſts in the fineneſs of the hair, and in the ſharpneſs of the bone which covers them; and maſters of the art conſidered the joining of the eyebrows as a deformity, though it is ſometimes to be met with in ancient ſtatues.

19 The mouth. The beauty of the mouth is peculiarly neceſſary to conſtitute a fine face. The lower lip muſt be fuller than the upper, in order to give an elegant rounding to the chin. The teeth ſeldom appear, except in laughing ſatyrs. In human figures the lips are generally cloſe, and a little opened in the figures of the gods. The lips of Venus are half open.

In figures of ideal beauty, the Grecian artiſts never interrupted the rounding of the chin by introducing a dimple: for this they conſidered not as a mark of beauty, and only to be admitted to diſtinguiſh individuals. The dimple indeed appears in ſome ancient ſtatues, but antiquaries ſuſpect it to be the work of a modern hand. It is ſuſpected alſo, that the dimple which is ſometimes found on the cheeks of ancient ſtatues is a modern innovation.

20 The ears. No part of the head was executed by the ancients with more care than the ears, though little attention has been given to them by modern artiſts. This character is ſo deciſive, that if we obſerve in any ſtatue that the ears are not highly finiſhed, but only roughly marked, we may conclude with certainty that we are examining a modern production. The ancients were very attentive to copy the preciſe form of the ear in taking likeneſſes. Thus, where we meet with a head the ears of which have a very large interior opening, we know it to be the head of Marcus Aurelius.

21 The hair. The manner in which the ancient artiſts formed the hair alſo enables us to diſtinguiſh their works from thoſe of the moderns. On hard and coarſe ſtones the hair was ſhort, and appeared as if it had been combed with a wide comb; for that kind of ſtone was difficult to work, and could not without immenſe labour be formed into curled and flowing hair. But the figures executed in marble in the moſt flouriſhing period of the art have the hair curled and flowing; at leaſt where the head was not intended to be an exact reſemblance, for then the artiſt conformed to his model. In the heads of women, the hair was thrown back, and tied behind in a waving manner, leaving conſiderable intervals; which gives the agreeable variety of light and ſhade, and produces the effects of the claro-obſcuro. The hair of the Amazons is diſpoſed in this manner. Apollo and Bacchus have their hair falling down their ſhoulders; and young perſons, till they arrived at manhood, wore their hair long. The colour of the hair which was reckoned moſt beautiful, was fair; and this they gave without diſtinction to the moſt beautiful of their gods, Apollo and Bacchus, and likewiſe to their moſt illuſtrious heroes.

22 The hands. Although the ravages of time have preſerved but few of the hands or feet of ancient ſtatues, it is evident from what remains how anxious the Grecian artiſts were to give every perfection to theſe parts. The hands of young perſons were moderately plump, with little cavities or dimples at the joints of the fingers. The fingers tapered very gently from the root to the point, like well-proportioned columns, and the joints were ſcarcely perceptible. The terminating joint was not bent, as it commonly appears in modern ſtatues.

23 The legs and feet. In the figures of young men the joints of the knee are faintly marked. The knee unites the leg to the thigh without making any remarkable projections or cavities. The moſt beautiful legs and beſt-turned knees, according to Winkelman, are preſerved in the Apollo Saurocthones, in the Villa Borgheſe; in the Apollo which has a ſwan at its feet; and in the Bacchus of Villa Medicis. The ſame able connoiſſeur remarks, it is rare to meet with beautiful knees in young perſons, or in the elegant repreſentations of art. As the ancients did not cover the feet as we do, they gave to them the moſt beautiful turning, and ſtudied the form of them with the moſt ſcrupulous attention.

24 The breaſt and lower part of the body. The breaſts of men were large and elevated. The breaſts of women did not poſſeſs much amplitude. The figures of the deities have always the breaſts of a virgin, the beauty of which the ancients made to conſiſt in a gentle elevation. So anxious were the women to reſemble this ſtandard, that they uſed ſeveral arts to reſtrain the growth of their breaſts. The breaſts of the nymphs and goddeſſes were never repreſented ſwelling, becauſe that is peculiar to thoſe women who ſuckle. The paps of Venus contract and end in a point, this being conſidered as an eſſential characteriſtic of perfect beauty. Some of the moderns have tranſgreſſed theſe rules, and have fallen into great improprieties.

The lower part of the body in the ſtatues of men was formed like that of the living body after a profound ſleep and good digeſtion. The navel was conſiderably ſunk, eſpecially in female ſtatues.

25 Ideal beauty.

As beauty never appears in equal perfection in every part of the ſame individual, perfect or ideal beauty can only be produced by ſelecting the moſt beautiful parts from different models; but this muſt be done with ſuch judgment and care, that theſe detached beauties when united may form the moſt exact ſymmetry. Yet the ancients ſometimes confined themſelves to one individual, even in the moſt flouriſhing age. Theodorus, whom Socrates and his diſciples viſited, ſerved as a model to the artiſts of his time. Phryne alſo appears to have been a model to the painters and ſculptors. But Socrates, in his converſation with Parrhaſius, ſays, that when a perfect beauty was to be produced, the artiſts joined together the moſt ſtriking beauties which could be collected from the fineſt figures. We know that Zeuxis, when he was going to paint Helen, united in one picture all the beauties of the moſt handſome women of Crotona.

26 The drapery of ſtatues.

The Grecian ſculptors, who repreſented with ſuch ſucceſs the moſt perfect beauty of the human form, were not regardleſs of the drapery of their ſtatues. They clothed their figures in the moſt proper ſtuff, which they wrought into that ſhape which was beſt calculated to give effect to their deſign.

The veſtments of women in Greece generally conſiſted of linen cloth, or ſome other light ſtuff, and in latter times of ſilk and ſometimes of woollen cloth. They had alſo garments embroidered with gold. In the works of ſculpture, as well as in thoſe of painting, one may diſtinguiſh the linen by its tranſparency and ſmall united folds. The other light ſtuffs which were worn by the women (A) were generally of cotton produced in the iſle of Cos; and theſe the art of ſtatuary was able to diſtinguiſh from the linen veſtments. The cotton cloth was ſometimes ſtriped, and ſometimes embelliſhed with a profuſion of flowers. Silk was alſo employed; but whether it was known in Greece before the time of the Roman emperors cannot eaſily be determined. In paintings, it is diſtinguiſhable by changing its colour in different lights to red, violet, and ſky-blue. There were two ſorts of purple; that which the Greeks called the *colour of the ſea*, and Tyrian purple, which reſembled lac. Woollen garments are eaſily known by the amplitude of their folds. Beſides theſe, cloth of gold ſometimes compoſed their drapery: but it was not like the modern fabric, conſiſting of a thread of gold or of ſilver ſpun with a thread of ſilk; it was compoſed of gold or ſilver alone, without any mixture.

The veſtments of the Greeks, which deſerve particular attention, are the tunic, the robe, and the mantle.

27 The tunic.

The tunic was that part of the dreſs which was next to the body. It may be ſeen in ſleeping figures, or in thoſe in diſhabille; as in the Flora Farneſe, and in the ſtatues of the Amazons in the Capitol. The youngeſt of the daughters of Niobe, who throws herſelf at her mother's ſide, is clothed only with a tunic. It was of linen, or ſome other light ſtuff, without ſleeves, fixed to the ſhoulders by a button, ſo as to cover the whole breaſt. None but the tunics of the goddeſs Ceres and comedians have long ſtraight ſleeves.

28 The robe.

The robes of women commonly conſiſted of two long pieces of woollen cloth, without any particular form, attached to the ſhoulders by a great many buttons, and ſometimes by a claſp. They had ſtraight ſleeves which came down to the wriſts. The young girls, as well as the women, faſtened their robe to their ſide by a cincture, in the ſame way as the high-prieſt of the Jews faſtened his, as it is ſtill done in many parts of Greece. The cincture formed on the ſide a knot of ribbons ſometimes reſembling a roſe in ſhape, which has been particularly remarked in the two beautiful daughters of Niobe. In the younger of theſe the cincture is ſeen paſſing over the ſhoulders and the back. Venus has two cinctures, the one paſſing over the ſhoulder, and the other ſurrounding the waiſt. The latter is called *ceſtus* by the poets.

29 The mantle.

The mantle was called *peplon* by the Greeks, which ſignifies properly the mantle of Pallas. The name was afterwards applied to the mantles of the other gods, as well as to thoſe of men. This part of the dreſs was not ſquare, as ſome have imagined, but of a roundiſh form. The ancients indeed ſpeak in general of ſquare mantles, but they received this ſhape from four taſſels which were affixed to them; two of theſe were viſible, and two were concealed under the mantle. The mantle was brought under the right arm, and over the left ſhoulder; ſometimes it was attached to the ſhoulder by two buttons, as may be ſeen in the beautiful ſtatue of Leucothoe at Villa Albani.

30 The colour of the veſtments.

The colour of veſtments peculiar to certain ſtatues is too curious to be omitted. To begin with the figures of the gods.—The drapery of Jupiter was red, that of Neptune is ſuppoſed by Winkelman to have been ſea-green. The ſame colour alſo belonged to the Nereids and Nymphs. The mantle of Apollo was blue or violet. Bacchus was dreſſed in white. Martianus Capella aſſigns green to Cybele. Juno's veſtments were ſky-blue, but ſhe ſometimes had a white veil. Pallas was robed in a flame-coloured mantle. In a painting of Herculaneum, Venus is in flowing drapery of a golden yellow. Kings were arrayed in purple; prieſts in white; and conquerors ſometimes in ſea-green.

With reſpect to the head, women generally wore no covering but their hair; when they wiſhed to cover their head, they uſed the corner of their mantle.—Sometimes we meet with veils of a fine tranſparent texture. Old women wore a kind of bonnet upon their head, an example of which may be ſeen in a ſtatue in the Capitol, called the *Præfica*; but Winkelman thinks it is a ſtatue of Hecuba.

The covering of the feet conſiſted of ſhoes or ſandals. The ſandals were generally an inch thick, and compoſed of more than one ſole of cork. Thoſe of Pallas in Villa Albani has two ſoles, and other ſtatues had no leſs than five.

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(A) Men ſometimes wore cotton, but all who did ſo were reckoned effeminate.

31
Four ſtyles of this art among the Greeks.

WINKELMAN has aſſigned four different ſtyles to this art. The *ancient* ſtyle, which continued until the time of Phidias; the *grand* ſtyle, formed by that celebrated ſtatuary; the *beautiful*, introduced by Praxiteles, Apelles, and Lyſippus; and the *imitative* ſtyle, practiſed by thoſe artiſts who copied the works of the ancient maſters.

32
The ancient ſtyle.

The moſt authentic monuments of the ancient ſtyle are medals, containing an inſcription, which leads us back to very diſtant times. The writing is from right to left in the Hebrew manner; a uſage which was abandoned before the time of Herodotus. The ſtatue of Agamemnon at Elis, which was made by Ornatas, has an inſcription from right to left. This artiſan flouriſhed 50 years before Phidias; it is in the intervening period therefore between theſe two artiſts, that we are to look for the ceſſation of this practice. The ſtatues formed in the ancient ſtyle were neither diſtinguiſhed by beauty of ſhape nor by proportion, but bore a cloſe reſemblance to thoſe of the Egyptians and Etrurians (B); the eyes were long and flat; the ſection of the mouth not horizontal; the chin was pointed; the curls of the hair were ranged in little rings, and reſembled grains incloſed in a heap of raiſins. What was ſtill worſe, it was impoſſible by inſpecting the head to diſtinguiſh the ſex.

The characters of this ancient ſtyle were theſe: The deſigning was energetic, but harſh; it was animated, but without gracefulneſs; and the violence of the expreſſion deprived the whole figure of beauty.

33
The grand ſtyle.

The grand ſtyle was brought to perfection by Phidias, Polycletus, Scopas, Alcamenes, Myron, and other illuſtrious artiſts. It is probable, from ſome paſſages of ancient writers, that in this ſtyle were preſerved ſome characters of the ancient manner, ſuch as the ſtraight lines, the ſquares and angles. The ancient maſters, ſuch as Polycletus, being the legiſlators of proportions, ſays Winkelman, and of conſequence thinking they had a right to diſtribute the meaſures and dimenſions of the parts of the human body, have undoubtedly ſacrificed ſome degree of the form of beauty to a grandeur which is harſh, in compariſon of the flowing contours and graceful forms of their ſucceſſors.—The moſt conſiderable monuments of the grand ſtyle are the ſtatues of Niobe and her daughters, and a figure of Pallas, to be ſeen in Villa Albani; which, however, muſt not be confounded with the ſtatue which is modelled according to the firſt ſtyle, and is alſo found in the ſame place. The head poſſeſſes all the characters of dignified beauty, at the ſame time exhibiting the rigidneſs of the ancient ſtyle. The face is defective in gracefulneſs; yet it is evident how eaſy it would have been to give the features more roundneſs and grace. The figures of Niobe and her daughters have not, in the opinion of Winkelman, that auſterity of appearance which marks the age of the ſtatue of Pallas. They are characteriſed by grandeur and ſimplicity: ſo ſimple are the forms, that they do not appear to be the tedious productions of art, but to have been created by an inſtantaneous effort of nature.

34
The graceful ſtyle.

The third ſtyle was the graceful or beautiful. Lyſippus was perhaps the artiſt who introduced this ſtyle. Being more converſant than his predeceſſors with the ſweet, the pure, the flowing, and the beautiful lines of nature, he avoided the ſquare forms which the maſters of the ſecond ſtyle had too much employed. He was of opinion that the uſe of the art was rather to pleaſe than to aſtoniſh, and that the aim of the artiſt ſhould be to raiſe admiration by giving delight. The artiſts who cultivated this ſtyle did not, however, neglect to ſtudy the ſublime works of their predeceſſors. They knew that grace is conſiſtent with the moſt dignified beauty, and that it poſſeſſes charms which muſt ever pleaſe: they knew alſo that theſe charms are enhanced by dignity. Grace is infuſed into all the movements and attitudes of their ſtatues, and it appears in the delicate turns of the hair, and even in the adjuſting of the drapery. Every ſort of grace was well known to the ancients; and great as the ravages of time have been amongſt the works of art, ſpecimens are ſtill preſerved, in which can be diſtinguiſhed *dignified* beauty, *attractive* beauty, and a beauty *peculiar to infants*. A ſpecimen of dignified beauty may be ſeen in the ſtatue of one of the muſes in the palace of Barberini at Rome; and in the garden of the pope, on the Quirinal, is a ſtatue of another muſe, which affords a fine inſtance of attractive beauty. Winkelman ſays that the moſt excellent model of infant beauty which antiquity has tranſmitted to us is a ſatyr of a year old, which is preſerved, though a little mutilated, in Villa Albani.

35
The imitative ſtyle.

The great reputation of Praxiteles and Apelles raiſed an ardent emulation in their ſucceſſors, who deſpairing to ſurpaſs ſuch illuſtrious maſters, were ſatisfied with imitating their works. But it is well known that a mere imitator is always inferior to the maſter whom he attempts to copy. When no original genius appears, the art muſt therefore decline.

36
Materials of Grecian ſtatues.

CLAY was the firſt material which was employed in ſtatuary. An inſtance of this may be ſeen in a figure of Alcamenes in bas-relief in Villa Albani. The ancients uſed their fingers, and eſpecially their nails, to render certain parts more delicate and lively: hence

37
Clay and plaſter.

aroſe the phraſe *ad unguem factus homo*, "an accompliſhed man." It was the opinion of Count Caylus that the ancients did not uſe models in forming their ſtatues. But to diſprove this, it is only neceſſary to mention an engraving on a ſtone in the cabinet of Stoſch, which repreſents Prometheus engraving the figure of a man, with a plummet in his hand to meaſure the proportions of his model. The ancients as well as the moderns made works in plaſter; but no ſpecimens remain except ſome figures in bas-relief, of which the moſt beautiful were found at Baia.

38
Ivory, ſilver, and gold.

The works made of ivory and ſilver were generally of a ſmall ſize. Sometimes, however, ſtatues of a prodigious ſize were formed of gold and ivory. The coloſſal Minerva of Phidias, which was compoſed of theſe materials, was 26 cubits high. It is indeed ſcarcely

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(B) This is a proof additional to thoſe that will be found in the articles to which we have referred, that the Greeks received the rudiments of the art of ſculpture from the nations to which they were confeſſedly indebted for the elements of ſcience.

poſſible to believe that ſtatues of ſuch a ſize could entirely conſiſt of gold and ivory. The quantity of ivory neceſſary to a coloſſal ſtatue is beyond conception. M. de Paw calculates that the ſtatue of Jupiter Olympus, which was 54 feet high, would conſume the teeth of 300 elephants.

39 Marble.

The Greeks generally hewed their marble ſtatues out of one block, though they after worked the heads ſeparately, and ſometimes the arms. The heads of the famous groupe of Niobe and her daughters have been adapted to their bodies after being ſeparately finiſhed. It is proved by a large figure repreſenting a river, which is preſerved in Villa Albani, that the ancients firſt hewed their ſtatues roughly before they attempted to finiſh any part. When the ſtatue had received its perfect figure, they next proceeded to poliſh it with pumice-ſtone, and again carefully retouched every part with the chiſel.

40 Porphyry.

The ancients, when they employed porphyry, uſually made the head and extremities of marble. It is true, that at Venice there are four figures entirely compoſed of porphyry; but theſe are the production of the Greeks of the middle age. They alſo made ſtatues of baſaltes and alabaſter.

41 Expreſſion and attitude.

WITHOUT expreſſion, geſture, and attitude, no figure can be beautiful, becauſe in theſe the graces always reſide. It was for this reaſon that the graces are always repreſented as the companions of Venus.

The expreſſion of tranquillity was frequent in Grecian ſtatues, becauſe, according to Plato, that was conſidered as the middle ſtate of the ſoul between pleaſure and pain. Experience, too, ſhows that in general the moſt beautiful perſons are endowed with the ſweeteſt and moſt engaging manner. Without a ſedate tranquillity dignified beauty could not exiſt. It is in this tranquillity, therefore, that we muſt look for the complete diſplay of genius.

42 In the ſtatues of the gods.

The moſt elevated ſpecies of tranquillity and repoſe was ſtudied in the figures of the gods. The father of the gods, and even inferior divinities, are repreſented without emotion or reſentment. It is thus that Homer paints Jupiter ſhaking Olympus by the motion of his hair and his eyebrows.

> Shakes his ambroſial curls, and gives the nod,
> The ſtamp of fate and ſanction of the god.

Jupiter is not always exhibited in this tranquil ſtate. In a bas-relief belonging to the marquis Rondini he appears ſeated on an arm-chair with a melancholy aſpect. The Apollo of the Vatican repreſents the god in a fit of rage againſt the ſerpent Python, which he kills at a blow. The artiſt, adopting the opinion of the poets, has made the noſe the ſeat of anger, and the lips the ſeat of diſdain.

43 In the ſtatues of heroes.

To expreſs the action of a hero, the Grecian ſculptors delineated the countenance of a noble virtuous character repreſſing his groans, and allowing no expreſſion of pain to appear. In deſcribing the actions of a hero the poet has much more liberty than the artiſt. The poet can paint them ſuch as they were before men were taught to ſubdue their paſſions by the reſtraints of law, or the refined cuſtoms of ſocial life. But the artiſt, obliged to ſelect the moſt beautiful forms, is reduced to the neceſſity of giving ſuch an expreſſion of the paſſions as may not ſhock our feelings and diſguſt us with his production. The truth of theſe remarks will be acknowledged by thoſe who have ſeen two of the moſt beautiful monuments of antiquity; one of which repreſents the fear of death, the other the moſt violent pains and ſufferings. The daughters of Niobe, againſt whom Diana has diſcharged her fatal arrows, are exhibited in that ſtate of ſtupefaction which we imagine muſt take place when the certain proſpect of death deprives the ſoul of all ſenſibility. The fable preſents us an image of that ſtupor which Eſchylus deſcribes as ſeizing the daughters of Niobe when they were transformed into a rock. The other monument referred to is the image of Laocoon, which exhibits the moſt agonizing pain that can affect the muſcles, the nerves, and the veins. The ſufferings of the body and the elevation of the ſoul are expreſſed in every member with equal energy, and form the moſt ſublime contraſt imaginable. Laocoon appears to ſuffer with ſuch fortitude, that, whilſt his lamentable ſituation pierces the heart, the whole figure fills us with an ambitious deſire of imitating his conſtancy and magnanimity in the pains and ſufferings that may fall to our lot.

Philoctetes is introduced by the poets ſhedding tears, uttering complaints, and rending the air with his groans and cries; but the artiſt exhibits him ſilent and bearing his pains with dignity. The Ajax of the celebrated painter Timomachus is not drawn in the act of deſtroying the ſheep which he took for the Grecian chiefs, but in the moments of reflection which ſucceeded that frenzy. So far did the Greeks carry their love of calmneſs and ſlow movements, that they thought a quick ſtep always announced ruſticity of manners. Demoſthenes reproaches Nicobulus for this very thing; and from the words he makes uſe of, it appears, that to ſpeak with inſolence and to walk haſtily were reckoned ſynonymous.

44 In the ſtatues of women.

In the figures of women, the artiſts have conformed to the principle obſerved in all the ancient tragedies, and recommended by Ariſtotle, never to make women ſhow too much intrepidity or exceſſive cruelty. Conformable to this maxim, Clytemneſtra is repreſented at a little diſtance from the fatal ſpot, watching the murderer, but without taking any part with him. In a painting of Timomachus repreſenting Medea and her children, when Medea lifts up the dagger they ſmile in her face, and her fury is immediately melted into compaſſion for the innocent victims. In another repreſentation of the ſame ſubject, Medea appears heſitating and indeciſive. Guided by the ſame maxims, the artiſts of moſt refined taſte were careful to avoid all deformity, chooſing rather to recede from truth than from their accuſtomed reſpect for beauty, as may be ſeen in ſeveral figures of Hecuba. Sometimes, however, ſhe appears in the decrepitude of age, her face furrowed with wrinkles, and her breaſts hanging down.

45 In the ſtatues of the Roman emperors.

Illuſtrious men, and thoſe inveſted with the offices of dignity, are repreſented with a noble aſſurance and firm aſpect. The ſtatues of the Roman emperors reſemble thoſe of heroes, and are far removed from every ſpecies of flattery, in the geſture, in the attitude, and action. They never appear with haughty looks, or with the ſplendour of royalty; no figure is ever ſeen preſenting any thing to them with bended knee, except captives; and none addreſſes them with an inclination of the head.

In modern works too little attention has been paid to the ancient *coſtume*. Winkelman mentions a bas-relief, which was lately executed at Rome for the fountain of Trevi, repreſenting an architect in the act of preſenting the plan of an aqueduct to Marcus Agrippa. The modern ſculptor, not content with giving a long beard to that illuſtrious Roman, contrary to all the ancient marble ſtatues as well as medals which remain, exhibits the architect on his knees.

In general, it was an eſtabliſhed principle to baniſh all violent paſſions from public monuments. This will ſerve as a deciſive mark to diſtinguiſh the true antique from ſuppoſititious works. A medal has been found exhibiting two Aſſyrians, a man and woman, tearing their hair, with this inſcription, ASSYRIA. ET. PALAESTINA. IN. POTEST. P. R. REDAC. S. C. The forgery of this medal is manifeſt from the word *Palaeſtina*, which is not to be found in any ancient Roman medal with a Latin inſcription. Beſides, the violent action of tearing the hair does not ſuit any ſymbolical figure. This extravagant ſtyle, which was called by the ancients *parenthyrſis*, has been imitated by moſt of the modern artiſts. Their figures reſemble comedians on the ancient theatres, who, in order to ſuit the diſtant ſpectators, put on painted maſks, employed exaggerated geſtures, and far overleaped the bounds of nature. This ſtyle has been reduced into a theory in a treatiſe on the paſſions compoſed by Le Brun. The deſigns which accompany that work exhibit the paſſions in the very higheſt degree, approaching even to frenzy: but theſe are calculated to vitiate the taſte, eſpecially of the young; for the ardour of youth prompts them rather to ſeize the extremity than the middle; and it will be difficult for that artiſt who has formed his taſte from ſuch empaſſioned models ever to acquire that noble ſimplicity and ſedate grandeur which diſtinguiſhed the works of ancient taſte.

46
Of proportion.

PROPORTION is the baſis of beauty, and there can be no beauty without it; on the contrary, proportion may exiſt where there is little beauty. Experience every day teaches us that knowledge is diſtinct from taſte; and proportion, therefore, which is founded on knowledge, may be ſtrictly obſerved in any figure, and yet the figure have no pretenſions to beauty. The ancients conſidering ideal beauty as the moſt perfect, have frequently employed it in preference to the beauty of nature.

The body conſiſts of three parts as well as the members. The three parts of the body are the trunk, the thighs, and the legs. The inferior parts of the body are the thighs, the legs, and the feet. The arms alſo conſiſt of three parts. Theſe three parts muſt bear a certain proportion to the whole as well as to one another. In a well formed man the head and body muſt be proportioned to the thighs, the legs, and the feet, in the ſame manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face alſo conſiſts of three parts, that is, three times the length of the noſe; but the head is not four times the length of the noſe, as ſome writers have aſſerted. From the place where the hair begins to the crown of the head are only three-fourths of the length of the noſe, or that part is to the noſe as 9 to 12.

It is probable that the Grecian, as well as Egyptian artiſts, have determined the great and ſmall proportions by fixed rules; that they have eſtabliſhed a poſitive meaſure for the dimenſions of length, breadth, and circumference. This ſuppoſition alone can enable us to account for the great conformity which we meet with in ancient ſtatues. Winkelman thinks that the foot was the meaſure which the ancients uſed in all their great dimenſions, and that it was by the length of it that they regulated the meaſure of their figures, by giving to them ſix times that length. This in fact is the length which Vitruvius aſſigns, *Pes vero altitudinis corporis ſextæ*, lib. iii. cap. 1. That celebrated antiquary thinks the foot is a more determinate meaſure than the head or the face, the parts from which modern painters and ſculptors too often take their proportions. This proportion of the foot of the body, which has appeared ſtrange and incomprehenſible to the learned Huetius, and has been entirely rejected by Perrault, is however founded upon experience. After meaſuring with great care a vaſt number of figures, Winkelman found this proportion obſerved not only in Egyptian ſtatues, but alſo in thoſe of Greece. This fact may be determined by an inſpection of thoſe ſtatues the feet of which are perfect. One may be fully convinced of it by examining ſome divine figures, in which the artiſts have made ſome parts beyond their natural dimenſions. In the Apollo Belvidere, which is a little more than ſeven heads high, the foot is three Roman inches longer than the head. The head of the Venus de Medicis is very ſmall, and the height of the ſtatue is ſeven heads and a half: the foot is three inches and a half longer than the head, or preciſely the ſixth part of the length of the whole ſtatue.

PRACTICE of SCULPTURE.

47
Grecian ſculpture to be ſtudied by the modern artiſts.

WE have been thus minute in our account of the Grecian ſculpture, becauſe it is the opinion of the ableſt critics that modern artiſts have been more or leſs eminent as they have ſtudied with the greater or leſs attention the models left us by that ingenious people: Winkelman goes ſo far as to contend that the moſt finiſhed works of the Grecian maſters ought to be ſtudied in preference even to the works of nature. This appears to be paradoxical; but the reaſon aſſigned by the Abbé for his opinion is, that the faireſt lines of beauty are more eaſily diſcovered, and make a more ſtriking and powerful impreſſion, by their reunion in theſe ſublime copies, than when they are ſcattered far and wide in the original. Allowing, therefore, the ſtudy of nature the high degree of merit it ſo juſtly claims, it muſt nevertheleſs be granted, that it leads to true beauty by a much more tedious, laborious, and difficult path, than the ſtudy of the *antique*, which preſents immediately to the artiſt's view the object of his reſearches, and combines in a clear and ſtrong point of light the various rays of beauty that are diſperſed through the wide domain of nature.

As ſoon as the artiſt has laid this excellent foundation, acquired an intimate degree of familiarity with the beauties of the Grecian ſtatues, and formed his taſte after the admirable models they exhibit, he may then proceed with advantage and aſſurance to the imitation of nature. The ideas he has already formed of the perfection of nature, by obſerving her diſperſed beauties combined and collected in the compoſitions of the ancient artiſts, will enable him to acquire with facility, and to employ with advantage, the detached and partial ideas of beauty which will be exhibited to his view in a ſurvey of nature in her actual ſtate. When he diſcovers theſe partial beauties, he will be capable of combining them with thoſe perfect forms of beauty with which he is already acquainted. In a word, by having always preſent to his mind the noble models already mentioned, he will be in ſome meaſure his own oracle, and will draw rules from his own mind.

48
Two ways of imitating nature.

There are, however, two ways of imitating nature. In the one a ſingle object occupies the artiſt, who endeavours to repreſent it with preciſion and truth; in the other, certain lines and features are taken from a variety of objects, and combined and blended into one regular whole. All kinds of copies belong to the firſt kind of imitation; and productions of this kind muſt be executed neceſſarily in the Dutch manner, that is to ſay, with high finiſhing, and little or no invention. But the ſecond kind of imitation leads directly to the inveſtigation and diſcovery of true beauty, of that beauty whoſe idea is connate with the human mind, and is only to be found there in its higheſt perfection. This is the kind of imitation in which the Greeks excelled, and in which men of genius excite the young artiſts to excel after their example, viz. by ſtudying nature as they did.

After having ſtudied in the productions of the Grecian maſters their choice and expreſſion of ſelect nature, their ſublime and graceful contours, their noble draperies, together with that ſedate grandeur and admirable ſimplicity that conſtitute their chief merit, the curious artiſts will do well to ſtudy the manual and mechanical part of their operations, as this is abſolutely neceſſary to the ſucceſsful imitation of their excellent manner.

49
Models of ſtatues.

It is certain that the ancients almoſt always formed their firſt models in wax: to this modern artiſts have ſubſtituted clay, or ſome ſuch compoſition: they prefer clay before wax in the carnations, on account of the yielding nature of the latter, and its ſticking in ſome meaſure to every thing it touches. We muſt not, however, imagine from hence that the method of forming models of wet clay was either unknown or neglected among the Greeks: on the contrary, it was in Greece that models of this kind were invented. Their author was Dibutades of Sicyon; and it is well known that Arceſilas, the friend of Lucullus, obtained a higher degree of reputation by his clay models than by all his other productions. Indeed, if clay could be made to preſerve its original moiſture, it would undoubtedly be the fitteſt ſubſtance for the models of the ſculptor; but when it is placed either in the fire or left to dry imperceptibly in the air, its ſolid parts grow more compact, and the figure loſing thus a part of its dimenſions, is neceſſarily reduced to a ſmaller volume. This diminution would be of no conſequence did it equally affect the whole figure, ſo as to preſerve its proportions entire. But this is not the caſe: for the ſmaller parts of the figure dry ſooner than the larger; and thus loſing more of their dimenſions in the ſame ſpace of time than the latter do, the ſymmetry and proportions of the figure inevitably ſuffer. This inconveniency does not take place in thoſe models that are made in wax. It is indeed extremely difficult, in the ordinary method of working the wax, to give it that degree of ſmoothneſs that is neceſſary to repreſent the ſoftneſs of the carnations or fleſhy parts of the body. This inconvenience may, however, be remedied, by forming the model firſt in clay, then moulding it in plaſter, and laſtly caſting it in wax. And, indeed, clay is ſeldom uſed but as a mould in which to caſt a figure of plaſter, ſtucco, or wax, to ſerve henceforth for a model by which the meaſures and proportions of the ſtatue are to be adjuſted. In making waxen models, it is common to put half a pound of colophony to a pound of wax; and ſome add turpentine, melting the whole with oil of olives.

50
Method of working the marble, and

So much for the firſt or preparatory ſteps in this procedure. It remains to conſider the manner of working the marble after the model ſo prepared; and the method here followed by the Greeks ſeems to have been extremely different from that which is generally obſerved by modern artiſts. In the ancient ſtatues we find the moſt ſtriking proofs of the freedom and boldneſs that accompanied each ſtroke of the chiſel, and which reſulted from the artiſt's being perfectly ſure of the accuracy of his idea, and the preciſion and ſteadineſs of his hand: the moſt minute parts of the figure carry theſe marks of aſſurance and freedom; no indication of timorouſneſs or diffidence appears; nothing that can induce us to fancy that the artiſt had occaſion to correct any of his ſtrokes. It is difficult to find, even in the ſecond-rate productions of the Grecian artiſts, any mark of a falſe ſtroke or a random touch. This firmneſs and preciſion of the Grecian chiſel were certainly derived from a more determined and perfect ſet of rules than thoſe which are obſerved in modern times.

The method generally obſerved by the modern ſculptor is as follows: Firſt, out of a great block of marble he ſaws another of the ſize required, which is performed with a ſmooth ſteel ſaw, without teeth, caſting water and ſand thereon from time to time; then he faſhions it, by taking off what is ſuperfluous with a ſteel point and a heavy hammer of ſoft iron; after this, bringing it near the meaſure required, he reduces it ſtill nearer with another finer point; he then uſes a flat cutting inſtrument, having notches in its edge; and then a chiſel to take off the ſcratches which the former has left; till, at length, taking raſps of different degrees of fineneſs, by degrees he brings his work into a condition for poliſhing.

After this, having ſtudied his model with all poſſible attention, he draws upon this model horizontal and perpendicular lines which interſect each other at right angles. He afterwards copies theſe lines upon his marble, as the painter makes uſe of ſuch tranſverſal lines to copy a picture, or to reduce it to a ſmaller ſize. Theſe tranſverſal lines or ſquares, drawn in an equal number upon the marble and upon the model, in a manner proportioned to their reſpective dimenſions, exhibit accurate meaſures of the ſurfaces upon which the artiſt is to work; but cannot determine, with equal preciſion, the depths that are proportioned to theſe ſurfaces.—The ſculptor, indeed, may determine theſe depths by obſerving the relation they bear to his model; but as his eye is the only guide he has to follow in this eſtimate, he is always more or leſs expoſed to error, or at leaſt to doubt. He is never ſure that the cavities made by his chiſel are exact; a degree of uncertainty accompanies each ſtroke; nor can he be aſſured that it has carried away neither too much nor too little of his marble. It is equally difficult to determine, by ſuch lines as have already been mentioned, the external and internal contours of the figure, or to transfer them from the model to the marble. By the internal contour is underſtood that which is deſcribed by the parts which approach towards the centre, and which are not marked in a ſtriking manner.

It is farther to be noticed, that in a complicated and laborious work, which an artiſt cannot execute without aſſiſtance, he is often obliged to make uſe of foreign hands, that have not the talents or dexterity that are neceſſary to finiſh his plan. A ſingle ſtroke of the chiſel that goes too deep is a defect not to be repaired; and ſuch a ſtroke may eaſily happen, where the depths are ſo imperfectly determined. Defects of this kind are inevitable, if the ſculptor, in chipping his marble, begins by forming the depths that are requiſite in the figure lie deſigns to repreſent. Nothing is more liable to error than this manner of proceeding. The cautious artiſt ought, on the contrary, to form theſe depths gradually, by little and little, with the utmoſt circumſpection and care; and the determining of them with preciſion ought to be conſidered as the laſt part of his work, and as the finiſhing touches of his chiſel.

51 of copying ancient ſtatues. The various inconveniences attending this method determined ſeveral eminent artiſts to look out for one that would be liable to leſs uncertainty, and productive of fewer errors. The French academy of painting at Rome hit on a method of copying the ancient ſtatues, which ſome ſculptors have employed with ſucceſs, even in the figures which they finiſhed after models in clay or wax. This method is as follows. The ſtatue that is to be copied is incloſed in a frame that fits it exactly. The upper part of this frame is divided into a certain number of equal parts, and to each of theſe parts a thread is fixed with a piece of lead at the end of it. Theſe threads, which hang freely, ſhow what parts of the ſtatue are moſt removed from the centre with much more perſpicuity and preciſion than the lines which are drawn on its ſurface, and which paſs equally over the higher and hollow parts of the block: they alſo give the artiſt a tolerable rule to meaſure the more ſtriking variations of height and depth, and thus render him more bold and determined in the execution of his plan.

But even this method is not without its defects: for as it is impoſſible, by the means of a ſtraight line, to determine with preciſion the procedure of a curve, the artiſt has, in this method, no certain rule to guide him in his contours; and as often as the line which he is to deſcribe deviates from the direction of the plumb line, which is his main guide, he muſt neceſſarily feel himſelf at a loſs, and be obliged to have recourſe to conjecture.

It is alſo evident, that this method affords no certain rule to determine exactly the proportion which the various parts of the figure ought to bear to each other, conſidered in their mutual relation and connections. The artiſt, indeed, endeavours to ſupply this defect by interſecting the plumb-lines by horizontal ones. This recourſe has, nevertheleſs, its inconveniences, ſince the ſquares formed by tranſverſal lines, that are at a diſtance from the figure (though they be exactly equal), yet repreſent the parts of the figure as greater or ſmaller, according as they are more or leſs removed from our poſition or point of view. But, notwithſtanding theſe inconveniences, the method now under conſideration is certainly the beſt that has hitherto been employed: it is more practicable and ſure than any other we know, though it appears, from the remarks we have now been making, that it does not exhibit a ſure and univerſal criterion to a ſculptor who executes after a model.

52 Of poliſhing the ſtatue. To poliſh the ſtatue, or make the parts of it ſmooth and ſleek, pumice-ſtone and ſmelt are uſed; then tripoli; and when a ſtill greater luſtre is required, burnt ſtraw is employed. For the *Caſting of Statues*, ſee FOUNDERY, and *PLASTER of Paris*.

SCUM, properly denotes the impurities which a liquor, by boiling, caſts up to the ſurface. The term *ſcum* is alſo uſed for what is more properly called the ſcoria of metals.

SCUPPERS, in a ſhip, are certain channels cut through the water-ways and ſides of a ſhip, at proper diſtances, and lined with plated lead, in order to carry the water off from the deck into the ſea. The ſcuppers of the lower deck of a ſhip of war are uſually furniſhed with a leathern pipe, called the *ſcupper-hoſe*, which hangs downward from the mouth or opening of the ſcupper. The intent of this is to prevent the water from entering when the ſhip inclines under a weight of ſail.

SCURVY, in *Medicine*, ſee that article, N° 351. where we have given an account of the ſymptoms, cauſes, and modes of prevention and cure, according to ſome of the moſt eminent writers in medicine. We have here only to add, that, in the opinion of Dr Beddoes, the mineral acids, eſpecially the nitric and vitriolic, may be employed in the prevention or cure of this dreadful diſeaſe with as much ſucceſs as the vegetable acids.—But of all the ſubſtances that can at once be cheaply procured and long preſerved, he thinks the concrete acid of tartar by far the moſt promiſing. It is very grateful, and comes near to the citric acid. In tropical countries the ſcurvy is ſeldom known.

SCURVY-Graſs. See COCHLEAREA, BOTANY *Index*.

SCUTAGE (*ſcutagium*, Sax. *ſcildpening*), was a tax or contribution raiſed by thoſe that held lands by knights ſervice, towards furniſhing the king's army, at one, two, or three merks for every knight's fee. Henry III. for his voyage to the Holy Land, had a tenth granted by the clergy, and *ſcutage*, three merks of every knight's fee by the *laity*. This was alſo levied by Henry II. Richard I. and King John. See *KNIGHT-Service*.

SCUTE, (*ſcutum*), a French gold coin of 3s. 4d. in the reign of King Henry V. Catharine queen of England had an aſſurance made her of ſundry caſtles, manors, lands, &c. valued at the ſum of 40,000 *ſcutes*, every

every two whereof were worth a noble. *Rot. Parl.* 1. *Hen.* VI.

SCUTELLARIA, Skull-cap, a genus of plants, belonging to the didynamia claſs; and in the natural method ranking under the 40th order, *Perſonatæ*. See Botany *Index*.

SCUTTLES, in a ſhip, ſquare holes cut in the deck, big enough to let down the body of a man, and which ſerve upon ſome occaſions to let the people down into any room below, or from one deck to another.

SCYLAX, a celebrated mathematician and geographer of Caria, flouriſhed under the reign of Darius Hyſtaſpes, about 558 B. C. Some have attributed to him the invention of geographical tables. We have under his name a geographical work publiſhed by Hoeſchelius; but it is written by a much later author, and is perhaps only an abridgement of Scylax's Ancient Geography.

SCYLLA, in *Ancient Geography*, a rock in the Fretum Siculum, near the coaſt of Italy, dangerous to ſhipping, oppoſite to Charybdis, a whirlpool on the coaſt of Sicily; both of them famous in mythology.

Sutherland's Tour up the Straits, Letter xii.

Scylla and Charybdis have been almoſt ſubdued by the repeated convulſions of this part of the earth, and by the violence of the current, which is continually increaſing the breadth of the ſtraits. If proper allowance be made for theſe circumſtances, we ſhall acquit the ancients of any exaggeration, notwithſtanding the very dreadful colours in which they have painted this paſſage. It is formed by a low peninſula, called *Cape Pelorus*, ſtretching to the eaſtward on the Sicilian ſide, immediately within which lies the famous whirlpool of Charybdis, and by the rocks of Scylla, which a few miles below on the Calabrian ſhore project towards the weſt. The current runs with ſurpriſing force from one to the other alternately in the direction of the tide, and the tides themſelves are very irregular. Thus veſſels, by ſhunning the one, were in the utmoſt danger of being ſwallowed up by the other.

At preſent, in moderate weather, when the tide is either at ebb or flood, boats paſs all over the whirlpool: but, in general, it is like the meeting of two contending currents, with a number of eddies all around; and, even now, there is ſcarcely a winter in which there are not ſome wrecks.

“ At the time when we paſſed the ſtraits (ſays Captain Sutherland, from whom we have obtained this accurate information) the weather was as favourable as we could wiſh; and yet, in ſpite of a ſtrong breeze and the current, which hurried us on with ſurpriſing velocity, the ſhip's head was ſuddenly whirled round near three points; but the wind blowing freſh, in a few ſeconds ſhe daſhed through the eddy that had caught her; for, to avoid Scylla, and ſecure Meſſina, we had kept pretty cloſe to Charybdis.” For a later account of theſe rocks, ſee Sicily.

SCYROS, an iſland in the Ægean ſea, at the diſtance of about 28 miles north-eaſt from Eubœa. It is 60 miles in circumference. It was originally in the poſſeſſion of the Pelaſgians and Carians. Achilles retired there to avoid going to the Trojan war, and became father of Neoptolemus by Deidamia the daughter of King Lycomedes. Scyros was conquered by the Athenians under Cimon. It was very rocky and barren. Now *Sciro*. E. Long. 25. 0. N. Lat. 38. 15.

SCYTALA laconica, in antiquity, a ſtratagem or device of the Lacedæmonians, for the ſecret writing of letters to their correſpondents, ſo that if they ſhould chance to be intercepted, nobody might be able to read them.—To this end they had two wooden rollers or cylinders, perfectly alike and equal; one whereof was kept in the city, the other by the perſon to whom the letter was directed. For the letter, a ſkin of very thin parchment was wrapped round the roller, and thereon was the matter written; which done, it was taken off, and ſent away to the party, who, upon putting it in the ſame manner upon his roller, found the lines and words in the very ſame diſpoſition as when they were firſt written. This expedient they ſet a very high value on; though, in truth, artleſs and groſs enough: the moderns have improved vaſtly on this method of writing. See Cipher.

SCYTALIA, a genus of plants belonging to the octandria claſs; and in the natural method ranking with thoſe that are doubtful. See Botany *Index*.

SCYTHE, in *Huſbandry*, a well known inſtrument which has been long employed for cutting graſs for hay. The ſame inſtrument with certain modifications in its conſtruction has been uſed in reaping grain, in place of the ſickle, the uſe of which is far more common, and in Scotland at leaſt prevails almoſt univerſally, although it muſt be admitted that the method of reaping by the ſcythe, where it is practicable, is attended with leſs labour, is more expeditious, and therefore more economical. But againſt the uſe of the ſcythe, as a reaping inſtrument, many objections have been raiſed. Some of theſe are probably founded in prejudice, while others, conſidering the ſlow progreſs which has been made in introducing this inſtrument as a ſubſtitute for the ſickle, reſt on a more ſolid foundation.

It is ſaid that this inſtrument ſhakes the ear, ſo that many of the grains are loſt; that it lets the corn fall after it is cut, in a ſcattered confuſed manner, in conſequence of which either a great deal of it is loſt, or much time is waſted in gathering it together. It is alſo affirmed that it can only be made uſe of in very even land, and which is free from ſtones; that it does not leave length enough of ſtubble on the ground, on which to lay the corn when it is cut; that it mixes noxious weeds with the corn, the ſeeds of which are ſown the enſuing year; and finally, that the uſe of the ſcythe is prejudicial to the health of the reaper.

It appears, however, that theſe objections have either no weight, or they are made by thoſe who are unacquainted with the ſcythes peculiarly adapted to this purpoſe, and with the manner in which they ought to be uſed. With a good ſcythe properly managed, the corn when cut, remains at firſt upright, afterwards falling gently on the rake fixed to the ſcythe, without any ſhaking or jolting, or at leaſt with leſs than what is occaſioned by the ſickle. The loſs of grain chiefly ariſes from the corn being too dry, and therefore it ought to be reaped on proper days, and ſuitable times of the day, which is more eaſily accompliſhed by the ſcythe than the ſickle, becauſe the one requires leſs time than the other. The ſtalks, held together by the rake, may be laid on the ground, or againſt the corn not yet cut down, in a ſtate ſo regular and connected, that thoſe by whom the ſheaves are collected and bound have themſelves alone to blame, ſhould any thing be left behind. It is ſufficiently even when lands are ploughed and harrowed

rowed in a proper manner; and the only neceſſary precaution in ſtony ground, is to keep the ſcythe a little higher, that it may not ſtrike againſt the ſtones. If the ſtubble be ſhort, the ſtraw cut off will of courſe be the longer, and of conſequence more valuable; and long ſtubble only incommodes the cattle afterwards ſent to feed upon it.

Theſe and ſimilar conſiderations, prevailed with the patriotic ſociety of Milan, to ſend to theſe places where ſcythes are uſed for reaping; and having procured a model from Sileſia, they ordered one of a proper ſize to be made. It was firſt tried on corn, and afterwards on millet; and notwithſtanding the firſt was far from being made with accuracy, and although ſuch an inſtrument had never before been made uſe of by the reaper, nearly half the uſual time was found to be ſaved, and the wonted fatigue and labour were much diminiſhed. The corn was cut without receiving any injurious ſhock, falling in an even and regular ſtate, by which means it was afterwards bound up with eaſe in compact ſheaves.

Plate cccclxxviii. fig. 1. Theſe inſtruments are ſo ſimple in their conſtruction, that a figure of one of them renders a deſcription almoſt unneceſſary. Fig. 1. repreſents the Sileſian ſcythe tried by the ſociety, the difference between which and the Auſtrian one we ſhall mention in our deſcription. The Sileſian ſcythe differs little from that commonly employed in mowing graſs, except that the blade is rather ſmaller; to it four teeth of wood are added, parallel to the blade, fixed and ſecured in a proper manner, and deſigned to keep the corn together after it is cut; ſo that inſtead of its falling in a confuſed ſtate, the reaper can lay it down in a regular and compact manner. The Auſtrian ſcythe is ſimilar to the former, but the blade is larger; of courſe the wooden teeth, being five in number, are longer; the handle is alſo flatter, and rather crooked.

In the firſt, the handle *a b* (ſee fig. 1.) is four feet three inches in length; the blade *b c* is about two feet; the piece of wood in which the teeth are fixed, one foot ten inches and a half. In the *ſecond*, the handle is four feet one inch; the blade, two feet eight inches; the piece in which the teeth are fixed, $11\frac{1}{2}$ inches.

The difference in the conſtruction of theſe two ſcythes renders it neceſſary to uſe them in a different manner, which will be better acquired in practice than by precept. Such as are accuſtomed to the uſe of the common ſcythe will ſoon find out the moſt advantageous manner of uſing theſe new kinds of ſcythes, and of laying down the corn properly after it is cut.

It is neceſſary to obſerve, that, in mowing graſs, the feet are held in a poſition nearly parallel to each other, whereas in reaping corn they ſhould be kept on a line, the one behind the other, bringing the right foot forward, and drawing the left towards it. The reaſon is, that when graſs is mowed it is left to fall where it is cut; but when corn is cut down, it is to be laid in a proper manner againſt that which is not yet cut, and which is at the reaper's left hand. Were the feet kept parallel to each other, the reaper would be under the neceſſity of extending and turning his body in a very inconvenient manner.

Theſe obſervations having been publiſhed, the ſociety made farther experiments on the ſubject, by which they diſcovered, that when the ſtalks of corn are bent down by reaſon of extremely wet weather, the wooden teeth of the ſcythes are apt to lay hold of ſome ears, to the ſtalks of which the iron does not extend; and therefore theſe not being cut below, are pulled ſo that the grain is ſcattered. This chiefly happens from the reapers not being accuſtomed to that kind of ſcythe, and therefore not knowing how to adapt it to particular exiſting circumſtances.

It occurred to an ingenious blackſmith, that, in order to remedy this inconvenience, a *collector* made of cloth ſhould be added to the common ſcythe, as may be ſeen at fig. 2. where *a b c* is a common ſcythe, *c d m l o f n e* Fig. 2. is the gatherer, which at *c d e* is compoſed of a thin plate of iron, having a hollow at its extremity for receiving the point of the blade. At *e d* are holes for ſewing in the cloth, which is coarſe, light, and of low price; it is alſo fixed to two thick iron wires, of which the upper one is continued to *f*, where it terminates in a hole in the handle; the other is fixed to the back of the blade. The manner of fixing this gatherer to the back of the ſcythe will be better underſtood by referring to fig. 3. which repreſents one of the irons, which, by Fig. 3. means of the ſcrew, are faſtened to the back of the ſcythe. Theſe proceed from, and make part of the upright irons *m n*, *l o*, which ſerve to keep the gatherer extended.

This contrivance is both cheap and ſimple; but an attempt was made to render it more ſo, by ſubſtituting two iron hoops for the gatherer, which are ſhewn in fig. 2. by the dotted lines *h g*, *k i*, with a croſs piece *p*, Fig. 2. which connects them. Experience has ſhewn, however, that the gatherer is in general preferable to theſe hoops, as it does not leave an ear of corn behind.

SCYTHIA, an ancient name for the northern parts of Aſia, now known by the name of *Tartary*; alſo for ſome of the north-eaſtern parts of Europe.

This vaſt territory, which extends itſelf from the Iſter or Danube, the boundary of the Celts, that is, from about the 25th to almoſt the 110th degree of eaſt longitude, was divided into Scythia in Europe and Scythia in Aſia, including, however, the two Sarmatias; or, as they are called by the Greeks, *Sauromatias*, now the Circaſſian Tartary, which lay between and ſevered the two Scythias from each other. Sauromatia was alſo diſtinguiſhed into European and Aſiatic; and was divided from the European Scythia by the river Don or Tanais, which falls into the Palus Meotis; and from the Aſiatic by the Rha, now Volga, which empties itſelf into the Caſpian ſea.

1. The Aſiatic Scythia comprehended in general, Great Tartary, and Ruſſia in Aſia; and, in particular, the Scythia beyond or without Imaus, contained the regions of Bogdoi or Oſtiacoi, and Tanguti. That within, or on this ſide Imaus, had Turkeſtan and Mongal, the Uſbeck or Zagatai, Kalmuc and Nagaian Tartars; beſides Siberia, the land of the Samoiedes and Nova Zembla. Theſe three laſt not being ſo ſoon inhabited as the former, as may be reaſonably ſuppoſed, were wholly unknown to the ancients; and the former were peopled by the Bactrians, Sogdians, Gandari, Sacks, and Maſſagetes. As for Sarmatia, it contained Albania, Iberia, and Colchis; which makes now the Circaſſian Tartary, and the province of Georgia.

2. Scythia in Europe reached (towards the ſouthweſt) to the Po and the Alps, by which it was divided from Celto-Gallia. It was bounded on the ſouth by the

the Iſter or Danube and the Euxine ſea. Its northern limits have been ſuppoſed to ſtretch to the ſpring-heads of the Boriſthenes or Nieper, and the Rha or Volga, and ſo to that of the Tanais.—The ancients divided this country into Scythia Arimaſpæa, which lay eaſtward, joining to Scythia in Aſia; and Sarmatia Europeana on the weſt. In Scythia, properly ſo called, were the Arimaſpæi on the north; the Getæ or Dacians along the Danube, on the ſouth; and the Neuri between theſe two. So that it contained the European Ruſſia or Muſcovy, and the Leſſer Crim Tartary eaſtward; and, on the weſt, Lithuania, Poland, part of Hungary, Tranſylvania, Walachia, Bulgaria, and Moldavia. Sarmatia is ſuppoſed to have reached northward to that part of Swedeland called *Feningia*, now *Finland;* in which they placed the Oœnes, Panoti, and Hippopodes. This part they divided from Northern Germany, now the weſt part of Sweden and Norway, by the *Mare Sarmaticum* or *Scythicum*, which they ſuppoſed ran up into the northern ocean, and, dividing Lapland into two parts, formed the weſtern part of Sweden, with Norway, into one iſland, and Finland into another; ſuppoſing this alſo to be cut off from the continent by the gulf of that name.

Although the ancient Scythians were celebrated as a warlike people, yet their hiſtory is too uncertain and obſcure to enable us to give any detail which would not prove equally tireſome and unintereſting to the reader. Mr Pinkerton, in a diſſertation on their origin, endeavours to prove that they were the moſt ancient of nations; and he aſſigns for the place of their firſt habitation the country known by the name of Perſia. From Perſia, he thinks, they proceeded in numerous hordes weſtward, ſurrounded the Euxine, peopled Germany, Italy, Gaul, the countries bordering on the Baltic, with part of Britain and Ireland. That the Scythians were of Aſiatic origin, cannot, we think, be queſtioned; and as Perſia was peopled at a very early period, it may not improbably have been their parent country: but when our author contends that their empire had ſubſiſted for more than 1500 years before Ninus the founder of the Aſſyrian monarchy, and that it extended from Egypt to the Ganges, and from the Perſian gulf and Indian ſea to the Caſpian, we cannot help thinking that his prejudices againſt the Celts, and his deſire to do honour to his favourite Goths, have made him advance a paradox inconſiſtent with the moſt authentic records of antiquity. His diſſertation however is ingenious, and replete with a variety of curious learning.

SCYTHIAN *Lamb*, in *Natural Hiſtory*. See *Scythian LAMB*.

SCYTHROPS, or CHANNEL-BILL, a genus of birds belonging to the order of Picæ. See ORNITHOLOGY, Nº 149.

SEA, in a ſtrict ſenſe, ſignifies a large portion of water almoſt ſurrounded by land, as the Baltic and Mediterranean ſeas; but it is frequently uſed for that vaſt body of water which encompaſſes the whole earth.

1
What proportion the ſurface of the ſea bears to that of the land.

What proportion the ſuperficies of the ſea bears to that of the land cannot eaſily be aſcertained. Buffon has ſuppoſed that the ſurface of our globe is equally divided between land and water, and has accordingly calculated the ſuperficies of the ſea to be 85,490,506 ſquare miles. But it is now well known that the ocean covers much more than the half of the earth's ſurface. Buffon believed the exiſtence of a vaſt ſouthern continent, which Captain Cook has ſhown to be viſionary. It was this circumſtance which miſled him. According to the moſt accurate obſervations hitherto made, the ſurface of the ſea is to the land as three to one; the ocean therefore extends over 128,235,759 ſquare miles, ſuppoſing the ſuperficies of the whole globe to be 170,981,012 ſquare miles. To aſcertain the depth of the ſea is ſtill more difficult than its ſuperficies, both on account of the numerous experiments which it would be neceſſary to make, and the want of proper inſtruments for that purpoſe. Beyond a certain depth the ſea has hitherto been found unfathomable; and though ſeveral methods have been contrived to obviate this difficulty, none of them has completely anſwered the purpoſe. We know in general that the depth of the ſea increaſes gradually as we leave the ſhore; but if this continued beyond a certain diſtance, the depth in the middle of the ocean would be prodigious. Indeed the numerous iſlands everywhere ſcattered in the ſea demonſtrate the contrary, by ſhowing us that the bottom of the water is unequal like the land, and that ſo far from uniformly ſinking, it ſometimes riſes into lofty mountains. If the depth of the ſea be in proportion to the elevation of the land, as has generally been ſuppoſed, its greateſt depth will not exceed five or ſix miles, for there is no mountain ſix miles perpendicular above the level of the ſea. The ſea has never been actually ſounded to a greater depth than a mile and 66 feet; every thing beyond that therefore reſts entirely upon conjecture and analogical reaſoning, which ought never to be admitted to determine a ſingle point that can be aſcertained by experiment, becauſe, when admitted, they have too often led to falſe concluſions. Along the coaſts, where the depth of the ſea is in general well known, it has always been found proportioned to the height of the ſhore: when the coaſt is high and mountainous, the ſea that waſhes it is deep; when, on the contrary, the coaſt is low, the water is ſhallow. Whether this analogy holds at a diſtance from the ſhore, experiments alone can determine.

2
Depth of the ſea.

3
Quantity of water which it contains.

To calculate the quantity of water contained in the ſea, while its depth is unknown, is impoſſible. But if we ſuppoſe with Buffon that its medium depth is the fourth part of a mile, the ocean, if its ſuperficies be 120,235,759 ſquare miles, will contain 32,058,939,75 cubic miles of water.

Buffon's Theory of the Earth, art. 10.

Let us now endeavour to compute the quantity of water which is conſtantly diſcharged into the ſea. For this purpoſe let us take a river whoſe velocity and quantity of water is known, the Po, for inſtance, which according to Riccioli is 1000 feet (or 100 perches of Bologna) broad, 10 feet deep, and runs at the rate of four miles in an hour; conſequently that river diſcharges into the ſea 200,000 cubic perches of water in an hour, or 4,800,000 in a day. A cubic mile contains 125,000,000 cubic perches; the Po therefore will take 26 days to diſcharge a cubic mile of water into the ſea. Let us now ſuppoſe, what is perhaps not very far from the truth, that the quantity of water which the ſea receives from the rivers in any country is proportioned to the extent of that country. The Po from its origin to its mouth traverſes a country 380 miles long, and the rivers which fall into it on every ſide riſe from ſources about ſixty miles diſtant from it.

The

The Po, therefore, and the rivers which it receives, water a country of 45,600 ſquare miles. Now ſince the whole ſuperficies of the dry land is about 42,745,253 ſquare miles, it follows, from our ſuppoſition, that the quantity of water diſcharged by all the rivers in the world, in one day, is 36 cubic miles, and in a year 13,140. If therefore the ſea contains 32,058,939 cubic miles of water, it would take all the rivers in the world 2439 years to diſcharge an equal quantity.

4
Why it does not increaſe.

It may ſeem ſurpriſing that the ſea, ſince it is continually receiving ſuch an immenſe ſupply of water, does not viſibly increaſe, and at laſt cover the whole earth. But our ſurpriſe will ceaſe, if we conſider that the rivers themſelves are ſupplied from the ſea, and that they do nothing more than carry back thoſe waters which the ocean is continually laviſhing on the earth. Dr Halley has demonſtrated that the vapours raiſed from the ſea and tranſported on land are ſufficient to maintain all the rivers in the world. The ſimplicity of this great proceſs is aſtoniſhing: the ſea not only connects diſtant countries, and renders it eaſy to tranſport the commodities of one nation to another, but its waters riſing in the air deſcend in ſhowers to fertilize the earth and nouriſh the vegetable kingdom, and collecting into rivers flow onwards, bringing fertility and wealth and commerce along with them, and again return to the ſea to repeat the ſame round.

5
Theories of philoſophers on this ſubject.

The knowledge of this proceſs of nature might, one would think, have convinced philoſophers that the proportion between ſea and land continued always nearly the ſame. Philoſophers however have formed different theories about this as well as moſt other ſubjects, maintaining on the one hand that the ſea is continually encroaching on the land, and on the other that the land is conſtantly gaining on the ſea. Both ſides have ſupported their theories by arguments, demonſtrations, and incontrovertible facts!

6
Arguments of thoſe who affirm that the ſea is encroaching on the land.

The height of the mountains, ſay the philoſophers who ſupport the encroachments of the ſea, is continually diminiſhing; expoſed to the violence of every ſtorm, the hardeſt rocks muſt at laſt give way and tumble down. The rivers are continually ſweeping along with them particles of earth which they depoſite in the bottom of the ſea. Both the depth of the ocean then and the height of the dry land muſt be always decreaſing; the waters therefore muſt, unleſs a part of them were annihilated, ſpread over a greater extent of ſurface in proportion as theſe cauſes operate. This reaſoning, convincing as it is, might be confirmed by a great number of facts: it will be ſufficient however to mention one or two. In the reign of Auguſtus the iſle of Wight made a part of Britain, ſo that the Engliſh croſſed over to it at low water with cart loads of tin; yet that iſland is at preſent ſeparated from Britain by a channel half a mile wide. The Godwin ſands on the eaſtern ſhore of England were formerly the fertile eſtate of Earl Godwin. Nor are the encroachments of the ſea confined to Britain. In the bay of Baiæ near Naples there are remains of houſes and ſtreets ſtill viſible below the preſent level of the ſea. The ſea, therefore, is making continued encroachments upon the land; and the time will come, ſay they, when the waters will again cover the ſurface of the earth.

7
Arguments of thoſe who affirm that the land is gaining on the ſea.

Such are the arguments of thoſe philoſophers who maintain the continual encroachments of the ſea. Thoſe who maintain the oppoſite theory, that the land is gradually gaining on the ſea, though they pretend not to deny the facts advanced by their opponents, affirm that they are altogether inſufficient to eſtabliſh the hypotheſis which they were brought forward to ſupport. Though the rivers carry down particles of earth into the ſea, theſe, ſay they, are either accumulated on other ſhores, or, collecting in the bottom of the ocean, harden into ſtone, which being poſſeſſed of a vegetative power riſes by degrees above the ſurface of the ſea, and forms rocks, and mountains, and iſlands. The vegetative nature of ſtone indeed is ſufficient, of itſelf, to convince us that the quantity of earth muſt be daily accumulating, and conſequently that the ſurface of the ſea is diminiſhing in extent. Celſius, a Swediſh philoſopher (for this diſpute has been carried on in Sweden with the greateſt keenneſs), has endeavoured to build this theory with more ſolid materials than vegetable ſtone. In a curious memoir, publiſhed in 1743, he aſſerts that the Baltic and the Atlantic, at leaſt that part of it which waſhes Norway, is conſtantly diminiſhing; and he proves this by the teſtimony of a great many aged pilots and fiſhermen, who affirmed that the ſea was become much ſhallower in many places than it had been during their youth: that many rocks formerly covered with water were now ſeveral feet above the ſurface of the ſea: that loaded veſſels uſed formerly to ride in many places where pinnaces and barks could now with difficulty ſwim. He produces inſtances of ancient ſea-port towns now ſeveral leagues from the ſhore, and of anchors and wrecks of veſſels found far within the country. He mentions a particular rock which 168 years before was at the bottom of the ſea, but was then raiſed eight feet above its ſurface. In another place where the water 50 years before had reached to the knee there was then none. Several rocks, too, which during the infancy of ſome old pilots had been two feet under water, were then three feet above it. From all theſe obſervations M. Celſius concludes, that the water of the Baltic decreaſes in height 4½ lines in a year, 4 inches 5 lines in 18 years, 4 feet 5 inches in a hundred years, and in a thouſand years 45 feet. Conſcious, however, that theſe facts, how concluſive ſoever as far as relates to the Baltic, can never determine the general queſtion, M. Celſius advances another argument in ſupport of his theory. All that quantity of moiſture, ſays he, which is imbibed by plants is loſt to the general maſs of water, being converted into earth by the putrefaction of vegetables. This notion had been mentioned by Newton, and was adopted by Van Helmont: if granted, it follows as a conſequence that the earth is continually increaſing and the water diminiſhing in a very rapid degree.

8
Theſe arguments examined.

Such are the arguments advanced in ſupport of both theories; for it is needleſs to mention a notion of Linnæus that the whole earth was formerly covered with water except a ſingle mountain. When fairly weighed, they amount to nothing more than this, that the ſea has encroached upon the land in ſome places, and retired in others; a concluſion which we are very willing to allow. What was advanced by thoſe philoſophers who maintain that the ſea is continually encroaching on the land, about the depth of the ſea conſtantly diminiſhing, muſt remain a mere aſſertion, till they prove by experiments, either that this is really the caſe, or that nature has no way of reſtoring thoſe particles of earth which are waſhed down by the rivers. Nor have they any good reaſon to affirm that the height of the mountains is decreaſing. Can a ſingle uncontrovertible inſtance be produced of this? Are the Alps or the Apennines, or Taurus, or Caucaſus, leſs lofty now than they were a thouſand years ago? We mean not to deny that the rain actually waſhes down particles of earth from the mountains, nor to affirm that the hardeſt rocks are able to reſiſt continual ſtorms, nor that many mountains have ſuffered, and continue to ſuffer daily, from a thouſand accidents. But the effects produced by all theſe cauſes are ſo trifling as to be altogether imperceptible (A). Nature has aſſiduouſly guarded againſt ſuch accidents; ſhe has formed the mountains of the moſt durable materials; and where they are covered with earth, ſhe has bound it together by a thick and firm matting of graſs, and thus ſecured it from the rains; and ſhould accident deprive it of this covering, ſhe takes care immediately to ſupply the defect. Even ſhould the earth be ſwept away together with its covering, nature has ſtill ſuch reſources left as frequently reſtore things to their former ſtate. Many kinds of moſs, one would be tempted to think, have been created for this very purpoſe: they take root and flouriſh almoſt upon the bare rock, and furniſh as they decay a ſufficient bed for ſeveral of the hardy Alpine plants. Theſe periſh in their turn, and others ſucceed them. The roots of the plants bind faſt the earth as it accumulates, more plants ſpring up and ſpread wider, till by degrees the whole ſurface is covered with a firm coat of graſs.

9
Bottom of the ſea.

As the ſea covers ſo great a portion of the globe, we ſhould, no doubt, by exploring its bottom, diſcover a vaſt number of intereſting particulars. Unfortunately in the greater part of the ocean this has hitherto been impoſſible. Part, however, has been examined; and the diſcoveries which this examination has produced may enable us to form ſome idea at leaſt of the whole. The bottom of the ſea, as might have been conjectured indeed beforehand, bears a great reſemblance to the ſurface of the dry land, being, like it, full of plains, rocks, caverns and mountains; ſome of which are abrupt and almoſt perpendicular, while others riſe with a gentle declivity, and ſometimes tower above the water and form iſlands. Neither do the materials differ which compoſe the bottom of the ſea and the baſis of the dry land. If we dig to a conſiderable depth in any part of the earth, we uniformly meet with rock; the ſame thing holds in the ſea. The ſtrata, too, are of the ſame kind, diſpoſed in the ſame manner, and form indeed but one whole. The ſame kind of mineral and bituminous ſubſtances are alſo found interſperſed with theſe ſtrata; and it is to them probably that the ſea is indebted for its bitter taſte. Over theſe natural and original ſtrata an artificial bed has pretty generally been formed, compoſed of different materials in different places. It conſiſts frequently of muddy tartareous ſubſtances firmly cemented together, ſometimes of ſhells or coral reduced to powder, and near the mouths of rivers it is generally compoſed of fine ſand or gravel. The bottom of the ſea reſembles the land likewiſe in another particular: many freſh ſprings and even rivers riſe out of it, which, diſplacing the ſalt water, render the lower part of the ſea wherever they abound quite freſh. An inſtance of this kind occurs near Goa on the weſtern coaſt of Indoſtan *, and another † in the Mediterranean ſea not far from Marſeilles. Theſe facts occaſioned a notion, which later experiments have exploded, that the ſea beyond a certain depth was always freſh.

* *Boyle de Fundo Maris.*

† *Marſigli Hiſtoire Phyſique de la Mer*, partie 1.

Subſtances of a very beautiful appearance are frequently brought up by the ſounding line from the bottom of the ſea. The plummet is hollowed below, and this cavity filled with tallow, to which ſome of the ſubſtances adhere which form the bed of the ocean. Theſe are generally ſand, gravel, or mud; but they are ſometimes of the brighteſt ſcarlet, vermilion, purple, and yellow; and ſometimes, though leſs frequently, they are blue, green, or white. Theſe colours are owing to a kind of jelly which envelopes the ſubſtances, and vaniſh entirely as ſoon as this jelly dries. At times, however, they aſſume the appearance of tartareous cruſts, and are then ſo permanent, that they can be received into white wax melted and poured round them, and perhaps by proper care might be converted into valuable paints.

10
Colour of the ſea.

Sea-water is really, as any one may convince himſelf by pouring it into a glaſs, as clear and tranſparent as river water. The various appearances therefore which it aſſumes are owing to accidental cauſes, and not to any change in the water itſelf. The depth, or the materials which compoſe the bottom of the ſea, occaſions it to aſſume different colours in different places. The Arabian gulf, for inſtance, is ſaid to be red from the colour of the ſands which form its bed. The appearance of the ſea is affected too by the winds and the ſun, while the clouds that paſs over it communicate all their various and fleeting colours. When the ſun ſhines it is green; when the ſun gleams through a fog it is yellow; near the north pole it appears black; while in the torrid zone its colour is often brown. Sometimes the ſea aſſumes a luminous appearance. See LIGHT, Vol. XII. page 2.

11
Saltneſs of the ſea.

The ſea contains the greateſt quantity of ſalt in the torrid zone, where otherwiſe from the exceſſive heat it would be in danger of putrefaction: as we advance northward this quantity diminiſhes, till at the pole it nearly vaniſhes altogether. Under the line Lucas found that the ſea contained a ſeventh part of ſolid contents, conſiſting chiefly of ſea-ſalt. At Harwich he found it yielded $\frac{1}{25}$th of ſea-ſalt. At Carlſcroon in Sweden it contains $\frac{1}{30}$th part (B), and on the coaſt of Greenland a great deal leſs. This deficiency of ſalt near the poles probably contributes a good deal towards the prodigious

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(A) M. Genſanne pretends that the Pyrenean mountains become an inch lower every ten years. But even according to his own calculation, it would require a million of years to level theſe mountains with the plain, though they continued to decreaſe at the ſame rate; and philoſophers tell us that this rate is conſtantly diminiſhing!

(B) This gradual diminution of ſaltneſs from the equator to the pole is not, however, without particular exceptions. The Mediterranean ſea contains $\frac{1}{27}$th of ſea-ſalt, which is leſs than the German ſea contains.

ous quantities of ice which are met with in theſe ſeas; for ſalt water requires a much greater degree of cold to freeze it than freſh water. It was this circumſtance, probably, together with its conſtant motion, which induced the ancients to believe that the ſea never froze. Even among the moderns it has been a generally received opinion, that ſea-ice is originally formed in rivers. Buffon has made the great quantities of ice with which the South ſea abounds an argument for the exiſtence of a continent near the Antarctic pole. But it is now well known that great quantities of ice are formed at a diſtance from land. Sea-ice is of two kinds; field ice, which extends along the ſhore, and is only two or three feet thick; and mountain ice, which abounds in the middle of the ocean. The ſize of theſe mountains is ſometimes prodigious. The ſea-ice is always freſh, and has been often of great uſe to navigators. The weight of ſea-water is to that of river-water as 73 to 70; that is, a cubic foot of ſea-water weighs 73lb. while the ſame quantity of river-water weighs only 70lb.; but this proportion varies in different places. It is worthy of our attention, too, that the water at the ſurface of the ſea contains leſs ſalt than near the bottom; the difference indeed is inconſiderable, but ſtill it is ſomething. The Compte de Marſigli found the ſame quantity of water, when taken from the bottom of the Mediterranean, to weigh one ounce three pennyweights 51 grains; whereas from the ſurface it weighed only one ounce three pennyweights 49 grains. He repeated the experiment frequently with nearly the ſame reſult.

12
Temperature of the sea.

Boyle de Temperie Regionum Submarinarum.

The ſea, with reſpect to temperature, may be divided into two regions: The firſt begins at the ſurface of the water, and deſcends as far as the influence of the ſun's rays; the ſecond reaches from thence to the bottom of the ſea. In ſummer the lower region is conſiderably colder than the upper: but it is probable that during winter the very reverſe takes place; at leaſt the Compte de Marſigli found it ſo repeatedly in the Mediterranean. This naturally reſults from the ſituation of the water near the bottom of the ſea. Uninfluenced by the changes in the atmoſphere, it retains always nearly the ſame degree of temperature: and this is conſiderably above congelation; for the lower region of the ſea, at leaſt in the temperate parts of the world, was never known to freeze. Captain Ellis let down a ſea-gage (ſee GAGE) in latitude 25° 12′ north, and longitude 25° 13′ weſt, to take the degrees of temperature and ſaltneſs of the ſea at different depths. It deſcended 5346 feet, which is a mile and eleven fathoms. He found the ſea ſalter and colder in proportion to its depth till the gage had deſcended 3900 feet, when the mercury in the thermometer came up at 53; but the water never grew colder, though he let down the gage 2446 feet lower. At the ſurface the thermometer ſtood at 84.

Phil. Tranſ. for 1571, p. 215.

13
The ſea has three motions. Motion occaſioned by the wind

The ſea has three kinds of motion: 1. The firſt is that undulation which is occaſioned by the wind. This motion is entirely confined to the ſurface; the bottom even during the moſt violent ſtorms remains perfectly calm. Mr Boyle has remarked, from the teſtimony of ſeveral divers, that the ſea is affected by the winds only to the depth of ſix feet. It would follow from this, that the height of the waves above the ſurface does not exceed ſix feet; and that this holds in the Mediterranean at leaſt, we are informed by the Compte de Marſigli, though he alſo ſometimes obſerved them, during a very violent tempeſt, riſe two feet higher. It is affirmed by Pliny, and ſeveral other ancient writers, that oil calms the waves of the ſea; and that divers were accuſtomed to carry ſome of it for that purpoſe in their mouths. This account was always conſidered by the moderns as a fable, and treated with ſuch contempt, that they did not even deign to put it to the teſt of experiment, till Dr Franklin accidentally diſcovered its truth. Happening in 1757 to be in the middle of a large fleet, he obſerved that the water round one or two veſſels was quite calm and ſmooth, while every where elſe it was very much agitated by the winds. He applied to the captain for an explanation of this phenomenon, who replied, that the cooks, he ſuppoſed, had thrown their greaſy water out at the ſcupper-holes, and by that means oiled the ſides of the veſſels in queſtion. This anſwer did not ſatisfy the Doctor at firſt; but recollecting what Pliny had ſaid on the ſubject, he reſolved at leaſt to make the experiment. He did ſo accordingly in 1762, and found that oil actually calmed the waves of the ſea. He repeated the experiment upon a pond at Clapham: the oil ſpread itſelf with great rapidity upon the ſurface, but did not produce the deſired effect, becauſe, having been thrown in upon the ſide oppoſite to the wind, it was immediately driven to the edge of the water. But upon throwing in a like quantity upon the other ſide of the lake, it calmed in an inſtant ſeveral yards of the ſurface; and gradually ſpreading, rendered all that part of the lake, to the extent of at leaſt half an acre, as ſmooth as glaſs. The curious effect produced by this liquid may be accounted for by the repulſion which exiſts between oil and water, and between oil and air, which prevents all immediate contact, all rubbing of the one upon the other.

14
ſtilled by oil.

15
Motion towards the weſt—Currents.

2. The ſecond kind of motion is that continual tendency which the whole water in the ſea has towards the weſt. It is greater near the equator than about the poles; and indeed cannot be ſaid to take place at all in the northern hemiſphere beyond the tropic. It begins on the weſt ſide of America, where it is moderate: hence that part of the ocean has been called *Pacific.* As the waters advance weſtward their motion is accelerated; ſo that, after having traverſed the globe, they ſtrike with great violence on the eaſtern ſhore of America. Being ſtopped by that continent, they turn northward, and run with conſiderable impetuoſity in the gulf of Mexico; from thence they proceed along the coaſt of North America, till they come to the ſouth ſide of the great bank at Newfoundland, when they turn off, and run down through the Weſtern Iſles. This current is called the *Gulf Stream.* It was firſt accurately deſcribed by Dr Franklin, who remarked alſo, that the water in it having been originally heated in the torrid zone, cools ſo gradually in its paſſage northward, that even the latitude might be found in any part of the ſtream by means of a thermometer.—This motion of the ſea weſtward has never been explained: it ſeems to have ſome connection with the trade-winds and the diurnal revolution of the earth on its axis.

16
Motion occaſioned by the tide.

3. The third and moſt remarkable motion of the ſea is the tide, which is a regular ſwell of the ocean once every 12 hours, owing, as Newton has demonſtrated, to the attraction of the moon. In the middle of the ſea the tide ſeldom riſes higher than one or two feet,

but on the coaſt it frequently reaches the height of 45 feet, and in ſome places even more. The tide generally riſes higher in the evening than in the morning: on the coaſt of Britain this holds in winter, but in ſummer the morning tides are higheſt. In ſome ſeas it is ſaid that there are no tides. This cannot be owing to their being ſurrounded by land, becauſe there is a tide in the lakes of North America. For an explanation of theſe and other phenomena we refer to the article TIDE.

SEA-Air, that part of the atmoſphere which is above the ſea.

Sea-air has been found ſalubrious and remarkably beneficial in ſome diſtempers. This may be owing to its containing a greater portion of oxigenous gas or vital air, and being leſs impregnated with noxious vapours than the land. Dr Ingenhouſz made ſeveral experiments to aſcertain the ſalubrity of ſea-air. By mixing equal meaſures of common air and nitrous air, he found, that at Graveſend, they occupied about 104, or one meaſure and $\frac{4}{100}$ of a meaſure: whereas on ſea, about three miles from the mouth of the Thames, two meaſures of air (one of common and one of nitrous air) occupied from 0.91 to 0.94. He attempted a ſimilar experiment on the middle of the channel between the Engliſh coaſt and Oſtend; but the motion of the ſhip rendered it impracticable. He found that in rainy and windy weather the ſea-air contained a ſmaller quantity of vital air than when the weather was calm. On the ſea-ſhore at Oſtend it occupied from 94½ to 97; at Bruges he found it at 105; and at Antwerp 109½. Dr Ingenhouſz thus concludes his paper:

Phil. Tranſ. 1780, p. 354. It appears, from theſe experiments, that the air at ſea and cloſe to it is in general purer and fitter for animal life than the air on the land, though it ſeems to be ſubject to the ſame inconſtancy in its degree of purity with that of the land; ſo that we may now with more confidence ſend our patients, labouring under conſumptive diſorders, to the ſea, or at leaſt to places ſituated cloſe to the ſea, which have no marſhes in their neighbourhood. It ſeems alſo probable, that the air will be found in general much purer far from the land than near the ſhore, the former being never ſubject to be mixed with land air.

Dr Damman, an eminent phyſician and profeſſor royal of midwifery at Ghent, told Dr Ingenhouſz, that when he was formerly a practitioner at Oſtend, during ſeven years, he found the people there remarkably healthy; that nothing was rarer there than to ſee a patient labouring under a conſumption or aſthma, a malignant, putrid, or ſpotted fever; that the diſeaſe to which they are the moſt ſubject, is a regular intermittent fever in autumn, when ſudden tranſitions from hot to cold weather happen.

People are in general very healthy at Gibraltar, though there are very few trees near that place; which Dr Ingenhouſz thinks is owing to the purity of the air ariſing from the neighbourhood of the ſea.

Moſt ſmall iſlands are very healthy.

At Malta people are little ſubject to diſeaſes, and live to a very advanced age.

SEA-Anemony. See *ANIMAL-Flower.*

SEA-Bear. }
SEA-Calf. } See PHOCA, } MAMMALIA *Index.*
SEA-Cow. See TRICHECUS, }

SEA-Crow, Mire-Crow, or *Pewit.* See LARUS, ORNITHOLOGY *Index.*

SEA, Dead. See ASPHALTITES.

SEA-Devil. See LOPHIUS, ICHTHYOLOGY *Index.*

SEA-Dragon, a monſter of a very ſingular nature. In the Gentleman's Magazine for the year 1749, we have the account of a ſea-dragon which was ſaid to be taken between Orford and Southwould, on the coaſt of Suffolk, and afterwards carried round the country as a curioſity by the fiſhermen who caught it.

"Its head and tail (ſays the writer) reſemble thoſe of an alligator; it has two large fins, which ſerve it both to ſwim and to fly; and though they were ſo dried that I could not extend them, yet they appear, by the folds, to be ſhaped like thoſe which painters have given to dragons and other winged monſters that ſerve as ſupporters to coats of arms. Its body is covered with impenetrable ſcales; its legs have two joints, and its feet are hoofed like thoſe of an aſs: it has five rows of very white and ſharp teeth in each jaw, and is in length about four feet, though it was longer when alive, it having ſhrunk as it became dry.

"It was caught in a net with mackerel; and being dragged on ſhore, was knocked down with a ſtretcher or boat-hook. The net being opened, it ſuddenly ſprung up, and flew above 50 yards: the man who firſt ſeized it had ſeveral of his fingers bitten off; and the wound mortifying, he died. It afterwards faſtened on the man's arm who ſhows it, and lacerated it ſo much, that the muſcles are ſhrunk, and the hand and fingers diſtorted; the wound is not yet healed, and is thought to be incurable. It is ſaid by ſome to have been deſcribed by naturaliſts under the name of the *Sea-dragon.*" We muſt add to the account now given of the monſter called a *ſea-dragon*, that we think it extremely probable that the animal was nothing more than a diſtorted or overgrown individual of ſome of the well known ſpecies of fiſh.

SEA-Gage. See *Sea-GAGE.*

SEA-Hare. See LAPLYSIA, HELMINTHOLOGY *Index.*

SEA-Horſe, in *Ichthyology*, the Engliſh name of the *Hippocampus.* See SYNGNATHUS, ICHTHYOLOGY *Index.*

SEA-Lemon. See DORIS, HELMINTHOLOGY *Index.*

SEA-Lion. See PHOCA, MAMMALIA *Index.*

SEA-Mall, or *SEA-Mew.* See LARUS, ORNITHOLOGY *Index.*

SEA-Man. See MERMAID.

SEA-Marks. The erection of beacons, light-houſes, and ſea-marks, is a branch of the royal PREROGATIVE. By 8 Eliz. 13. the corporation of the Trinity-houſe are empowered to ſet up any beacons or ſea-marks wherever they ſhall think them neceſſary; and if the owner of the land or any other perſon ſhall deſtroy them, or take down any ſteeple, tree, or other known ſea-mark, he ſhall forfeit 100l. ſterling; or, in caſe of inability to pay it, he ſhall be *ipſo facto* outlawed.

SEA-Needle, Gar-fiſh. See ESOX, ICHTHYOLOGY *Index.*

SEA-Nettle. See *ANIMAL-Flower.*

SEA-Pie, or *Oyſter-Catcher.* See HÆMATOPUS, ORNITHOLOGY *Index.*

SEA-Plants, are thoſe vegetables that grow in ſalt-water within the ſhores of the ſea. The old botaniſts divided

divided theſe into three claſſes. 1. The firſt claſs, according to their arrangement, contained the *algæ*, the *fuci*, the *ſea-moſſes*, or *confervas*, and the different ſpecies of ſponges. 2. The ſecond contained ſubſtances of a hard texture, like ſtone or horn, which ſeem to have been of the ſame nature with what we call *zoophyta*, with this difference, that we refer ſponges to this claſs and not to the firſt. The third claſs is the ſame with our *lithophyta*, comprehending *corals*, *madrepora*, &c. It is now well known that the genera belonging to the ſecond and third of theſe claſſes, and even ſome referred to the firſt, are not vegetables, but animals, or the productions of animals. See CORALLINA, MADREPORA, SPONGIA. Sea-plants, then, properly ſpeaking, belong to the claſs of cryptogamia, and the order of algæ; and, according to Bomare, are all comprehended under the genus of fucus. We may alſo add ſeveral ſpecies of the ulva and conferva and the ſargazo. The fuci and marine ulvæ are immerſed in the ſea, are ſeſſile, and without root. The marine confervæ are either ſeſſile or floating. The ſargazo grows beyond ſoundings.

As ſome ſpecies of the fucus, when dried and preſerved, are extremely beautiful, the curious, and eſpecially thoſe who proſecute the ſtudy of botany, muſt be anxious to know the beſt method of preſerving them, without deſtroying their colour and beauty. The following method is recommended by M. Mauduyt. Take a ſheet of paper, or rather of paſteboard, and cover it with varniſh on both ſides; and having rowed in a boat to the rock where the fucus abounds, plunge your varniſhed paper into the water, and, detaching the fucus, receive it upon the paper. Agitate the paper gently in the water, that the plants may be properly ſpread over it; and lift them up together ſoftly out of the water: then fix down with pins the ſtrong ſtalks, that they may not be diſplaced, and leave the plant lying upon the varniſhed paper to dry in the open air. When it is fully dry, the different parts will retain their poſition, and the plant may be preſerved within the leaves of a book. To free it from the ſlime and ſalt which adhere to it, waſh it gently in freſh water, after being removed from the rock on which it grew.

SEA-Serpent, a monſtrous creature, ſaid to inhabit the northern ſeas about Greenland and the coaſts of Norway. The following marvellous account of this monſter is given by Guthrie. "In 1756, one of them was ſhot by a maſter of a ſhip: its head reſembled that of a horſe; the mouth was large and black, as were the eyes, a white mane hanging from its neck: it floated on the ſurface of the water, and held its head at leaſt two feet out of the ſea: between the head and neck were ſeven or eight folds, which were very thick; and the length of this ſnake was more than 100 yards, ſome ſay fathoms. They have a remarkable averſion to the ſmell of caſtor; for which reaſon, ſhip, boat, and bark maſters provide themſelves with quantities of that drug, to prevent being overſet, the ſerpent's olfactory nerves being remarkably exquiſite. The particularities related of this animal would be incredible, were they not atteſted upon oath. Egede, a very reputable author, ſays, that on the 6th day of July 1734, a large and frightful ſea-monſter raiſed itſelf ſo high out of the water, that its head reached above the main-top-maſt of the ſhip; that it had a long ſharp ſnout, broad paws, and ſpouted water like a whale; that the body ſeemed to be covered with ſcales; the ſkin was uneven and wrinkled, and the lower part was formed like a ſnake. The body of this monſter is ſaid to be as thick as a hogſhead; his ſkin is variegated like a tortoiſe ſhell; and his excrement, which floats upon the ſurface of the water, is corroſive." Notwithſtanding the belief of Guthrie, and the teſtimony which he produces, we cannot help doubting of the exiſtence of the ſea-ſerpent. Its bulk is ſaid to be ſo diſproportionate to all the known animals of our globe, that it requires more than ordinary evidence to render it credible: but the evidence which is offered is ſo very feeble and unſatisfactory, that no man of ſound judgement would think it ſufficient to eſtabliſh the truth of an extraordinary fact.

Attempts have lately been made to revive the opinion of the exiſtence of mermaids and ſea-ſerpents. An individual of the latter, it is ſuppoſed, was ſome time ago thrown on ſhore in Orkney. Part of the ſkeleton is ſaid to be in the muſeum of the Univerſity of Edinburgh, and another part is in the poſſeſſion of Mr Home of London, who thinks that it may have belonged to an individual of ſome of the whale tribe, perhaps a monſter of that tribe; but according to others it is to be conſidered as conſtituting a diſtinct genus. We cannot avoid obſerving, that this point muſt remain unſettled till other ſpecies of this new genus have been diſcovered, or at leaſt till an entire individual have been deſcribed by an experienced naturaliſt.

SEA-Sickneſs, a diſorder incident to moſt perſons on their firſt going to ſea, occaſioned by the agitation of the veſſel. This diſorder has not been much treated of, although it is very irkſome and diſtreſſing to the patient during its continuance. It has, however, been found beneficial in aſthmatic and pulmonary complaints, and the inſtances in which it has proved fatal, are extremely rare. The ſea ſickneſs appears to be a ſpaſmodic affection of the ſtomach, occaſioned by the alternate preſſure and receſs of its contents againſt its lower internal ſurface, according as the riſe and fall of the ſhip oppoſe the action of gravity.

The ſeas in which the attacks of this diſorder are accompanied with the greateſt violence, are thoſe where the waves have an uninterrupted freedom of action; and of conſequence bays, gulfs and channels, may be navigated with leſs inconvenience, as the waves, meeting with more frequent reſiſtance, the veſſel does not experience that gentle uniform vacillation which induces ſickneſs, and renders the head giddy. A perſon feels leſs inconvenience from the diſorder in a ſmall veſſel on the wide ocean, on which the ſlighteſt motion of the waves makes a ſtrong impreſſion. He is alſo leſs expoſed to it in a very large veſſel deeply laden, as the waves, in this caſe, ſcarcely affect the veſſel. It is in ſhips of an ordinary ſize, and which carry but a light cargo, that the paſſenger ſuffers moſt from the ſea-ſickneſs. The ſooner it takes place after embarkation, the continuance of it becomes the more probable. It does not always ceaſe immediately on landing, but in ſome caſes continues for a conſiderable time.

Many methods of preventing, or at leaſt of mitigating this diſorder, have been recommended, of which the moſt efficacious appear to be the following.

1. Not to go on board immediately after eating, and not to eat, when on board, any large quantity at a time.

2. To take much exerciſe, with as little intermiſſion as poſſible; as indolent paſſengers are always the greateſt ſufferers from the diſorder.

3. To keep much upon deck, even when the weather is ſtormy, as the ſea breeze is not ſo apt to affect the ſtomach as the impure air of the cabin, rendered ſo for want of proper circulation.

4. Not to watch the motion of the waves, particularly when ſtrongly agitated with tempeſt.

5. Carefully to ſhun all employments by which the mind may be haraſſed, as reading, ſtudying, gaming, &c. and to ſeek all opportunities of mental relaxation.

6. To drink occaſionally liquids containing carbonic acid, as the froth of beer ſtrongly fermented, or wine and Seltzer water mixed together, and ſweetened with pounded ſugar.

7. It will alſo be beneficial to take ſulphuric acid dulcified, dropped on a bit of ſugar, or in peppermint water, or ten drops of ether.

The proper diet conſiſts of bread and freſh meat, to be eaten cold with pepper. All ſweet ſavoured food ſhould be carefully avoided, and the paſſenger ought to refrain from fat, and particularly from ſuch meat as is in the ſmalleſt degree tainted. Even the ſmell of flowers is injurious, for which reaſon marine productions ought not to be examined; but the fumes of vinegar may be advantageouſly inhaled. The drink ſhould conſiſt of lemonade or tart wines, but never of common water. An accidental diarrhœa has often relieved the patient from ſea-ſickneſs, and therefore a gentle laxative in ſuch a diſorder ſeems to be indicated. It will alſo be found uſeful to apply a tonic anodyne plaſter to the pit of the ſtomach, ſpread upon leather, and covered with linen.

When ſymptoms of vomiting appear, they may often be remedied by the patient placing himſelf in a horizontal poſition on his back or belly, and lying perfectly ſtill. If the fits of vomiting are too violent to be repreſſed, they ſhould be promoted by a ſtrong doſe of ſalt water; not, however, to be often repeated, as it debilitates the ſtomach. When the emetic operates, the patient ſhould bend his body, bringing his knees towards his breaſt, and ſupporting his head againſt a firm reſting-place. His garters and cravat muſt be untied, a precaution which will ſecure him from the danger of a rupture.

The vomiting having ſubſided, a ſtate of repoſe will prevent its return, and the eyes may be kept ſhut for a conſiderable time. The patient muſt make choice of a cool, ventilated place, remembering to keep himſelf warm and well clothed, as perſpiration is highly beneficial. A gargle of ſugar diſſolved in vinegar is to be taken in the morning, accompanied with frequent and ſpare eating. Water muſt never be taken in its pure ſtate, but mixed with wine, vinegar, or brandy. A glaſs of wine may be taken in the morning, with an infuſion of orange peel, gentian root, or peruvian bark. A glaſs of punch occaſionally taken will be extremely beneficial, by which perſpiration is promoted.

Perſons accuſtomed to ſmoke tobacco, will find the uſe of the pipe ſalutary on ſuch occaſions, but the practice of ſmoking will be injurious to all others. We may add that warm clothing, flannel ſhirts, caps, trowſers, &c. are powerful remedies againſt exceſſive expectoration, with every other ſymptom of this dreadful malady.

SEA-Star. See ASTERIAS, } HELMINTHOLOGY *Index.*
SEA-Urchin. See ECHINUS, }

SEA-Water, the ſalt water of the ſea. The principal ſalts contained in ſea-water are, 1ſt, Common marine or culinary ſalt, compounded of foſſil alkali or ſoda and marine acid; 2dly, A ſalt formed by the union of the ſame acid with magneſian earth; and, laſtly, A ſmall quantity of ſelenite. The quantity of ſaline matter contained in a pint of ſea-water, in the Britiſh ſeas, is, according to Neumann, about one ounce in each pint (A).

The ſaltneſs of this water is ſuppoſed to ariſe from numerous mines and mountains of ſalt diſperſed here and there in the depths of the ſea. Dr Halley ſuppoſes that it is probable the greateſt part of the ſea-ſalt, and of all ſalt lakes, as the Caſpian ſea, the Dead ſea, the lake of Mexico, and the Titicaca in Peru, is derived from the water of the rivers which they receive: and ſince this ſort of lakes has no exit or diſcharge but by the exhalation of vapours, and alſo ſince theſe vapours are entirely freſh or devoid of ſuch particles, it is certain that the ſaltneſs of the ſea and of ſuch lakes muſt from time to time increaſe; and therefore the ſaltneſs at this time muſt be greater than at any time heretofore. He further adds, that if, by experiments made in different ages, we could find the different quantity of ſalt which the ſame quantity of water (taken up in the ſame place, and in all other the ſame circumſtances) would afford, it would be eaſy from thence, by rules of proportion, to find the age of the world very nearly, or the time wherein it has been acquiring its preſent ſaltneſs.

This opinion of Dr Halley is ſo improbable, that it is ſurpriſing ſo acute a philoſopher could have adopted it. That freſh water rivers ſhould in the courſe of many thouſand years produce ſaltneſs in the ſea, is quite incredible. If this were the caſe, every ſea or great body of water which receives rivers muſt be ſalt, and muſt poſſeſs a degree of ſaltneſs in proportion to the quantity of water which the rivers diſcharge. But ſo

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(A) In Bergman's analyſis of ſea-water taken up in the beginning of June 1776, about the latitude of the Canaries, from the depth of 60 fathoms, the ſolid contents of a pint of the water were,

		Grs.		ʒ.	℈	Grs.
Of common ſalt	-	$253\frac{6}{11}$				
Salited magneſia	-	$69\frac{1}{11}$	or	5	1	$10\frac{9}{11}$
Gypſum	-	$8\frac{2}{11}$				
Total	-	$330\frac{9}{11}$				

ſo far is this from being true, that the Palus Meotis and the great lakes in America do not contain ſalt but freſh water. It may indeed be objected, that the quantity of ſalt which the rivers carry along with them and depoſit in the ſea, muſt depend on the nature of the ſoil through which they flow, which may in ſome places contain no ſalt at all: and this may be the reaſon why the great lakes in America and the Palus Meotis are freſh. But to this opinion, which is merely hypothetical, there are unſurmountable objections. It is a curious fact that the ſaltneſs of the ſea is greateſt under the line, and diminiſhes gradually as we advance to the poles: We muſt therefore ſuppoſe, if Dr Halley's theory be true, that the earth contains more ſalt in the tropical regions than in the temperate zones, and more in the temperate zones than in the frigid; and conſequently that the rivers in theſe different regions contain a quantity of ſalt proportionable to their diſtance from the equator. This, however, muſt be firſt proved by experiment, and cannot be aſſumed as an eſtabliſhed fact. But there is another circumſtance that entirely deſtroys this theory. If we allow that the ſea receives its ſaltneſs from the rivers, it muſt be equally ſalt or nearly ſo in every part of the earth. For, according to a ſimple and well known principle in chemiſtry, "when any ſubſtance is diſſolved in water with the aſſiſtance of agitation, at whatever part of the water it is introduced, it will be equally diffuſed through the whole liquid." Now though it were true that a greater quantity of ſalt were introduced into the ſea under the line than towards the poles, from the conſtant agitation occaſioned by the wind and tide, the ſalt muſt ſoon pervade the whole maſs of water. To ſay that the ſuperior degree of heat in the tropical regions may diſſolve a greater quantity of ſalt, will not deſtroy our argument; for it is an eſtabliſhed principle in chemiſtry, that cold water will diſſolve nearly as great a quantity of ſalt as hot water can diſſolve.

The ſaltneſs of the ſea has alſo been aſcribed to the ſolution of ſubterraneous mines of ſalt, which is ſuppoſed to abound in the bottom of the ſea and along its ſhores. But this hypotheſis cannot be ſupported. If the ſea were conſtantly diſſolving ſalt, it would ſoon become ſaturated; for it cannot be ſaid that it is deprived of any part of its ſalt by evaporation, ſince rain-water is freſh. If the ſea were to become ſaturated, neither fiſhes nor vegetables could live in it. We muſt therefore deſpair of being able to account for the ſaltneſs of the ſea by ſecond cauſes; and muſt ſuppoſe that it has been ſalt from the creation. It is impoſſible indeed to ſuppoſe that the waters of the ſea were at any period freſh ſince the formation of fiſhes and ſea-plants: for as theſe will not live in water ſaturated with ſalt, neither will they live in water that is freſh; we therefore conclude that the ſaltneſs of the ſea has been nearly the ſame in all ages. This is the ſimpleſt hypotheſis of the three that has been mentioned. It explains beſt the various phenomena, and is involved in feweſt difficulties. We ſhall, however, allow that there may be ſome exceptions; that the ſaltneſs of ſome ſeas, or of particular parts of the ſame ſea, may be increaſed by mines of rock-ſalt diſperſed near its ſhores.

With regard to the uſe of this ſalt property of ſea-water, it is obſerved, that the ſaltneſs of the ſea preſerves its waters pure and ſweet, which otherwiſe would corrupt and ſtink like a filthy lake, and conſequently that none of the myriads of creatures which now live therein could then have a being. From thence alſo the ſea water becomes much heavier, and therefore ſhips of greater ſize and quantity may be uſed thereon. Salt-water alſo doth not freeze ſo ſoon as freſh-water, whence the ſeas are more free for navigation. We have a diſſertation, by Dr Ruſſel, concerning the medical uſes of ſea-water in diſeaſes of the glands, &c. wherein the author premiſes ſome obſervations upon the nature of ſea-water, conſidered as impregnated with particles of all the bodies it paſſes over, ſuch as ſubmarine plants, fiſh, ſalts, minerals, &c. and ſaturated with their ſeveral effluvia, to enrich it and keep it from putrefaction: whence this fluid is ſuppoſed to contract a ſoapineſs; and the whole collection, being pervaded by the ſulphureous ſteams paſſing through it, to conſtitute what we call *ſea-water;* the confeſſed diſtinguiſhing characteriſtics of which are ſaltneſs, bitterneſs, nitroſity, and unctuoſity: whence the author concludes, that it may be juſtly expected to contribute ſignally to the improvement of phyſic. The caſes in which our author informs us we are to expect advantages from ſea-water are, 1. In all recent obſtructions of the glands of the inteſtines and meſentery. 2. All recent obſtructions of the pulmonary glands, and thoſe of the viſcera, which frequently produce conſumptions. 3. All recent glandular ſwellings of the neck, or other parts. 4. Recent tumours of the joints, if they are not ſuppurated, or become ſchirrous or cancerous, and have not carious bones for their cauſe. 5. Recent defluxions upon the glands of the eyelids. 6. All defœdations of the ſkin, from an eryſipelas to a lepra. 7. Diſeaſes of the glands of the noſe, with their uſual companion a thickneſs of the lip. 8. Obſtructions of the kidneys, where there is no inflammation, and the ſtone not large. 9. In recent obſtructions of the liver, this method will be proper, where it prevents conſtipations of the belly, and aſſiſts other medicines directed in icterical caſes. The ſame remedy is ſaid to be of ſignal ſervice in the bronchocele; and is likewiſe recommended for the prevention of thoſe bilious colics that ſo frequently affect our mariners.

Preſervation of SEA-*Water from Putrefaction.* As it is ſometimes neceſſary to preſerve ſea-water in caſks for bathing and other purpoſes, it is of importance to know how to keep it from putrefaction. Many experiments were made to determine this point by Mr Henry, and are recorded in the firſt volume of the Memoirs of the Literary and Philoſophical Society of Mancheſter. His firſt experiment we ſhall here preſent to our readers. "To one quart of ſea-water were added two ſcruples of freſh quick-lime; to another, half an ounce of common culinary ſalt; and a third was kept as a ſtandard without any addition. The mouths of the bottles being looſely covered with paper, they were expoſed to the action of the ſun in ſome of the hotteſt weather in ſummer. In about a week the ſtandard became very offenſive; and the water, with the additional quantity of ſalt, did not continue ſweet many hours longer; whereas that with lime continued many months without ever exhibiting the leaſt marks of putridity." When he added a dram more of quicklime, the whole of the magneſia contained in the water was ſeparated; and when a further addition was made, a lime-water was immediately formed. He therefore concluded, that two ſcruples of quicklime are ſufficient to preſerve a quart of ſea-water. The proportions, however, may vary a little, according to the ſtrength of the quicklime employed.

1 Different methods of freſhening ſea-water.

2 Dr Irving's.

Freſhening of SEA-*Water.* The method of making ſea-water freſh was long a deſideratum in navigation. Many methods have been propoſed for this purpoſe. Mr Appleby publiſhed an account of a proceſs which he had inſtituted in the year 1734. He diſtilled ſea-water with a quantity of *lapis infernalis* and calcined bones; but this proceſs was ſoon laid aſide, as it was not only difficult in itſelf, but rendered the water unpalatable. Dr Butler propoſed ſoap-leys in place of Mr Appleby's ingredients; but the water was ſtill liable to the ſame objection. Dr Stephen Hales recommended powdered chalk; but his method was expenſive, and did not improve the taſte of the water. Dr Lind of Portſmouth diſtilled ſea-water without any ingredients; but as the experiment he made was performed in a veſſel containing only two quarts, with a glaſs receiver, in his ſtudy, nothing concluſive can be drawn from it for the uſe of ſailors. At length Dr Irving brought the proceſs to a very high degree of ſimplicity and perfection, by which the water is obtained pure, without much expence of fuel or a complicated apparatus. For this valuable diſcovery he received a reward of 5000l. The advantages of this method remain to be ſtated, which may be reduced to the following: 1. The aboliſhing all ſtills, ſtill-heads, worm-pipes, and their tubes, which occupy ſo much ſpace as to render them totally incompatible with the neceſſary buſineſs of the ſhip; and uſing in the room of theſe the ſhip's kettle or boiler, to the top whereof may occaſionally be applied a ſimple tube, which can be eaſily made on board a veſſel at ſea, of iron plate, ſtove funnel, or tin ſheet; ſo that no ſituation can prevent a ſhip from being completely ſupplied with the means of diſtilling ſea-water. 2. In conſequence of the principles of diſtillation being fully aſcertained, the contrivance of the ſimpleſt means of obtaining the greateſt quantity of diſtilled water, by making the tube ſufficiently large to receive the whole column of vapour, and placing it nearly in a horizontal direction, to prevent any compreſſion of the fluid, which takes place ſo much with the common worm. 3. The adopting of the ſimpleſt and moſt efficacious means of condenſing vapour; for nothing more is required in the diſtillation but keeping the ſurface of the tube always wet, which is done by having ſome ſea-water at hand, and a perſon to dip a mop or ſwab into this water, and paſs it along the upper ſurface of the tube. By this operation the vapour contained in the tube will be entirely condenſed with the greateſt rapidity imaginable; for by the application of the wet mop thin ſheets of water are uniformly ſpread, and mechanically preſſed upon the ſurface of the hot tube; which being converted into vapour make way for a ſucceſſion of freſh ſheets; and thus, both by the evaporation and cloſe contact of the cold water conſtantly repeated, the heat is carried off more effectually than by any other method yet known. 4. The carrying on the diſtillation without any addition, a correct chemical analyſis of ſea-water having evinced the futility of mixing ingredients with it, either to prevent an acid from riſing with the vapour, or to deſtroy any bituminous oil ſuppoſed to exiſt in ſea-water, and to contaminate the diſtilled water, giving it that fiery unpalatable taſte inſeparable from the former proceſſes. 5. The aſcertaining the proper quantity of ſea-water that ought to be diſtilled, whereby the freſh water is prevented from contracting a noxious impregnation of metallic ſalts, and the veſſel from being corroded and otherwiſe damaged by the ſalts caking on the bottom of it. 6. The producing a quantity of ſweet and wholeſome water, perfectly agreeable to the taſte, and ſufficient for all the purpoſes of ſhipping. 7. The taking advantage of the dreſſing the ſhip's proviſions, ſo as to diſtil a very conſiderable quantity of water from the vapour, which would otherwiſe be loſt, without any addition of fuel. To ſum up the merits of this method in a few words: The uſe of a ſimple tube, of the moſt eaſy conſtruction, applicable to any ſhip's kettle. The rejecting all ingredients; aſcertaining the proportion of water to be diſtilled, with every advantage of quality, ſaving of fuel, and preſervation of boilers. The obtaining freſh water, wholeſome, palatable, and in ſufficient quantities. Taking advantage of the vapour which aſcends in the kettle while the ſhip's proviſions are boiling. All theſe advantages are obtained by the above-mentioned ſimple addition to the common ſhip's kettles. But Dr Irving propoſes to introduce two further improvements. The firſt is a hearth, or ſtove, ſo conſtructed that the fire which is kept up the whole day for the common buſineſs of the ſhip ſerves likewiſe for diſtillation; whereby a ſufficient quantity of water for all the economical purpoſes of the ſhip may be obtained, with a very inconſiderable addition to the expence of fuel. The other improvement is that of ſubſtituting, even in the largeſt ſhips, caſt-iron boilers, of a new conſtruction, in the place of coppers.

3 Directions for diſtilling ſea-water.

As ſoon as ſea-water is put into the boiler, the tube is to be fitted either into the top or lid, round which, if neceſſary, a bit of wet linen may be applied, to make it fit cloſe to the mouth of the veſſel; there will be no occaſion for luting, as the tube acts like a funnel in carrying off the vapour. When the water begins to boil, the vapour ſhould be allowed to paſs freely for a minute, which will effectually clean the tube and upper part of the boiler. The tube is afterwards to be kept conſtantly wet, by paſſing a mop or ſwab, dipped in ſea water, along its upper ſurface. The waſte water running from the mop may be carried off by means of a board made like a ſpout, and placed beneath the tube. The diſtillation may be continued till three-fourths of the water be drawn off, and no further. This may be aſcertained either by a gauge-rod put into the boiler, or by meaſuring the water diſtilled. The brine is then to be let out. Water may be diſtilled in the ſame manner while the proviſions are boiling. When the tube is made on ſhore, the beſt ſubſtance for the purpoſe is thin copper well tinned, this being more durable in long voyages than tin-plates. Inſtead of mopping, the tube, if required, may have a caſe made alſo of copper, ſo much larger in diameter as to admit a thin ſheet of water to circulate between them by means of a ſpiral copper thread, with a pipe of an inch diameter at each end of the caſe; the lower for receiving cold water, and the upper for carry it off when heated.

When only a very ſmall portion of room can be conveniently allow for diſtillation, the machine (fig. 2.), which is only 27 inches long, may be ſubſtituted, as was

SCYTHES.

PLATE CCCCLXXVIII.

Fig. 1.

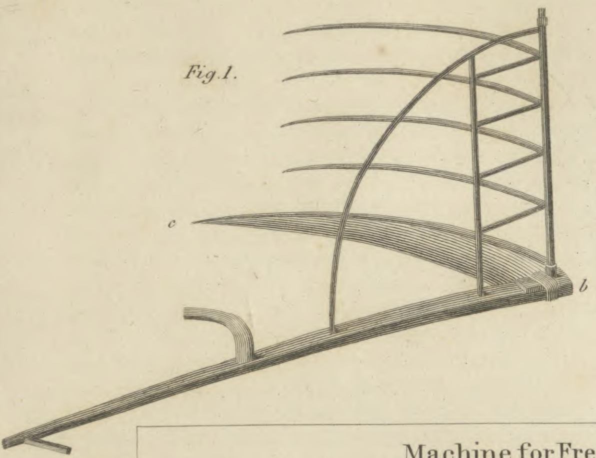


Fig. 2.

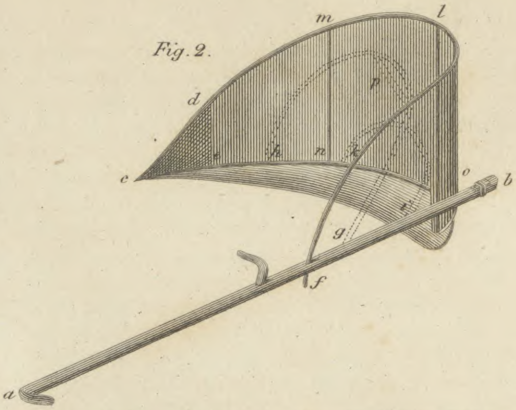


Fig. 3.

Machine for Freshening SEA WATER.

Fig. 1.

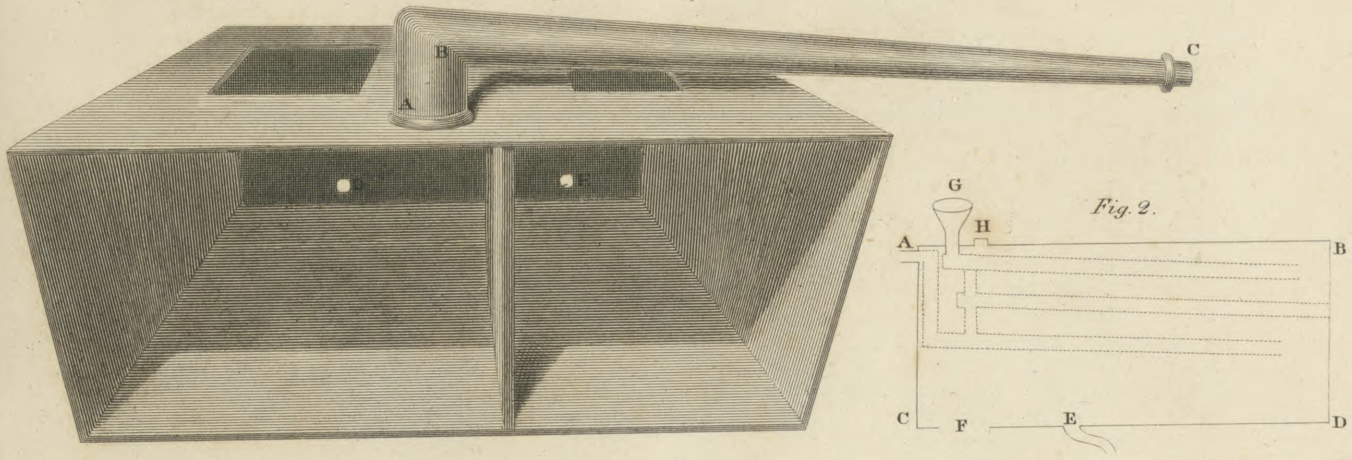


Fig. 2.

SECTOR

Fig. 3.

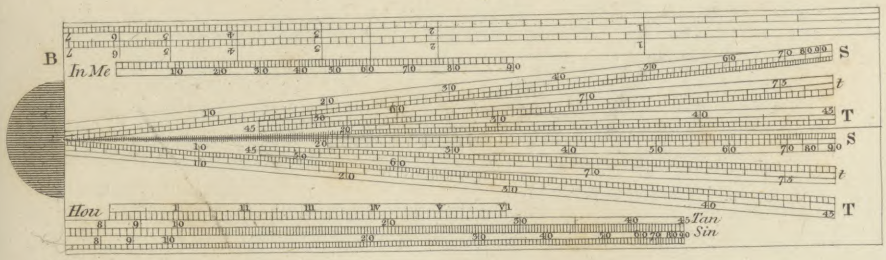


Fig. 1.

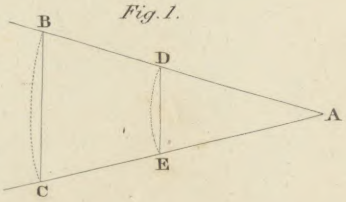
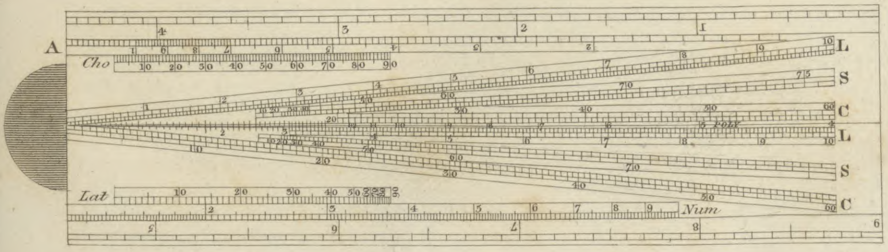
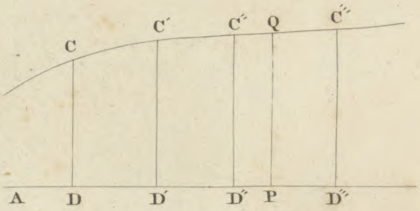


Fig. 4.



SERIES



E. Mitchell sculpt.

was done in this voyage. The principal intention of this machine, however, is to diſtil rum and other liquors; for which purpoſe it has been employed with extraordinary ſucceſs, in preventing an *empyreuma*, or fiery taſte.

Plate cccclxxviii. fig. 1.

Figure 1. repreſents in perſpective a ſection of the two boilers taken out of the frame. In the back part at D, E, are ſeen openings for the cocks. On the top is a diſtilling tube A, B, C, five inches diameter at A, and decreaſing in ſize to three inches at C; the length from B to C is five feet. Near C is a ring to prevent the water which is applied to the ſurface from mixing with the diſtilled water. In the inſide of the tube below B, is a ſmall lip or ledging, to hinder the diſtilled water from returning into the boiler by the rolling of the ſhip.

Fig. 2.

In figure 2. A, B, C, D, repreſent a vertical ſection of a copper box, 27 inches long, ſeven inches wide, and 11 in height, tinned on the inſide. In the bottom F is an aperture about ſix inches in diameter, having a ring to fit on the ſtill or boiler. The dotted lines which run nearly horizontal, are veſſels of thin copper, tinned on the outſide, two feet long, ſeven inches wide, and three quarters of an inch deep. At G is a funnel to receive cold water, which is conveyed into the veſſels by communicating pipes, contrived in ſuch a manner as to form a complete and quick circulation of the water through their whole extent. When the water is become hot by the action of the ſteam, it is diſcharged by the horizontal pipe at A. E is a pipe from which the diſtilled water or ſpirits run, and is bent in ſuch a form that the liquor running from it acts as a valve, and hinders any ſteam from eſcaping that way. On the top of the box, at H, is a ſafety-valve, which prevents any danger from a great accumulation of vapour not condenſed for want of a proper ſupply of cold water.

4
Lorgna's method of freſhening it by congelation.

We ſhall now mention a different method, diſcovered by the Chevalier Lorgna, by congelation of ſea-water. Sea-water requires a very great degree of cold in order to become ice. Our author found that a freezing mixture, made by mixing three parts of pounded ice with two parts of common ſalt, was quite ſufficient to freeze it. The cold produced by this mixture is equal to about 4° below 0 of Fahrenheit's thermometer.

A quantity of ſea-water is never entirely congealed, a portion of it always remaining fluid; and, what is very remarkable, this fluid part is incomparably more full of ſalt and more nauſeous than the reſt: hence, if this be ſeparated from the congealed part, the latter on being melted will be found to contain much leſs ſalt than it did before congelation. This we ſhall call *the water of the firſt purification.*

If the water of the firſt purification be again congealed, a part of it will remain fluid as in the firſt operation. This fluid portion will contain a greater proportion of ſalt than the reſt, which is of courſe more pure, and, being melted, forms the water of the ſecond purification. Thus, by repeatedly freezing the ſame ſea-water, and ſeparating the fluid from the congealed part in every operation, it is at laſt perfectly purified, ſo as to be entirely diveſted of ſalt, and as fit for drink and other purpoſes as the pureſt water that is uſed.

At firſt the ſea-water, in order to be congealed, requires a very great degree of cold, as mentioned above, the ice formed in it conſiſts rather of ſcales or filaments than of a compact body, and the quantity of the fluid parts bears a conſiderable proportion to the quantity of ice. But as the water, by undergoing the ſucceſſive congelations, becomes more and more pure, ſo it becomes capable of being congealed by a ſmaller and ſmaller degree of cold; the ice is at the ſame time more compact, and in greater quantity; the fluid part at laſt becoming very inconſiderable.

SEA-Weed, or *Alga Marina*, is commonly uſed as a manure on the ſea-coaſt, where it can be procured in abundance. The beſt ſort grows on rocks, and is that from which kelp is made. The next to this is called the *peaſy ſea-weed;* and the worſt is that with a long ſtalk. In the neighbourhood of Berwick, the farmers mix it with ſtable-dung and earth, and thus obtain a great quantity of excellent manure. Sea weed is found alſo to be a very fit manure for gardens, as it not only enriches them, but deſtroys the vermin by which they are uſually infeſted.

SEA-Wolf. See ANARRHICAS, ICHTHYOLOGY *Index*.

Saltneſs of the SEA. See *SEA-Water*.

South SEA. See *PACIFIC Ocean*, and *SOUTH Sea*.

SEAL, a puncheon, piece of metal, or other matter, uſually either round or oval; whereon are engraven the arms, device, &c. of ſome prince, ſtate, community, magiſtrate, or private perſon, often with a legend or inſcription; the impreſſion whereof in wax ſerves to make acts, inſtruments, &c. authentic.

The uſe of ſeals, as a mark of authenticity to letters and other inſtruments in writing, is extremely ancient. We read of it among the Jews and Perſians in the earlieſt and moſt ſacred records of hiſtory. And in the book of Jeremiah there is a very remarkable inſtance, not only of an atteſtation by ſeal, but alſo of the other uſual formalities attending a Jewiſh purchaſe. In the civil law alſo, ſeals were the evidences of truth, and were required, on the part of the witneſſes at leaſt, at the atteſtation of every teſtament. But in the times of our Saxon anceſtors, they were not much in uſe in England. For though Sir Edward Coke relies on an inſtance of King Edwyn's making uſe of a ſeal about 100 years before the Conqueſt, yet it does not follow that this was the uſage among the whole nation: and perhaps the charter he mentions may be of doubtful authority, from this very circumſtance of its being ſealed; ſince we are aſſured by all our ancient hiſtorians that ſealing was not then in common uſe. The method of the Saxons was, for ſuch as could write to ſubſcribe their names, and, whether they could write or not, to affix the ſign of the croſs; which cuſtom our illiterate vulgar do for the moſt part to this day keep up, by ſigning a croſs for their mark when unable to write their names. And indeed this inability to write, and therefore making a croſs in its ſtead, is honeſtly avowed by Cædwalla, a Saxon king, at the end of one of his charters. In like manner, and for the ſame inſurmountable reaſon, the Normans, a brave but illiterate nation, at their firſt ſettlement in France uſed the practice of ſealing only, without writing their names; which cuſtom continued when learning made its way among them, though the reaſon for doing it had ceaſed; and hence the charter of Edward the Confeſſor to Weſtminſter-abbey, himſelf being brought up in Normandy, was witneſſed only by his ſeal, and is generally thought to be the oldeſt ſealed charter of any authenticity in England.

land. At the Conqueſt, the Norman lords brought over into this kingdom their own faſhions; and introduced waxen ſeals only, inſtead of the Engliſh method of writing their names, and ſigning with the ſign of the croſs. . The impreſſions of theſe ſeals were ſometimes a knight on horſeback, ſometimes other devices; but coats of arms were not introduced into ſeals, nor indeed uſed at all till about the reign of Richard I. who brought them from the croiſade in the Holy Land, where they were firſt invented and painted on the ſhields of the knights, to diſtinguiſh the variety of perſons of every Chriſtian nation who reſorted thither, and who could not, when clad in complete ſteel, be otherwiſe known or aſcertained.

This neglect of ſigning, and reſting only upon the authenticity of ſeals, remained very long among us; for it was held in all our books, that ſealing alone was ſufficient to authenticate a deed: and ſo the common form of atteſting deeds, "ſealed and delivered," continues to this day; notwithſtanding the ſtatute 29 Car. II. c. 3. revives the Saxon cuſtom, and expreſsly directs the ſigning in all grants of lands and many other ſpecies of deeds: in which, therefore, ſigning ſeems to be now as neceſſary as ſealing, though it hath been ſometimes held that the one includes the other.

The king's *great ſeal* is that whereby all patents, commiſſions, warrants, &c. coming down from the king are ſealed; the keeping whereof is in the hands of the lord chancellor. The king's *privy ſeal* is a ſeal that is uſually firſt ſet to grants that are to paſs the great ſeal.

SEAL. See *KEEPER of the Privy Seal.*

SEAL is alſo uſed for the wax or lead, and the impreſſion thereon affixed to the thing ſealed.

An amalgam of mercury with gold, reduced to the conſiſtence of butter, by ſtraining off part of the mercury through leather, has been recommended as a proper material for taking off the impreſſion of ſeals in wax. In this ſtate, the compound ſcarcely contains one part of mercury to two of gold; yet is of a ſilver whiteneſs, as if there was none of the precious metal in it. In this ſtate it grows ſoft on being warmed or worked between the fingers; and is therefore proper for the purpoſe above mentioned, but is not ſuperior to ſome amalgams made with the inferior metals, as is well known to ſome impoſtors, who have ſold for this uſe amalgams of the baſe metals as curious preparations of gold.

SEAL. See PHOCA, MAMMALIA *Index.*

SEALER, an officer in chancery appointed by the lord chancellor or keeper of the great ſeal, to ſeal the writs and inſtruments there made in his preſence.

SEALING, in *Architecture*, the fixing a piece of wood or iron in a wall with plaſter, mortar, cement, lead, or other ſolid binding. For ſtaples, hinges, and joints, plaſter is very proper.

SEALING-Wax. See WAX.

SEAM, or SEME, of corn, is a meaſure of eight buſhels.

SEAM of Glaſs, the quantity of 120 pounds, or 24 ſtones, each five pounds weight. The ſeam of wood is an horſe-load working.

SEAM, in mines, the ſame with a ſtratum or bed; as a ſeam of coal.

SEAMANSHIP.

1 Definition.

BY this word we expreſs that noble art, or, more purely, the qualifications which enable a man to exerciſe the noble art of working a ſhip. A SEAMAN, in the language of the profeſſion, is not merely a mariner or labourer on board a ſhip, but a man who underſtands the ſtructure of this wonderful machine, and every ſubordinate part of its mechaniſm, ſo as to enable him to employ it to the beſt advantage for puſhing her forward in a particular direction, and for avoiding the numberleſs dangers to which ſhe is expoſed by the violence of the winds and waves. He alſo knows what courſes can be held by the ſhip, according to the wind that blows, and what cannot, and which of theſe is moſt conducive to her progreſs in her intended voyage; and he muſt be able to perform every part of the neceſſary operation with his own hands. As the ſeamen expreſs it, he muſt be able to "hand, reef, and ſteer."

2 Importance of it.

We are juſtified in calling it a *noble art*, not only by its importance, which it is quite needleſs to amplify or embelliſh, but by its immenſe extent and difficulty, and the prodigious number and variety of principles on which it is founded—all of which muſt be poſſeſſed in ſuch a manner that they ſhall offer themſelves without reflection in an inſtant, otherwiſe the pretended ſeaman is but a lubber, and cannot be truſted on his watch.

The art is practiſed by perſons without what we call *education*, and in the humbler walks of life, and therefore it ſuffers in the eſtimation of the careleſs ſpectator. It is thought little of, becauſe little attention is paid to it. But if multiplicity, variety, and intricacy of principles, and a ſyſtematic knowledge of theſe principles, intitle any art to the appellation of *ſcientific* and *liberal*, ſeamanſhip claims theſe epithets in an eminent degree. We are amuſed with the pedantry of the ſeaman, which appears in his whole language. Indeed it is the only pedantry that amuſes. A ſcholar, a ſoldier, a lawyer, nay, even the elegant courtier, would diſguſt us, were he to make the thouſandth part of the alluſions to his profeſſion that is well received from the jolly ſeaman; and we do the ſeaman no more than juſtice. His profeſſion *muſt* engroſs his whole mind, otherwiſe he can never learn it. He poſſeſſes a prodigious deal of knowledge; but the honeſt tar cannot tell what he knows, or rather what he feels, for his ſcience is really at his fingers ends. We can ſay with confidence, that if a perſon of education, verſed in mechanics, and acquainted with the ſtructure of a ſhip, were to obſerve with attention the movements which are made on board a firſt or ſecond rate ſhip of war during a ſhifting ſtorm, under the direction of an intelligent officer, he would be rapt in admiration. 3 Difficulty of the art,

What a pity it is, that an art ſo important, ſo difficult, and ſo intimately connected with the invariable laws of mechanical nature, ſhould be ſo held by its poſſeſſors, that it cannot improve, but muſt die with each individual. Having no advantages of previous education,

tion, they cannot arrange their thoughts; they can hardly be ſaid to think. They can far leſs expreſs or communicate to others the intuitive knowledge which they poſſeſs; and their art, acquired by habit alone, is little different from an inſtinct. We are as little intitled to expect improvement here as in the architecture of the bee or the beaver. The ſpecies (pardon the alluſion, ye generous hearts of oak) cannot improve. Yet a ſhip is a machine. We know the forces which act on it, and we know the reſults of its conſtruction—all theſe are as fixed as the laws of motion. What hinders this to be reduced to a ſet of practical maxims, as well founded and as logically deduced as the working of a ſteam engine or a cotton mill. The ſtoker or the ſpinner acts only with his hands, and may "whiſtle as he works, for want of thought;" but the mechaniſt, the engineer, thinks for him, improves his machine, and directs him to a better practice. May not the rough ſeaman look for the ſame aſſiſtance; and may not the ingenious ſpeculatiſt in his cloſet unravel the intricate thread of mechaniſm which connects all the manual operations with the unchangeable laws of nature, and both furniſh the ſeaman with a better machine and direct him to a more dexterous uſe of it?

4
which has been zealouſly cultivated by the French philoſophers.

We cannot help thinking that much may be done; nay, we may ſay that much has been done. We think highly of the progreſſive labours of Renaud, Pitot, Bouguer, Du Hamel, Groignard, Bernoulli, Euler, Romme, and others; and are both ſurpriſed and ſorry that Britain has contributed ſo little in theſe attempts. Gordon is the only one of our countrymen who has given a profeſſedly ſcientific treatiſe on a ſmall branch of the ſubject. The government of France has always been ſtrongly impreſſed with the notion of great improvements being attained by ſyſtematic ſtudy of this art; and we are indebted to the endeavours of that ingenious nation for any thing of practical importance that has been obtained. M. Bouguer was profeſſor of hydrology at one of the marine academies of France, and was enjoined, as part of his duty, to compoſe diſſertations both on the conſtruction and the working of ſhips. His *Traité du Navire*, and his *Manœuvre des Vaiſſeaux*, are undoubtedly very valuable performances: So are thoſe of Euler and Bernoulli, conſidered as mathematical diſſertations, and they are wonderful works of genius, conſidered as the productions of perſons who hardly ever ſaw a ſhip, and were totally unacquainted with the profeſſion of a ſeaman. In this reſpect Bouguer had great ſuperiority, having always lived at a ſea-port, and having made many very long voyages. His treatiſes therefore are infinitely better accommodated to the demands of the ſeamen, and more directly inſtructive; but ſtill the author is more a mathematician than an artiſt, and his performance is intelligible only to mathematicians. It is true, the academical education of the young gentlemen of the French navy is ſuch, that a great number of them may acquire the preparatory knowledge that is neceſſary; and we are well informed that, in this reſpect, the officers of the Britiſh navy are greatly inferior to them.

5
Argument againſt the utility of their performances,

But this very circumſtance has furniſhed to many perſons an argument againſt the utility of thoſe performances. It is ſaid, "that notwithſtanding this ſuperior mathematical education, and the poſſeſſion of thoſe boaſted performances of M. Bouguer, the French are greatly inferior, in point of ſeamanſhip, to our countrymen, who have not a page in their language to inſtruct them, and who could not peruſe it if they had it." Nay, ſo little do the French themſelves ſeem ſenſible of the advantage of theſe publications, that no perſon among them has attempted to make a familiar abridgement of them, written in a way fitted to attract attention; and they ſtill remain neglected in their original abſtruſe and unintereſting form.

6
which are confeſſedly erroneous in their fundamental principles;

We wiſh that we could give a ſatisfactory anſwer to this obſervation. It is juſt, and it is important. Theſe very ingenious and learned diſſertations are by no means ſo uſeful as we ſhould expect. They are large books, and appear to contain much; and as their plan is logical, it ſeems to occupy the whole ſubject, and therefore to have done almoſt all that can be done. But, alas! they have only opened the ſubject, and the ſtudy is yet in its infancy. The whole ſcience of the art muſt proceed on the knowledge of the impulſions of the wind and water. Theſe are the forces which act on the machine; and its motions, which are the ultimatum of our reſearch, whether as an end to be obtained or as a thing to be prevented, muſt depend on theſe forces. Now it is with reſpect to this fundamental point that we are as yet almoſt totally in the dark. And in the performances of M. Bouguer, as alſo in thoſe of the other authors we have named, the theory of theſe forces, by which their quantity and the direction of their action are aſcertained, is altogether erroneous; and its reſults deviate ſo enormouſly from what is obſerved in the motions of a ſhip, that the perſon who ſhould direct the operations on ſhipboard, in conformity to the maxims deducible from M. Bouguer's propoſitions, would be baffled in moſt of his attempts, and be in danger of loſing the ſhip. The whole proceeds on the ſuppoſed truth of that theory which ſtates the impulſe of a fluid to be in the proportion of the ſquare of the ſine of the angle of incidence; and that its action on any ſmall portion, ſuch as a ſquare foot of the ſails or hull, is the ſame as if that portion were detached from the reſt, and were expoſed ſingle and alone, to the wind or water in the ſame angle. But we have ſhown, in the article RESISTANCE *of Fluids*, both from theory and experience, that both of theſe principles are erroneous, and this to a very great degree, in caſes which occur moſt frequently in practice, that is, in the ſmall angles of inclination. When the wind falls nearly perpendicular on the ſails, theory is not very erroneous: but in theſe caſes, the circumſtances of the ſhip's ſituation are generally ſuch that the practice is eaſy, occurring almoſt without thought; and in this caſe, too, even conſiderable deviations from the very beſt practice are of no great moment. The intereſting caſes, where the intended movement requires or depends upon very oblique actions of the wind on the ſails, and its practicability or impracticability depends on a very ſmall variation of this obliquity; a miſtake of the force, either as to intenſity or direction, produces a mighty effect on the reſulting motion. This is the caſe in ſailing to windward; the moſt important of all the general problems of ſeamanſhip. The trim of the ſails, and the courſe of the ſhip, ſo as to gain moſt on the wind, are very nice things; that is, they are confined within very narrow limits, and a ſmall miſtake produces a very conſiderable effect. The ſame thing obtains in many of the nice problems of tacking, box-hauling, wearing after lying to in a ſtorm, &c.

The error in the ſecond aſſertion of the theory is ſtill greater, and the action on one part of the ſail or hull is ſo greatly modified by its action on another adjoining part, that a ſtay-ſail is often ſeen hanging like a looſe rag, although there is nothing between it and the wind; and this merely becauſe a great ſail in its neighbourhood ſends off a lateral ſtream of wind, which completely hinders the wind from getting at it. Till the theory of the action of fluids be eſtabliſhed, therefore, we cannot tell what are the forces which are acting on every point of the ſail and hull: Therefore we cannot tell either the mean intenſity or direction of the whole force which acts on any particular ſail, nor the intenſity and mean direction of the reſiſtance to the hull; circumſtances abſolutely neceſſary for enabling us to ſay what will be their energy in producing a rotation round any particular axis. In like manner, we cannot, by ſuch a computation, find the ſpontaneous axis of converſion (ſee Rotation), or the velocity of ſuch converſion. In ſhort, we cannot pronounce with tolerable confidence *à priori* what will be the motions in any caſe, or what diſpoſitions of the ſails will produce the movement we wiſh to perform. The experienced ſeaman learns by habit the general effects of every diſpoſition of the ſails; and though his knowledge is far from being accurate, it ſeldom leads him into any very blundering operation. Perhaps he ſeldom makes the beſt adjuſtment poſſible, but ſeldomer ſtill does he deviate very far from it; and in the moſt general and important problems, ſuch as working to windward, the reſult of much experience and many corrections has ſettled a trim of the ſails, which is certainly not far from the truth, but (it muſt be acknowledged) deviates widely and uniformly from the theories of the mathematician's cloſet. The honeſt tar, therefore, muſt be indulged in his joke on the uſeleſs labours of the mathematician, who can neither hand, reef, nor ſteer.

After this account of the theoretical performances in the art of ſeamanſhip, and what we have ſaid in another place on the ſmall hopes we entertain of ſeeing a perfect theory of the impulſe of fluids, it will not be expected that we enter very minutely on the ſubject in this place; nor is it our intention. But let it be obſerved, that the theory is defective in one point only; and although this is a moſt important point, and the errors in it deſtroy the concluſions of the chief propoſitions, the reaſonings remain in full force, and the *modus operandi* is preciſely ſuch as is ſtated in the theory. The *principles* of the art are therefore to be found in theſe treatiſes; but falſe inferences have been drawn, by computing from erroneous quantities. The rules and the practice of the computation, however, are ſtill beyond controverſy: Nay, ſince the proceſs of inveſtigation is legitimate, we may make uſe of it in order to diſcover the very circumſtance in which we are at preſent miſtaken: for by converting the propoſition, inſtead of finding the motions by means of the ſuppoſed forces, combined with the known mechaniſm, we may diſcover the forces by means of this mechaniſm and the obſerved motions.

7 though uſe may be made of them.

8 Deſign of this article.

We ſhall therefore in this place give a very general view of the movements of a ſhip under ſail, ſhowing how they are produced and modified by the action of the wind on her ſails, the water on her rudder and on her bows. We ſhall not attempt a preciſe determination of any of theſe movements; but we ſhall ſay enough to enable the curious landſman to underſtand how this mighty machine is managed amidſt the fury of the winds and waves: and, what is more to our wiſh, we hope to enable the uninſtructed but thinking ſeaman to generaliſe that knowledge which he poſſeſſes; to claſs his ideas, and give them a ſort of rational ſyſtem; and even to improve his practice, by making him ſenſible of the immediate operation of every thing he does, and in what manner it contributes to produce the movement which he has in view.

9 A ſhip conſidered as in free ſpace impelled and reſiſted by oppoſite forces.

A ſhip may be conſidered at preſent as a maſs of inert matter in free ſpace, at liberty to move in every direction, according to the forces which impel or reſiſt her: and when ſhe is in actual motion, in the direction of her courſe, we may ſtill conſider her as at reſt in abſolute ſpace, but expoſed to the impulſe of a current of water moving equally faſt in the oppoſite direction: for in both caſes the preſſure of the water on her bows is the ſame; and we know that it is poſſible, and frequently happens in currents, that the impulſe of the wind on her ſails, and that of the water on her bows, balance each other ſo preciſely, that ſhe not only does not ſtir from the place, but alſo remains ſteadily in the ſame poſition, with her head directed to the ſame point of the compaſs. This ſtate of things is eaſily conceived by any perſon accuſtomed to conſider mechanical ſubjects, and every ſeaman of experience has obſerved it. It is of importance to conſider it in this point of view, becauſe it gives us the moſt familiar notion of the manner in which theſe forces of the wind and water are ſet in oppoſition, and made to balance or not to balance each other by the intervention of the ſhip, in the ſame manner as the goods and the weights balance each other in the ſcales by the intervention of a beam or ſteelyard.

10 Impulſe of the wind on the ſails oppoſite to that of the water on the bows.

When a ſhip proceeds ſteadily in her courſe, without changing her rate of ſailing, or varying the direction of her head, we muſt in the firſt place conceive the accumulated impulſes of the wind on all her ſails as preciſely equal and directly oppoſite to the impulſe of the water on her bows. In the next place, becauſe the ſhip does not change the direction of her keel, ſhe reſembles the balanced ſteelyard, in which the energies of the two weights, which tend to produce rotations in oppoſite directions, and thus to change the poſition of the beam, mutually balance each other round the fulcrum; ſo the energies of the actions of the wind on the different ſails balance the energies of the water on the different parts of the hull.

The ſeaman has two principal taſks to perform. The firſt is to keep the ſhip ſteadily in that courſe which will bring her fartheſt on in the line of her intended voyage. This is frequently very different from that line, and the choice of the beſt courſe is ſometimes a matter of conſiderable difficulty. It is ſometimes poſſible to ſhape the courſe preciſely along the line of the voyage; and yet the intelligent ſeaman knows that he will arrive ſooner, or with greater ſafety, at his port, by taking a different courſe; becauſe he will gain more by increaſing his ſpeed than he loſes by increaſing the diſtance. Some principle muſt direct him in the ſelection of this courſe. This we muſt attempt to lay before the reader.

11 Skill of the ſeaman diſplayed in ſhaping his courſe.

Having choſen ſuch a courſe as he thinks moſt advantageous, he muſt ſet ſuch a quantity of ſail as the ſtrength of the wind will allow him to carry with ſafety and effect, and muſt trim the ſails properly, or ſo adjuſt their poſitions to the direction of the wind, that they may have the greateſt poſſible tendency to impel the ſhip in the line of her courſe, and to keep her ſteadily in that direction.

His other taſk is to produce any deviations which he ſees proper from the preſent courſe of the ſhip; and to produce theſe in the moſt certain, the ſafeſt, and the moſt expeditious manner. It is chiefly in this movement that the mechanical nature of a ſhip comes into view, and it is here that the ſuperior addreſs and reſource of an expert ſeaman is to be perceived.

Under the article SAILING ſome notice has been taken of the firſt taſk of the ſeaman, and it was there ſhown how a ſhip, after having taken up her anchor and fitted her ſails, accelerates her motion, by degrees which continually diminiſh, till the increaſing reſiſtance of the water becomes preciſely equal to the diminiſhed impulſe of the wind, and then the motion continues uniformly the ſame ſo long as the wind continues to blow with the ſame force and in the ſame direction.

It is perfectly conſonant to experience that the impulſe of fluids is in the duplicate ratio of the relative velocity. Let it be ſuppoſed that when water moves one foot per ſecond, its perpendicular preſſure or impulſe on a ſquare foot is m pounds. Then, if it be moving with the velocity V eſtimated in feet per ſecond, its perpendicular impulſe on a ſurface S, containing any number of ſquare feet, muſt be $m\,SV^2$.

In like manner, the impulſe of air on the ſame ſurface may be repreſented by $n\,SV^2$; and the proportion of the impulſe of theſe two fluids will be that of m to n. We may expreſs this by the ratio of q to 1, making

$$\frac{m}{n}=q.$$

12 Impulſe of the water computed in ounces on the ſquare foot.

M. Bouguer's computations and tables are on the ſuppoſition that the impulſe of ſea-water moving one foot per ſecond is 23 ounces on a ſquare foot, and that the impulſe of the wind is the ſame when it blows at the rate of 24 feet per ſecond. Theſe meaſures are all French. They by no means agree with the experiments of others; and what we have already ſaid, when treating of the *RESISTANCE of Fluids*, is enough to ſhow us that nothing like preciſe meaſures can be expected. It was ſhown as the reſult of a rational inveſtigation, and confirmed by the experiments of Buat and others, that the impulſions and reſiſtances at the ſame ſurface, with the ſame obliquity of incidence and the ſame velocity of motion, are different according to the form and ſituation of the adjoining parts. Thus the total reſiſtance of a thin board is greater than that of a long priſm, having this board for its front or bow, &c.

We are greatly at a loſs what to give as abſolute meaſures of theſe impulſions.

1. With reſpect to water. The experiments of the French academy on a priſm two feet broad and deep, and four feet long, indicate a reſiſtance of 0.973 pounds avoirdupois to a ſquare foot, moving with the velocity of one foot per ſecond at the ſurface of ſtill water.

Mr Buat's experiments on a ſquare foot wholly immerſed in a ſtream were as follow:

A ſquare foot as a thin plate	1,81 pounds.
Ditto as the front of a box one foot long	1,42
Ditto as the front of a box three feet long	1,29

The reſiſtance of ſea-water is about $\frac{1}{23}$ greater.

2. With reſpect to air, the varieties are as great.—The reſiſtance of a ſquare foot to air moving with the velocity of one foot per ſecond appears from Mr Robins's experiments on 16 ſquare inches to be on a

ſquare foot	0,001596 pounds,
Chevalier Borda's on 16 inches	0,001757
——— on 81 inches	0,002042
Mr Rouſe's on large ſurfaces	0,002291

Preciſe meaſures are not to be expected, nor are they neceſſary in this inquiry. Here we are chiefly intereſted in their proportions, as they may be varied by their mode of action in the different circumſtances of obliquity and velocity.

13 Direct impulſe on the ſail perpendicular to the yard.

We begin by recurring to the fundamental propoſition concerning the impulſe of fluids, viz. that the abſolute preſſure is always in a direction perpendicular to the impelled ſurface, whatever may be the direction of the ſtream of fluid. We muſt therefore illuſtrate the doctrine, by always ſuppoſing a flat ſurface of ſail ſtretched on a yard, which can be braced about in any direction, and giving this ſail ſuch a poſition and ſuch an extent of ſurface, that the impulſe on it may be the ſame both as to direction and intenſity with that on the real ſails. Thus the conſideration is greatly ſimplified. The direction of the impulſe is therefore perpendicular to the yard. Its intenſity depends on the velocity with which the wind meets the ſail, and the obliquity of its ſtroke. We ſhall adopt the conſtructions founded on the common doctrine, that the impulſe is as the ſquare of the ſine of the inclination, becauſe they are ſimple; whereas, if we were to introduce the values of the oblique impulſes, ſuch as they have been obſerved in the excellent experiments of the Academy of Paris, the conſtructions would be complicated in the extreme, and we could hardly draw any conſequences which would be intelligible to any but expert mathematicians. The concluſions will be erroneous, not in kind but in quantity only; and we ſhall point out the neceſſary corrections, ſo that the final reſults will be found not very different from real obſervation.

14 A ſhip compared to an oblong box.

If a ſhip were a round cylindrical body like a flat tub, floating on its bottom, and fitted with a maſt and ſail in the centre, ſhe would always ſail in the direction perpendicular to the yard. This is evident. But ſhe is an oblong body, and may be compared to a cheſt, whoſe length greatly exceeds its breadth. She is ſo ſhaped, that a moderate force will puſh her through the water with the head or ſtern foremoſt; but it requires a very great force to puſh her ſidewiſe with the ſame velocity. A fine ſailing ſhip of war will require about 12 times as much force to puſh her ſidewiſe as to puſh her head foremoſt. In this reſpect therefore ſhe will very much reſemble a cheſt whoſe length is 12 times its breadth; and whatever be the proportion of theſe reſiſtances in different ſhips, we may always ſubſtitute a box which ſhall have the ſame reſiſtances headwiſe and ſidewiſe.

Let EFGH (fig. 1.) be the horizontal ſection of ſuch

Plate CCCCLXXIX. fig. 1.

ſuch a box, and AB its middle line, and C its centre. In whatever direction this box may chance to move, the direction of the whole reſiſtance on its two ſides will paſs through C. For as the whole ſtream has one inclination to the ſide EF, the equivalent of the equal impulſes on every part will be in a line perpendicular to the middle of EF. For the ſame reaſon, it will be in a line perpendicular to the middle of FG. Theſe perpendiculars muſt croſs in C. Suppoſe a maſt erected at C, and YC y to be a yard hoiſted on it carrying a ſail. Let the yard be firſt conceived as braced right athwart at right angles to the keel, as repreſented by Y′y′. Then, whatever be the direction of the wind abaft this ſail, it will impel the veſſel in the direction CB. But if the ſail has the oblique poſition Y y, the impulſe will be in the direction CD perpendicular to CY, and will both puſh the veſſel ahead and ſidewiſe: For the impulſe CD is equivalent to the two impulſes CK and CI (the ſides of a rectangle of which CD is the diagonal). The force CI puſhes the veſſel ahead, and CK puſhes her ſidewiſe. She muſt therefore take ſome intermediate direction $a\,b$, ſuch that the reſiſtance of the water to the plane FG is to its reſiſtance to the plane EF as CI to CK.

5 Makes leeway when not ſailing directly before the wind.

The angle b CB between the real courſe and the direction of the head is called the LEEWAY; and in the courſe of this diſſertation we ſhall expreſs it by the ſymbol x. It evidently depends on the ſhape of the veſſel and on the poſition of the yard. An accurate knowledge of the quantity of leeway, correſponding to different circumſtances of obliquity of impulſe, extent of ſurface, &c. is of the utmoſt importance in the practice of navigation; and even an approximation is valuable. The ſubject is ſo very difficult that this muſt content us for the preſent.

16 How to find the quantity of leeway,

Let V be the velocity of the ſhip in the direction C b, and let the ſurfaces FG and FE be called A′ and B′. Then the reſiſtance to the lateral motion is $m\,V^2 \times B' \times$ ſine ^{2}, b CB, and that to the direct motion is $m\,V^2 \times A' \times$ ſine^2, b CK, or $m\,V^2 \times A' \times$ coſ. ^{2} bCB. Therefore theſe reſiſtances are in the proportion of $B' \times$ ſine ^{2}, x to $A' \times$ coſ. ^{2}, x (repreſenting the angle of leeway b CB by the ſymbol x).

Therefore we have CI : CK, or CI : ID $=$ A′. coſ. $^2 x$: B′ · ſine $^2 x$, $=$ A′ : B′ · $\frac{\text{ſine}\,^2 x}{\text{coſ.}\,^2 x}$ $=$ A : B · tangent $^2 x$.

Let the angle YCB, to which the yard is braced up, be called the TRIM of the ſails, and expreſſed by the ſymbol b. This is the complement of the angle DCI. Now CI : ID $=$ rad. : tan. DCI, $=$ 1 : tan. DCI, $=$ 1 : cotan. b. Therefore we have finally 1 : cotan. $b =$ A′ : B′ · tan. $^2 x$, and A′ · cotan. $b =$ B′ · tangent $^2 x$, and tan. $^2 x = \frac{A}{B}$ cot. b. This equation evidently aſcertains the mutual relation between the trim of the ſails and the leeway in every caſe where we can tell the proportion between the reſiſtances to the direct and broadſide motions of the ſhip, and where this proportion does not change by the obliquity of the courſe. Thus, ſuppoſe the yard braced up to an angle of 30° with the keel. Then cotan. 30° $=$ 1,732 very nearly. Suppoſe alſo that the reſiſtance ſidewiſe is 12 times greater than the reſiſtance headwiſe. This gives A′ $=$ 1 and B′ $=$ 12. Therefore 1,732 $=$ 12 $\times$ tangent $^2 x$, and tangent $^2 x = \frac{1{,}732}{12}$, $=$ 0,14434, and tan. $x =$ 0,3799, and $x =$ 20° 48′, very nearly two points of leeway.

This computation, or rather the equation which gives room for it, ſuppoſes the reſiſtances proportional to the ſquares of the ſines of incidence. The experiments of the Academy of Paris, of which an abſtract is given in the article *RESISTANCE of Fluids*, ſhow that this ſuppoſition is not far from the truth when the angle of incidence is great. In the preſent caſe the angle of incidence on the front FG is about 70°, and the experiments juſt now mentioned ſhow that the real reſiſtances exceed the theoretical ones only $\frac{1}{180}$. But the angle of incidence on EF is only 20° 48′. Experiment ſhows that in this inclination the reſiſtance is almoſt quadruple of the theoretical reſiſtances. Therefore the lateral reſiſtance is aſſumed much too ſmall in the preſent inſtance. Therefore a much ſmaller leeway will ſuffice for producing a lateral reſiſtance which will balance the lateral impulſe CK, ariſing from the obliquity of the ſail, viz. 30°. The matter of fact is, that a pretty good ſailing ſhip, with her ſails braced to this angle at a medium, will not make above five or ſix degrees leeway in ſmooth water and eaſy weather; and yet in this ſituation the hull and rigging preſent a very great ſurface to the wind, in the moſt improper poſitions, ſo as to have a very great effect in increaſing her leeway. And if we compute the reſiſtances for this leeway of ſix degrees by the actual experiments of the French Academy on the angle, we ſhall find the reſult not far from the truth; that is, the direct and lateral reſiſtances will be nearly in the proportion of CI to ID.

It reſults from this view of the matter, that the leeway is in general much ſmaller than what the uſual theory aſſigns.

17 which depends on the trim of the ſails.

We alſo ſee, that according to whatever law the reſiſtances change by a change of inclination, the leeway remains the ſame while the trim of the ſails is the ſame. The leeway depends only on the direction of the impulſe of the wind; and this depends ſolely on the poſition of the ſails with reſpect to the keel, whatever may be the direction of the wind. This is a very important obſervation, and will be frequently referred to in the progreſs of the preſent inveſtigation. Note, however, that we are here conſidering only the action on the ſails, and on the ſame ſails. We are not conſidering the action of the wind on the hull and rigging. This may be very conſiderable; and it is always in a lee direction, and augments the leeway; and its influence muſt be ſo much the more ſenſible as it bears a greater proportion to the impulſe on the ſails. A ſhip under courſes, or cloſe-reefed topſails and courſes, muſt make more leeway than when under all her canvas trimmed, to the ſame angle. But to introduce this additional cauſe of deviation here would render the inveſtigation too complicated to be of any uſe.

18 Illuſtration of this doctrine by experiments. Fig. 2.

This doctrine will be conſiderably illuſtrated by attending to the manner in which a lighter is tracked along a canal, or ſwings to its anchor in a ſtream. The track rope is made faſt to ſome ſtaple or bolt E on the deck (fig. 2.), and is paſſed between two of the timberheads of the bow D, and laid hold of at F on ſhore. The men or cattle walk along the path FG, the rope keeps

keeps extended in the directions DF, and the lighter arranges itſelf in an oblique poſition AB, and is thus dragged along in the direction *a b*, parallel to the ſide of the canal. Or, if the canal has a current in the oppoſite direction *b a*, the lighter may be kept ſteady in its place by the rope DF made faſt to a poſt at F. In this caſe, it is always obſerved, that the lighter ſwings in a poſition AB, which is oblique to the ſtream *a b*. Now the force which retains it in this poſition, and which preciſely balances the action of the ſtream, is certainly exerted in the direction DF; and the lighter would be held in the ſame manner if the rope were made faſt at C amidſhip, without any dependence on the timberheads at D; and it would be held in the ſame poſition, if, inſtead of the ſingle rope CF, it were riding by two ropes CG and CH, of which CH is in a direction right ahead, but oblique to the ſtream, and the other CG is perpendicular to CH or AB. And, drawing DI and DK perpendicular to AB and CG, the ſtrain on the rope CH is to that on the rope CG as CI to CK. The action of the rope in theſe caſes is preciſely analogous to that of the ſail *y* Y; and the obliquity of the keel to the direction of the motion, or to the direction of the ſtream, is analogous to the leeway. All this muſt be evident to any perſon accuſtomed to mechanical diſquiſitions.

19 On models and

A moſt important uſe may be made of this illuſtration. If an accurate model be made of a ſhip, and if it be placed in a ſtream of water, and ridden in this manner by a rope made faſt at any point D of the bow, it will arrange itſelf in ſome determined poſition AB. There will be a certain obliquity to the ſtream, meaſured by the angle B *o b*; and there will be a correſponding obliquity of the rope, meaſured by the angle FCB. Let *y* CY be perpendicular to CF. Then CY will be the poſition of the yard, or trim of the ſails correſponding to the leeway *b* CB. Then, if we ſhift the rope to a point of the bow diſtant from D by a ſmall quantity, we ſhall obtain a new poſition of the ſhip, both with reſpect to the ſtream and rope; and in this way may be obtained the relation between the poſition of the ſails and the leeway, independent of all theory, and ſuſceptible of great accuracy; and this may be done with a variety of models ſuited to the moſt uſual forms of ſhips.

20 on ſhips.

Fig. 3.

In farther thinking on this ſubject, we are perſuaded that theſe experiments, inſtead of being made on models, may with equal eaſe be made on a ſhip of any ſize. Let the ſhip ride in a ſtream at a mooring D (fig. 3.) by means of a ſhort hawſer BCD from her bow, having a ſpring AC on it carried out from her quarter. She will ſwing to her moorings, till ſhe ranges herſelf in a certain poſition AB with reſpect to the direction *a b* of the ſtream; and the direction of the hawſer DC will point to ſome point E of the line of the keel. Now, it is plain to any perſon acquainted with mechanical diſquiſitions, that the deviation BE *b* is preciſely the leeway that the ſhip will make when the average poſition of the ſails is that of the line GEH perpendicular to ED; at leaſt this will give the leeway which is produced by the ſails alone. By heaving on the ſpring, the knot C may be brought into any other poſition we pleaſe; and for every new poſition of the knot the ſhip will take a new poſition with reſpect to the ſtream and to the hawſer. And we perſiſt in ſaying, that more information will be got by this train of experiments than from any mathematical theory: for all the theories of the impulſes of fluids muſt proceed on phyſical poſtulates with reſpect to the motions of the filaments, which are exceedingly conjectural.

21 The compariſon of a ſhip to an oblong body is only uſeful to give clear notions on the ſubject.

And it muſt now be farther obſerved, that the ſubſtitution which we have made of an oblong parallelopiped for a ſhip, although well ſuited to give us clear notions of the ſubject, is of ſmall uſe in practice: for it is next to impoſſible (even granting the theory of oblique impulſions) to make this ſubſtitution. A ſhip is of a form which is not reducible to equations; and therefore the action of the water on her bow or broadſide can only be had by a moſt laborious and intricate calculation for almoſt every ſquare foot of its ſurface. (See *Bezout's Cours de Mathem.* vol. v. p. 72, &c). And this muſt be different for every ſhip. But, which is more unlucky, when we have got a parallelopiped which will have the ſame proportion of direct and lateral reſiſtance for a particular angle of leeway, it will not anſwer for another leeway of the ſame ſhip; for when the leeway changes, the figure actually expoſed to the action of the water changes alſo. When the leeway is increaſed, more of the lee-quarter is acted on by the water, and a part of the weather-bow is now removed from its action. Another parallelopiped muſt therefore be diſcovered, whoſe reſiſtances ſhall ſuit this new poſition of the keel with reſpect to the real courſe of the ſhip.

We therefore beg leave to recommend this train of experiments to the notice of the Association for the Improvement of Naval Architecture as a very promiſing method for aſcertaining this important point. And we proceed, in the next place, to aſcertain the relation between the velocity of the ſhip and that of the wind, modified as they may be by the trim of the ſails and the obliquity of the impulſe.

22 The relation between the velocity of the ſhip and wind aſcertained.

Fig. 4.

Let AB (fig. 4, 5, and 6.) repreſent the horizontal ſection of a ſhip. In place of all the drawing ſails, that is, the ſails which are really filled, we can always ſubſtitute one ſail of equal extent, trimmed to the ſame angle with the keel. This being ſuppoſed attached to the yard DCD, let this yard be firſt of all at right angles to the keel, as repreſented in fig. 4. Let the wind blow in the direction WC, and let CE (in the direction WC continued) repreſent the velocity V of the wind. Let CF be the velocity *v* of the ſhip. It muſt alſo be in the direction of the ſhip's motion, becauſe when the ſail is at right angles to the keel, the abſolute impulſe on the ſail is in the direction of the keel, and there is no lateral impulſe, and conſequently no leeway. Draw EF, and complete the parallelogram CFE *e*, producing *e* C through the centre of the yard to *w*. Then *w* C will be the relative or apparent direction of the wind, and C *e* or FE will be its apparent or relative velocity: For if the line C *e* be carried along CF, keeping always parallel to its firſt poſition, and if a particle of air move uniformly along CE (a fixed line in abſolute ſpace) in the ſame time, this particle will always be found in that point of CE where it is interſected at that inſtant by the moving line C; ſo that if C *e* were a tube, the particle of air, which really moves in the line CE, would always be found in the tube C *e*. While CE is the real direction of the wind, C *e* will be the poſition of the

vane

vane at the maſt head, which will therefore mark the apparent direction of the wind, or its motion relative to the moving ſhip.

We may conceive this in another way. Suppoſe a cannon-ſhot fired in the direction CE at the paſſing ſhip, and that it paſſes through the maſt at C with the velocity of the wind. It will not paſs through the off-ſide of the ſhip at P, in the line CE: for while the ſhot moves from C to P, the point P has gone forward, and the point p is now in the place where P was when the ſhot paſſed through the maſt. The ſhot will therefore paſs through the ſhip's ſide in the point p, and a perſon on board ſeeing it paſs through C and p will ſay that its motion was in the line Cp.

23 When a ſhip is in motion the apparent direction of the wind is always different from the real direction.

Thus it happens, that when a ſhip is in motion the apparent direction of the wind is always ahead of its real direction. The line wC is always found within the angle WCB. It is eaſy to ſee from the conſtruction, that the difference between the real and apparent directions of the wind is ſo much the more remarkable as the velocity of the ſhip is greater: For the angle WCw or ECe depends on the magnitude of Ee or CF, in proportion to CE. Perſons not much accuſtomed to attend to theſe matters are apt to think all attention to this difference to be nothing but affectation of nicety. They have no notion that the velocity of a ſhip can have any ſenſible proportion to that of the wind. "Swift as the wind" is a proverbial expreſſion; yet the velocity of a ſhip always bears a very ſenſible proportion to that of the wind, and even very frequently exceeds it. We may form a pretty exact notion of the velocity of the wind by obſerving the ſhadows of the ſummer clouds flying along the face of a country, and it may be very well meaſured by this method. The motion of ſuch clouds cannot be very different from that of the air below; and when the preſſure of the wind on a flat ſurface, while blowing with a velocity meaſured in this way, is compared with its preſſure when its velocity is meaſured by more unexceptionable methods, they are found to agree with all deſirable accuracy. Now obſervations of this kind frequently repeated, ſhow that what we call a pleaſant briſk gale blows at the rate of about 10 miles an hour, or about 15 feet in a ſecond, and exerts a preſſure of half a pound on a ſquare foot. Mr Smeaton has frequently obſerved the ſails of a windmill, driven by ſuch a wind, moving faſter, nay much faſter, towards their extremities, ſo that the ſail, inſtead of being preſſed to the frames on the arms, was taken aback, and fluttering on them. Nay, we know that a good ſhip, with all her ſails ſet and the wind on the beam, will in ſuch a ſituation ſail above ten knots an hour in ſmooth water. There is an obſervation made by every experienced ſeaman, which ſhows this difference between the real and apparent directions of the wind very diſtinctly. When a ſhip that is ſailing briſkly with the wind on the beam tacks about, and then ſails equally well on the other tack, the wind always appears to have ſhifted and come more ahead. This is familiar to all ſeamen. The ſeaman judges of the direction of the wind by the poſition of the ſhip's vanes. Suppoſe the ſhip ſailing due weſt on the ſtarboard tack, with the wind apparently N. N. W. the vane pointing S. S. E. If the ſhip put about, and ſtands due eaſt on the larboard tack, the vane will be found no longer to point S. S. E. but perhaps S. S. W. the wind appearing N.N.E. and the ſhip muſt be nearly cloſe-hauled in order to make an eaſt courſe. The wind appears to have ſhifted four points. If the ſhip tacks again, the wind returns to its old quarter. We have often obſerved a greater difference than this. The celebrated aſtronomer Dr Bradley, taking the amuſement of ſailing in a pinnace on the river Thames, obſerved this, and was ſurpriſed at it, imagining that the change of wind was owing to the approaching to or retiring from the ſhore. The boatmen told him that it always happened at ſea, and explained it to him in the beſt manner they were able. The explanation ſtruck him, and ſet him a muſing on an aſtronomical phenomenon which he had been puzzled by for ſome years, and which he called THE ABERRATION OF THE FIXED STARS. Every ſtar changes its place a ſmall matter for half a year, and returns to it at the completion of the year. He compared the ſtream of light from the ſtar to the wind, and the teleſcope of the aſtronomer to the ſhip's vane, while the earth was like the ſhip, moving in oppoſite directions when in the oppoſite points of its orbit. The teleſcope muſt always be pointed ahead of the real direction of the ſtar, in the ſame manner as the vane is always in a direction ahead of the wind; and thus he aſcertained the progreſſive motion of light, and diſcovered the proportion of its velocity to the velocity of the earth in its orbit, by obſerving the deviation which was neceſſarily given to the teleſcope. Obſerving that the light ſhifted its direction about 40″, he concluded its velocity to be about 11,000 times greater than that of the earth; juſt as the intelligent ſeaman would conclude from this apparent ſhifting of the wind, that the velocity of the wind is about triple that of the ſhip. This is indeed the beſt method for diſcovering the velocity of the wind. Let the direction of the vane at the maſt-head be very accurately noticed on both tacks, and let the velocity of the ſhip be alſo accurately meaſured. The angle between the directions of the ſhip's head on theſe different tacks being halved, will give the real direction of the wind, which muſt be compared with the poſition of the vane in order to determine the angle contained between the real and apparent directions of the wind or the angle ECe; or half of the obſerved ſhifting of the wind will ſhow the inclination of its true and apparent directions. This being found, the proportion of EC to FC (fig. 6.) is eaſily meaſured.

24 Obſervation of Dr Bradley on this ſubject.

We have been very particular on this point, becauſe ſince the mutual actions of bodies depend on their relative motions only, we ſhould make prodigious miſtakes if we eſtimated the action of the wind by its real direction and velocity, when they differ ſo much from the relative or apparent.

25 Velocity of a ſhip when its ſails are at right angles to the keel.

We now reſume the inveſtigation of the velocity of the ſhip (fig. 4.), having its ſails at right angles to the keel, and the wind blowing in the direction and with the velocity CE, while the ſhip proceeds in the direction of the keel with the velocity CF. Produce Ee, which is parallel to BC, till it meet the yard in g, and draw FG perpendicular to Eg. Let a repreſent the angle WCD, contained between the ſail and the real direction of the wind, and let b be the angle of trim DCB. CE the velocity of the wind was expreſſed by V, and CF the velocity of the ſhip by v.

The abſolute impulſe on the ſail is (by the uſual theory

theory) proportional to the ſquare of the relative velocity, and to the ſquare of the ſine of the angle of incidence; that is, to $FE^2 \times \text{ſin.}^2\ w\,CD$. Now the angle $GFE = w\,CD$, and EG is equal to $FE \times \text{ſin.}\ GFE$; and EG is equal to $Eg - gG$. But $Eg = EC \times \text{ſin.}\ ECg, = V \times \text{ſin.}\ a$; and $gG = CF, = v$. Therefore $EG = V \times \text{ſin.}\ a - v$, and the impulſe is proportional to $\overline{V \times \text{ſin.}\ a - v}^2$. If S repreſent the ſurface of the ſail, the impulſe, in pounds, will be $nS\,(V \times \text{ſin.}\ a - v)^2$.

Let A be the ſurface which, when it meets the water perpendicularly with the velocity v, will ſuſtain the ſame preſſure or reſiſtance which the bows of the ſhip actually meets with. This impulſe, in pounds, will be mAv^2. Therefore, becauſe we are conſidering the ſhip's motion as in a ſtate of uniformity, the two preſſures balance each other; and therefore $mAv^2 = nS\,(V \times \text{ſin.}\ a - v)^2$, and $\frac{m}{n} A v^2 = S\,(V \times \text{ſin.}\ a - v)^2$; therefore $\sqrt{\frac{m}{n}}\,\sqrt{A} \times v = \sqrt{S} \times V \times \text{ſin.}\ a - v\sqrt{S}$, and

$$v = \frac{\sqrt{S} \times v \times \text{ſin.}\ a}{\sqrt{\frac{m}{n}A} + \sqrt{S}} = \frac{V \times \text{ſin.}\ a}{\sqrt{\frac{mA}{nS}} + 1} = \frac{V \times \text{ſin.}\ a}{\sqrt{q\frac{A}{S}} + 1}.$$

We ſee, in the firſt place, that the velocity of the ſhip is (*cæteris paribus*) proportional to the velocity of the wind, and to the ſine of its incidence on the ſail jointly; for while the ſurface of the ſail S and the equivalent ſurface for the bow remains the ſame, v increaſes or diminiſhes at the ſame rate with $V \cdot \text{ſin.}\ a$.—When the wind is right aſtern, the ſine of a is unity, and then the ſhip's velocity is $\frac{V}{\sqrt{\frac{mA}{nS}} + 1}$.

Note, that the denominator of this fraction is a common number; for m and n are numbers, and A and S being quantities of one kind, $\frac{A}{S}$ is alſo a number.

It muſt alſo be carefully attended to, that S expreſſes a quantity of ſail actually receiving wind with the inclination a. It will not always be true, therefore, that the velocity will increaſe as the wind is more abaft, becauſe ſome ſails will then becalm others. This obſervation is not, however, of great importance; for it is very unuſual to put a ſhip in the ſituation conſidered hitherto; that is, with the yards ſquare, unleſs ſhe be right before the wind.

If we would diſcover the relation between the velocity and the quantity of ſail in this ſimple caſe of the wind right aft, obſerve that the equation $v = \frac{V}{\sqrt{\frac{mA}{nS}} + 1}$ gives us $\sqrt{\frac{mA}{nS}}\,v + v = V$, and $\sqrt{\frac{mA}{nS}}\,v = V - v$, and $\frac{mA}{nS} v^2 = V - v^2$, and $\frac{nS}{mA} = \frac{v^2}{(V - v)^2}$; and becauſe n and m and A are conſtant quantities, S is proportional to $\frac{v^2}{(V - v)^2}$, or the ſurface of ſail is proportional to the ſquare of the ſhip's velocity directly, and to the ſquare of the relative velocity inverſely. Thus, if a ſhip be ſailing with one-eighth of the velocity of the wind, and we would have her ſail with one-fourth of it, we muſt quadruple the ſail. This is more eaſily ſeen in another way. The velocity of the ſhip is proportional to the velocity of the wind; and therefore the relative velocity is alſo proportional to that of the wind, and the impulſe of the wind is as the ſquare of the relative velocity. Therefore, in order to increaſe the relative velocity by an increaſe of ſail only, we muſt make this increaſe of ſail in the duplicate proportion of the increaſe of velocity.

Let us, in the next place, conſider the motion of a ſhip whoſe ſails ſtand oblique to the keel.

26
Its velocity when the ſails ſtand oblique to the keel.

Fig. 5. and 6.

The conſtruction for this purpoſe differs a little from the former, becauſe, when the ſails are trimmed to any oblique poſition DCB (fig. 5. and 6.), there muſt be a deviation from the direction of the keel, or a leeway BCb. Call this x. Let CF be the velocity of the ſhip. Draw, as before, Eg perpendicular to the yard, and FG perpendicular to Eg; alſo draw FH perpendicular to the yard: then, as before, EG, which is in the ſubduplicate ratio of the impulſe on the ſail, is equal to $Eg - Gg$. Now Eg is, as before, $= V \times \text{ſin.}\ a$, and G$g$ is equal to FH, which is $= CF \times \text{ſin.}\ FCH$, or $= v \times \text{ſin.}\ (b + x)$. Therefore we have the impulſe $= nS\,(V \cdot \text{ſin.}\ a - v \cdot \text{ſin.}\ (b + x)^2$.

This expreſſion of the impulſe is perfectly ſimilar to that in the former caſe, its only difference conſiſting in the ſubductive part, which is here $v \times \text{ſin.}\ \overline{b + x}$ inſtead of v. But it expreſſes the ſame thing as before, viz. the diminution of the impulſe. The impulſe being reckoned ſolely in the direction perpendicular to the ſail, it is diminiſhed ſolely by the ſail withdrawing itſelf *in that direction* from the wind; and as g E may be conſidered as the real impulſive motion of the wind, GE muſt be conſidered as the relative and effective impulſive motion. The impulſe would have been the ſame had the ſhip been at reſt, and had the wind met it perpendicularly with the velocity GE.

27
Connection between the impulſe and motion of the ſhip.

We muſt now ſhow the connection between this impulſe and the motion of the ſhip. The ſail, and conſequently the ſhip, is preſſed by the wind in the direction CI perpendicular to the ſail or yard with the force which we have juſt now determined. This (in the ſtate of uniform motion) muſt be equal and oppoſite to the action of the water. Draw IL at right angles to the keel. The impulſe in the direction CI (which we may meaſure by CI) is equivalent to the impulſes CL and LI. By the firſt the ſhip is impelled right forward, and by the ſecond ſhe is driven ſidewiſe. Therefore we muſt have a leeway, and a lateral as well as a direct reſiſtance. We ſuppoſe the form of the ſhip to be known, and therefore the proportion is known, or diſcoverable, between the direct and lateral reſiſtances correſponding to every angle x of leeway. Let A be the ſurface whoſe perpendicular reſiſtance is equal to the direct reſiſtance of the ſhip correſponding to the leeway x, that is, whoſe reſiſtance is equal to the reſiſtance really felt by the ſhip's bows in the direction of the keel when ſhe is ſailing with this leeway; and let B in like manner be the ſurface whoſe perpendicular reſiſtance is equal to the actual reſiſtance to the ſhip's motion in the direction LI, perpendicular to the keel. (*N. B.* This is not equivalent to A and B′ adapted to the rectangular box, but to $A' \cdot \text{coſ.}^2\ x$ and $B' \cdot \text{ſin.}^2\ x$). We have therefore

therefore $\text{A} : \text{B} = \text{CL} : \text{LI}$, and $\text{LI} = \frac{\text{CL} \cdot \text{B}}{\text{A}}$. Alſo, becauſe $\text{CI} = \sqrt{\text{CL}^2 + \text{LI}^2}$, we have $\text{A} : \sqrt{\text{A}^2 + \text{B}^2} = \text{CL} : \text{CI}$, and $\text{CI} = \frac{\text{CL} \cdot \sqrt{\text{A}^2 + \text{B}^2}}{\text{A}}$. The reſiſtance in the direction LC is properly meaſured by $m \text{A} v^2$, as has been already obſerved. Therefore the reſiſtance in the direction IC muſt be expreſſed by $m \sqrt{\text{A}^2 + \text{B}^2|}\ v^2$; or (making C the ſurface which is equal to $\sqrt{\text{A}^2 + \text{B}^2}$, and which will therefore have the ſame perpendicular reſiſtanee to the water having the velocity v) it may be expreſſed by $m \text{C} v^2$.

Therefore, becauſe there is an equilibrium between the impulſe and reſiſtance, we have $m \text{C} v^2 = n \text{S} (\text{V} \cdot \text{ſin.}\ a - v \cdot \text{ſin.}\ \overline{b+x})^2$ and $\frac{m}{n} \text{C} v^2$, or $q \text{C} v^2 = \text{S} (\text{V} \cdot \text{ſin.}\ a - v \cdot \text{ſin.}\ \overline{b+x})^2$, and $\sqrt{q} \sqrt{\text{C}}\, v = \sqrt{\text{S}} (\text{V} \cdot \text{ſin.}\ a - v \cdot \text{ſin.}\ \overline{b+n})$.

Therefore $v = \frac{\sqrt{\text{S}} \cdot \text{V} \cdot \text{ſin.}\ a}{\sqrt{q} \sqrt{\text{C}} + \sqrt{\text{S}} \cdot \text{ſin.}\ \overline{b+x}}, = \frac{\text{V} \cdot \text{ſin.}\ a}{\sqrt{q} \frac{\sqrt{\text{C}}}{\sqrt{\text{S}}} + \text{ſin.}\ \overline{b+x}}, = \text{V} \frac{\text{Sin.}\ a}{\sqrt{q} \frac{\sqrt{\text{C}}}{\sqrt{\text{S}}} + \text{ſin.}\ \overline{b+x}}.$

Obſerve that the quantity which is the coefficient of V in this equation is a common number; for ſin. a is a number, being a deeimal fraction of the radius 1, Sin. $\overline{b+x}$ is alſo a number, for the ſame reaſon. And ſince m and n were numbers of pounds, $\frac{m}{n}$ or q is a common number. And becauſe C and S are ſurfaces, or quantities of one kind, $\frac{\text{C}}{\text{S}}$ is alſo a common number.

This is the ſimpleſt expreſſion that we can think of for the velocity acquired by the ſhip, though it muſt be acknowledged to be too complex to be of very prompt uſe. Its complication ariſes from the neceſſity of introducing the leeway x. This affects the whole of the denominator; for the ſurface C depends on it, becauſe C is $= \sqrt{\text{A}^2 + \text{B}^2}$, and A and B are analogous to $\text{A}' \text{coſ.}^2 x$ and $\text{B}' \text{ſin.}^2 x$.

28 Important conſequences deduced from the foregoing theorem.

But we can deduce ſome important conſequences from this theorem.

While the ſurface S of the ſail actually filled by the wind remains the ſame, and the angle DCB, which in future we ſhall call the TRIM of the ſails, alſo remains the ſame, both the leeway x and the ſubſtituted ſurface C remains the ſame. The denominator is therefore conſtant; and the velocity of the ſhip is proportional to $\sqrt{\text{S}} \cdot \text{V} \cdot \text{ſin.}\ a$; that is, directly as the velocity of the wind, directly as the abſolute inclination of the wind to the yard, and directly as the ſquare root of the ſurface of the ſails.

We alſo learn from the conſtruction of the figure that FG parallel to the yard cuts CE in a given ratio. For CF is in a conſtant ratio to Eg, as has been juſt now demonſtrated. And the angle DCF is conſtant. Therefore CF · ſin. b, or FH or Gg, is proportional to Eg, and OC to EC, or EC is cut in one proportion, whatever may be the angle ECD, ſo long as the angle DCF is conſtant.

We alſo ſee that it is very poſſible for the velocity of the ſhip on an oblique courſe to exceed that of the wind. This will be the caſe when the number $\frac{\text{ſin.}\ a}{\sqrt{q \frac{\text{C}}{\text{S}}} + \text{ſin.}\ \overline{b+x}}$ exceeds unity, or when ſin. a is greater than $\sqrt{q \frac{\text{C}}{\text{S}}} + \text{ſin.}\ \overline{b+x}$. Now this may eaſily be by ſufficiently enlarging S and diminiſhing $b+x$. It is indeed frequently ſeen in fine ſailers with all their ſails ſet and not hauled too near the wind.

We remarked above that the angle of leeway x affects the whole denominator of the fraction which expreſſes the velocity. Let it be obſerved that the angle ICL is the complement of LCD, or of b. Therefore, $\text{CL} : \text{LI}$, or $\text{A} : \text{B} = 1 : \text{tan. ICL}, = 1 : \text{cot.}\ b$, and $\text{B} = \text{A} \cdot \text{cotan.}\ b$. Now A is equivalent to $\text{A}' \cdot \text{coſ.}^2 x$, and thus b becomes a function of x. C is evidently ſo, being $\sqrt{\text{A}^2 + \text{B}^2}$. Therefore before the value of this fraction can be obtained, we muſt be able to compute, by our knowledge of the form of the ſhip, the value of A for every angle x of leeway. This can be done only by reſolving her bows into a great number of elementary planes, and computing the impulſes on each and adding them into one ſum. The computation is of immenſe labour, as may be ſeen by one example given by Bouguer. When the leeway is but ſmall, not exceeding ten degrees, the ſubſtitution of the rectangular priſm of one determined form is abundantly exact for all leeways contained within this limit; and we ſhall ſoon ſee reaſon for being contented with this approximation. We may now make uſe of the formula expreſſing the velocity for ſolving the chief problems in this part of the ſeaman's taſk.

29 Problem I. To determine the beſt poſition of the ſails for ſtanding on a given courſe, when the direction and velocity of the wind and its angle with the courſe are given.

And firſt let it be required to determine the beſt poſition of the ſail for ſtanding on a given courſe $a\,b$, when CE the direction and velocity of the wind, and its angle with the courſe WCF, are given. This problem has exerciſed the talents of the mathematicians ever ſince the days of Newton. In the article PNEUMATICS we gave the ſolution of one very nearly related to it, namely, to determine the poſition of the ſail which would produce the greateſt impulſion in the direction of the courſe. The ſolution was, to place the yard CD in ſuch a poſition that the tangent of the angle FCD may be one half of the tangent of the angle DCW. This will indeed be the beſt poſition of the ſail for beginning the motion; but as ſoon as the ſhip begins to move in the direction CF, the effective impulſe of the wind is diminiſhed, and alſo its inclination to the ſail. The angle DCw diminiſhes continually as the ſhip accelerates; for CF is now accompanied by its equal eE, and by an angle ECe or WCw. CF increaſes, and the impulſe on the ſail diminiſhes, till an equilibrium obtains between the reſiſtance of the water and the impulſe of the wind. The impulſe is now meaſured by $\text{CE}^2 \times \text{ſin.}^2\ e\text{CD}$ inſtead of $\text{CE}^2 \times \text{ſin.}^2\ \text{ECD}$, that is, by EG^2 inſtead of $\text{E}g^2$.

This introduction of the relative motion of the wind renders the actual ſolution of the problem extremely difficult.

difficult. It is very eaſily expreſſed geometrically: Divide the angle wCF in ſuch a manner that the tangent of DCF may be half of the tangent of DCw, and the problem may be conſtructed geometrically as follows.

Fig. 7. Let WCF (fig. 7.) be the angle between the ſail and courſe. Round the centre C deſcribe the circle WDFY; produce WC to Q, ſo that CQ$=\frac{1}{3}$WC, and draw QY parallel to CF cutting the circle in Y; biſect the arch WY in D, and draw DC. DC is the proper poſition of the yard.

Draw the chord WY, cutting CD in V and CF in T; draw the tangent PD cutting CF in S and CY in R.

It is evident that WY, PR, are both perpendicular to CD, and are biſected in V and D; therefore (by reaſon of the parallels QY, CF) 4 : 3=QW : CW, =YW : TW, =RP : SP. Therefore PD : PS=2 : 3, and PD : DS=2 : 1. *Q. E. D.* But this diviſion cannot be made to the beſt advantage till the ſhip has attained its greateſt velocity, and the angle wCF has been produced.

We muſt conſider all the three angles, a, b, and x, as variable in the equation which expreſſes the value of v, and we muſt make the fluxion of this equation $= o$; then, by means of the equation B $=$ A$\cdot$ cotan. b, we muſt obtain the value of b and of $\dot{b}$ in terms of x and $\dot{x}$. With reſpect to a, obſerve, that if we make the angle WCF$=p$, we have $p=a+b+x$; and p being a conſtant quantity, we have $\dot{a}+\dot{b}+\dot{x}=o$. Subſtituting for a, b, $\dot{a}$ and $\dot{b}$, their values in terms of x and $\dot{x}$, in the fluxionary equation $=o$, we readily obtain x, and then a and b, which ſolves the problem.

Let it be required, in the next place, to determine the courſe and the trim of the ſails moſt proper for plying to windward.

30 Problem II. To determine the courſe and trim of the ſails moſt proper for plying to windward.

In fig. 6. draw FP perpendicular to WC. CF is the motion of the ſhip; but it is only by the motion PC that ſhe gains to windward. Now CP is $=$ CF $\times$ coſin. WCF, or $v\cdot$ coſin. $(a+b+x)$. This muſt be rendered a maximum, as follows.

By means of the equation which expreſſes the value of v and the equation B$=$A$\cdot$ cotan. b, we exterminate the quantities v and b; we then take the fluxion of the quantity into which the expreſſion $v\cdot$ coſ. $(a+b+x)$ is changed by this operation. Making this fluxion $=o$, we get the equation which muſt ſolve the problem. This equation will contain the two variable quantities a and x with their fluxions; then make the coefficient of $\dot{x}$ equal to o, alſo the coefficient of $\dot{a}$ equal to o. This will give two equations which will determine a and x, and from this we get $b=p-a-x$.

31 Problem III. To determine the beſt courſe and trim of the ſails for getting away from a given line of coaſt.

Should it be required, in the third place, to find the beſt courſe and trim of the ſails for getting away from a given line of coaſt CM (fig. 6.), the proceſs perfectly reſembles this laſt, which is in fact getting away from a line of coaſt which makes a right angle with the wind. Therefore, in place of the angle WCF, we muſt ſubſtitute the angle WCM$\pm$WCF. Call this angle e. We muſt make $v\cdot$ coſ. $(e\pm a\pm b\pm x)$ a maximum. The analytical proceſs is the ſame as the former, only e is here a conſtant quantity.

32 Obſervations on the preceding problems.

Theſe are the three principal problems which can be ſolved by means of the knowledge that we have obtained of the motion of the ſhip when impelled by an oblique ſail, and therefore making leeway; and they may be conſidered as an abſtract of this part of M. Bouguer's work. We have only pointed out the proceſs for this ſolution, and have even omitted ſome things taken notice of by M. Bezout in his very elegant compendium. Our reaſons will appear as we go on. The learned reader will readily ſee the extreme difficulty of the ſubject, and the immenſe calculations which are neceſſary even in the ſimpleſt caſes, and will grant that it is out of the power of any but an expert analyſt to derive any uſe from them; but the mathematician can calculate tables for the uſe of the practical ſeaman. Thus he can calculate the beſt poſition of the ſails for advancing in a courſe 90° from the wind, and the velocity in that courſe; then for 85°, 80°, 75°, &c. M. Bouguer has given a table of this kind; but to avoid the immenſe difficulty of the proceſs, he has adapted it to the apparent direction of the wind. We have inſerted a few of his numbers, ſuited to ſuch caſes as can be of ſervice, namely, when all the ſails draw, or none ſtand in the way of others. Column 1ſt is the apparent angle of the wind and courſe; column 2d is the correſponding angle of the ſails and keel; and column 3d is the apparent angle of the ſails and wind.

33 M. Bouguer's table for finding the beſt poſition of the ſails for advancing in any courſe.

1 wCF	2 DCB	3 wCD
103° 53′	42° 30′	61° 23′
99 13	40 —	59 13
94 25	37 30	56 55
89 28	35 —	54 28
84 23	32 30	51 53
79 06	30 —	49 06
73 39	27 30	46 09
68 —	25 —	43 —

In all theſe numbers we have the tangent of wCD double of the tangent of DCF.

34 Inutility of theſe calculations.

But this is really doing but little for the ſeaman. The apparent direction of the wind is unknown to him till the ſhip is ſailing with uniform velocity; and he is ſtill uninformed as to the leeway. It is, however, of ſervice to him to know, for inſtance, that when the angle of the vanes and yards is 56 degrees, the yard ſhould be braced up to 37° 30′, &c.

But here occurs a new difficulty. By the conſtruction of a ſquare-rigged ſhip it is impoſſible to give the yards that inclination to the keel which the calculation requires. Few ſhips can have their yards braced up to 37° 30′; and yet this is required in order to have an incidence of 56°, and to hold a courſe 94° 25′ from the apparent direction of the wind, that is, with the wind apparently 4° 25′ abaft the beam. A good ſailing ſhip in this poſition may acquire a velocity even exceeding that of the wind. Let us ſuppoſe it only one half of this velocity. We ſhall find that the angle WCw is in this caſe about 29°, and the ſhip is nearly going 123° from the wind, with the wind almoſt perpendicular to the ſail; therefore this utmoſt bracing up of the ſails is only giving them the poſition ſuited to a wind broad on the quarter. It is impoſſible therefore to comply with the demand of the mathematician, and the ſeaman muſt be contented to employ a leſs favourable diſpoſition of his ſails in all caſes where his courſe does not lie at leaſt eleven points from the wind.

Let

Let us ſee whether this reſtriction, ariſing from neceſſity, leaves any thing in our choice, and makes one courſe preferable to another. We ſee that there are a prodigious number of courſes, and theſe the moſt uſual and the moſt important, which we muſt hold with one trim of the ſails; in particular, ſailing with the wind on the beam, and all caſes of plying to windward, muſt be performed with this unfavourable trim of the ſails. We are certain that the ſmaller we make the angle of incidence, real or apparent, the ſmaller will be the velocity of the ſhip; but it may happen that we ſhall gain more to windward, or get ſooner away from a lee-coaſt, or any object of danger, by ſailing ſlowly on one courſe than by ſailing quickly on another.

We have ſeen that while the trim of the ſails remains the ſame, the leeway and the angle of the yard and courſe remains the ſame, and that the velocity of the ſhip is as the ſine of the angle of real incidence, that is, as the ſine of the angle of the ſail and the real direction of the wind.

Fig. 8. Let the ſhip AB (fig. 8.) hold the courſe CF, with the wind blowing in the direction WC, and having her yards DCD braced up to the ſmalleſt angle BCD which the rigging can admit. Let CF be to CE as the velocity of the ſhip to the velocity of the wind; join FE and draw C w parallel to EF; it is evident that FE is the relative motion of the wind, and wCD is the relative incidence on the ſail. Draw FO parallel to the yard DC, and deſcribe a circle through the points COF; then we ſay that if the ſhip, with the ſame wind and the ſame trim of the ſame drawing ſails, be made to ſail on any other courſe Cf, her velocity along CF is to the velocity along Cf as CF is to Cf; or, in other words, the ſhip will employ the ſame time in going from C to any point of the circumference CFO.

Join fO. Then, becauſe the angles CFO, cfO are on the ſame chord CO, they are equal, and fO is parallel to dCd, the new poſition of the yard correſponding to the new poſition of the keel ab, making the angle dCb=DCB. Alſo, by the nature of the circle, the line CF is to Cf as the ſine of the angle CFO to the ſine of the angle COf, that is (on account of the parallels CD, OF and Cd, Of), as the ſine of WCD to the ſine of WCd. But when the trim of the ſails remains the ſame, the velocity of the ſhip is as the ſine of the angle of the ſail with the direction of the wind; therefore CF is to Cf as the velocity on CF to that on Cf, and the propoſition is demonſtrated.

35 To determine the beſt courſe for avoiding a rock. Let it now be required to determine the beſt courſe for avoiding a rock R lying in the direction CR, or for withdrawing as faſt as poſſible from a line of coaſt PQ. Draw CM through R, or parallel to PQ, and let m be the middle of the arch CmM. It is plain that m is the moſt remote from CM of any point of the arch CmM, and therefore the ſhip will recede farther from the coaſt PQ in any given time by holding the courſe Cm than by any other courſe.

This courſe is eaſily determined; for the arch CmM =360°— (arch CO + arch OM), and the arch CO is the meaſure of twice the angle CFO, or twice the angle DCB, or twice $\overline{b+x}$, and the arch OM meaſures twice the angle ECM.

Thus, ſuppoſe the ſharpeſt poſſible trim of the ſails to be 35°, and the obſerved angle ECM to be 70°; then CO+OM is 70°+140° or 210°. This being taken from 360°, leaves 150°, of which the half Mm is 75°, and the angle MCm is 37° 30′. This added to ECM makes ECm 107° 30′, leaving WCm=72° 30′, and the ſhip muſt hold a courſe making an angle of 72° 30′ with the real direction of the wind, and WCD will be 37° 30′.

This ſuppoſes no leeway. But if we know that under all the ſail which the ſhip can carry with ſafety and advantage ſhe makes 5 degrees of leeway, the angle DCm of the ſail and courſe, or $b+x$, is 40°. Then CO+OM=220°, which being taken from 360° leaves 140°, of which the half is 70°, =Mm, and the angle MCm= 35°, and ECm = 105°, and WCm = 75°, and the ſhip muſt lie with her head 70° from the wind, making 5 degrees of leeway, and the angle WCD is 35°.

The general rule for the poſition of the ſhip is, *that the line on ſhipboard which biſects the angle* b+x *may alſo biſect the angle* WCM, or make the angle between the courſe and the line from which we wiſh to withdraw equal to the angle between the ſail and the real direction of the wind.

36 Corollaries. It is plain that this problem includes that of plying to windward. We have only to ſuppoſe ECM to be 90°; then, taking our example in the ſame ſhip, with the ſame trim and the ſame leeway, we have $b+x$=40°. This taken from 90° leaves 50° and WCn=90—25=65, and the ſhip's head muſt lie 60° from the wind, and the yard muſt be 25° from it.

It muſt be obſerved here, that it is not always eligible to ſelect the courſe which will remove the ſhip faſteſt from the given line CM; it may be more prudent to remove from it more ſecurely though more ſlowly. In ſuch caſes the procedure is very ſimple, viz. to ſhape the courſe as near the wind as is poſſible.

The reader will alſo eaſily ſee that the propriety of theſe practices is confined to thoſe courſes only where the practicable trim of the ſails is not ſufficiently ſharp. Whenever the courſe lies ſo far from the wind that it is poſſible to make the tangent of the apparent angle of the wind and ſail double the tangent of the ſail and courſe, it ſhould be done.

37 The adjuſtment of the ſails ſuppoſed in the theory impracticable. Theſe are the chief practical conſequences which can be deduced from the theory. But we ſhould conſider how far this adjuſtment of the ſails and courſe can be performed. And here occur difficulties ſo great as to make it almoſt impracticable. We have always ſuppoſed the poſition of the ſurface of the ſail to be diſtinctly obſervable and meaſurable; but this can hardly be affirmed even with reſpect to a ſail ſtretched on a yard. Here we ſuppoſed the ſurface of the ſail to have the ſame inclination to the keel that the yard has. This is by no means the caſe; the ſail aſſumes a concave form, of which it is almoſt impoſſible to aſſign the direction of the mean impulſe. We believe that this is always conſiderably to leeward of a perpendicular to the yard, lying between CI and CE (fig. 6.). This is of ſome advantage, being equivalent to a ſharper trim. We cannot affirm this, however, with any confidence, becauſe it renders the impulſe on the weather-leech of the ſail ſo exceedingly feeble as hardly to have any effect. In ſailing cloſe to the wind the ſhip is kept ſo near that the weather-leech of the ſail is almoſt ready to receive the wind edgewiſe, and to flutter or ſhiver. The moſt effective or drawing ſails with a ſide-wind, eſpecially when

when plying to windward, are the ſtayſails. We believe that it is impoſſible to ſay, with any thing approaching to preciſion, what is the poſition of the general ſurface of a ſtayſail, or to calculate the intenſity and direction of the general impulſe; and we affirm with confidence that no man can pronounce on theſe points with any exactneſs. If we can gueſs within a third or a fourth part of the truth, it is all we can pretend to; and after all, it is but a gueſs. Add to this, the ſails coming in the way of each other, and either becalming them or ſending the wind upon them in a direction widely different from that of its free motion. All theſe points we think beyond our power of calculation, and therefore that it is in vain to give the ſeaman mathematical rules, or even tables of adjuſtment ready calculated; ſince he can neither produce that medium poſition of his ſails that is required, nor tell what is the poſition which he employs.

This is one of the principal reaſons why ſo little advantage has been derived from the very ingenious and promiſing diſquiſitions of Bouguer and other mathematicians, and has made us omit the actual ſolution of the chief problems, contenting ourſelves with pointing out the proceſs to ſuch readers as have a reliſh for theſe analytical operations.

38 The theory itſelf erroneous,

But there is another principal reaſon for the ſmall progreſs which has been made in the theory of ſeamanſhip: This is the error of the theory itſelf, which ſuppoſes the impulſions of a fluid to be in the duplicate ratio of the ſine of incidence. The moſt careful compariſon which has been made between the reſults of this theory and matter of fact is to be ſeen in the experiments made by the members of the Royal Academy of Sciences at Paris, mentioned in the article *RESISTANCE of Fluids*. We ſubjoin another abſtract of them in the following table; where col. 1ſt gives the angle of incidence; col. 2d gives the impulſions really obſerved; col. 3d the impulſes, had they followed the duplicate ratio of the ſines; and col. 4th the impulſes, if they were in the ſimple ratio of the ſines.

Angle of Incid	Impulſion obſerved.	Impulſe as Sine ².	Impulſe as Sine.
90	1000	1000	1000
84	989	989	995
78	958	957	978
72	908	905	951
66	845	835	914
60	771	750	866
54	693	655	809
48	615	552	743
42	543	448	669
36	480	346	587
30	440	250	500
24	424	165	407
18	414	96	309
12	406	43	208
6	400	11	105

Here we ſee an enormous difference in the great obliquities. When the angle of incidence is only ſix degrees, the obſerved impulſe is forty times greater than the theoretical impulſe; at 12° it is ten times greater; at 18° it is more than four times greater; and at 24° it is almoſt three times greater.

39 and the deductions from it uſeleſs.

No wonder then that the deductions from this theory are ſo uſeleſs and ſo unlike what we familiarly obſerve. We took notice of this when we were conſidering the leeway of a rectangular box, and thus ſaw a reaſon for admitting an incomparably ſmaller leeway than what would reſult from the laborious computations neceſſary by the theory. This error in theory has as great an influence on the impulſions of air when acting obliquely on a ſail; and the experiments of Mr Robins and of the Chevalier Borda on the oblique impulſions of air are perfectly conformable (as far as they go) to thoſe of the academicians on water. The oblique impulſions of the wind are therefore much more efficacious for preſſing the ſhip in the direction of her courſe than the theory allows us to ſuppoſe; and the progreſs of a ſhip plying to windward is much greater, both becauſe the oblique impulſes of the wind are more effective, and becauſe the leeway is much ſmaller, than we ſuppoſe. Were not this the caſe, it would be impoſſible for a ſquare-rigged ſhip to get to windward. The impulſe on her ſails when cloſe hauled would be ſo trifling that ſhe would not have a third part of the velocity which we ſee her acquire: and this trifling velocity would be waſted in leeway; for we have ſeen that the diminution of the oblique impulſes of the water is accompanied by an increaſe of leeway. But we ſee that in the great obliquities the impulſions continue to be very conſiderable, and that even an incidence of ſix degrees gives an impulſe as great as the theory allows to an incidence of 40. We may therefore, on all occaſions, keep the yards more ſquare; and the loſs which we ſuſtain by the diminution of the very oblique impulſe will be more than compenſated by its more favourable direction with reſpect to the ſhip's keel. Let us take an example of this. Suppoſe the wind about two points before the beam, making an angle of 68° with the keel. The theory aſſigns 43° for the inclination of the wind to the ſail, and 15° for the trim of the ſail. The perpendicular impulſe being ſuppoſed 1000, the theoretical impulſe for 45° is 465. This reduced in the proportion of radius to the ſine of 25°, gives the impulſe in the direction of the courſe only 197.

But if we eaſe off the lee-braces till the yard makes an angle of 50° with the keel, and allows the wind an incidence of no more than 18°, we have the experimented impulſe 414, which, when reduced in the proportion of radius to the ſine of 50°, gives an effective impulſe 317. In like manner, the trim 56°, with the incidence 12°, gives an effective impulſe 337; and the trim 62°, with the incidence only 6°, gives 353.

Hence it would at firſt ſight appear that the angle DCB of 62° and WCD of 6° would be better for holding a courſe within 6 points of the wind than any more oblique poſition of the ſails; but it will only give a greater initial impulſe. As the ſhip accelerates, the wind apparently comes ahead, and we muſt continue to brace up as the ſhip freſhens her way. It is not unuſual for her to acquire half or two thirds of the velocity of the wind; in which caſe the wind comes apparently ahead more than two points, when the yards muſt be braced up to 35°, and this allows an impulſe no greater than about 7°. Now this is very frequently obſerved.

obſerved in good ſhips, which in a briſk gale and ſmooth water will go five or ſix knots cloſe-hauled, the ſhip's head ſix points from the wind, and the ſails no more than juſt full, but ready to ſhiver by the ſmalleſt luff. All this would be impoſſible by the uſual theory; and in this reſpect theſe experiments of the French academy gave a fine illuſtration of the ſeaman's practice. They account for what we ſhould otherwiſe be much puzzled to explain; and the great progreſs which is made by a ſhip cloſe-hauled being perfectly agreeable to what we ſhould expect from the law of oblique impulſion deducible from theſe ſo often mentioned experiments, while it is totally incompatible with the common theory, ſhould make us abandon the theory without heſitation, and ſtrenuouſly ſet about the eſtabliſhment of another, founded entirely on experiments. For this purpoſe the experiments ſhould be made on the oblique impulſions of air on as great a ſcale as poſſible, and in as great a variety of circumſtances, ſo as to furniſh a ſeries of impulſions for all angles of obliquity. We have but four or five experiments on this ſubject, viz. two by Mr Robins, and two or three by the Chevalier Borda. Having thus gotten a ſeries of impulſions, it is very practicable to raiſe on this foundation a practical inſtitute, and to give a table of the velocities of a ſhip ſuited to every angle of inclination and of trim; for nothing is more certain than the reſolution of the impulſe perpendicular to the ſail into a force in the direction of the keel, and a lateral force.

40
Experiments proper for eſtabliſhing another

We are alſo diſpoſed to think that experiments might be made on a model very nicely rigged with ſails, and trimmed in every different degree, which would point out the mean direction of the impulſe on the ſails, and the comparative force of theſe impulſes in different directions of the wind. The method would be very ſimilar to that for examining the impulſe of the water on the hull. If this can alſo be aſcertained experimentally, the intelligent reader will eaſily ſee that the whole motion of a ſhip under ſail may be determined for every caſe. Tables may then be conſtructed by calculation, or by graphical operations, which will give the velocities of a ſhip in every different courſe, and correſponding to every trim of ſail. And let it be here obſerved, that the trim of the ſail is not to be eſtimated in degrees of inclination of the yards; becauſe, as we have already remarked, we cannot obſerve nor adjuſt the lateen ſails in this way. But, in making the experiments for aſcertaining the impulſe, the exact poſition of the tacks and ſheets of the ſails are to be noted; and this combination of adjuſtments is to paſs by the name of a certain trim. Thus that trim of all the ſails may be called 40, whoſe direction is experimentally found equivalent to a flat ſurface trimmed to the obliquity 40°.

Having done this, we may conſtruct a figure for each trim ſimilar to fig. 8. where, inſtead of a circle, we ſhall have a curve COM'F', whoſe chords CF', cf', &c. are proportional to the velocities in theſe courſes; and by means of this curve we can find the point m', which is moſt remote from any line CM from which we wiſh to withdraw: and thus we may ſolve all the principal problems of the art.

We hope that it will not be accounted preſumption in us to expect more improvement from a theory founded on judicious experiments only, than from a theory of the impulſe of fluids, which is found ſo inconſiſtent with obſervation, and of whoſe fallacy all its authors, from Newton to D'Alembert, entertained ſtrong ſuſpicions. Again, we beg leave to recommend this view of the ſubject to the attention of the SOCIETY FOR THE IMPROVEMENT OF NAVAL ARCHITECTURE. Should theſe patriotic gentlemen entertain a favourable opinion of the plan, and honour us with their correſpondence, we will cheerfully impart to them our notions of the way in which both theſe trains of experiments may be proſecuted with ſucceſs, and reſults obtained in which we may confide; and we content ourſelves at preſent with offering to the public theſe hints, which are not the ſpeculations of a man of mere ſcience, but of one who, with a competent knowledge of the laws of mechanical nature, has the experience of ſeveral years ſervice in the royal navy, where the art of working of ſhips was a favourite object of his ſcientific attention.

41
Recommended to the Society for the Improvement of Naval Architecture.

42
Means employed to prevent or produce deviations from a courſe.

With theſe obſervations we conclude our diſcuſſion of the firſt part of the ſeaman's taſk, and now proceed to conſider the means that are employed to prevent or to produce any deviations from the uniform rectilineal courſe which has been ſelected.

Here the ſhip is to be conſidered as a body in free ſpace, convertible round her centre of inertia. For whatever may be the point round which ſhe turns, this motion may always be conſidered as compounded of a rotation round an axis paſſing through her centre of gravity or inertia. She is impelled by the wind and by the water acting on many ſurfaces differently inclined to each other, and the impulſe on each is perpendicular to the ſurface. In order therefore that ſhe may continue ſteadily in one courſe, it is not only neceſſary that the impelling forces, eſtimated in their mean direction, be equal and oppoſite to the reſiſting forces eſtimated in their mean direction; but alſo that theſe two directions may paſs through one point, otherwiſe ſhe will be affected as a log of wood is when puſhed in oppoſite directions by two forces, which are equal indeed, but are applied to different parts of the log. A ſhip muſt be conſidered as a lever, acted on in different parts by forces in different directions, and the whole balancing each other round that point or axis where the equivalent of all the reſiſting forces paſſes. This may be conſidered as a point ſupported by this reſiſting force and as a ſort of fulcrum: therefore, in order that the ſhip may maintain her poſition, the energies or *momenta* of all the impelling forces round this point muſt balance each other.

43
Impulſes on a ſhip ſailing right before the wind different from thoſe on her when ſailing obliquely.

When a ſhip ſails right afore the wind, with her yards ſquare, it is evident that the impulſes on each ſide of the keel are equal, as alſo their mechanical *momenta* round any axis paſſing perpendicular through the keel. So are the actions of the water on her bows. But when ſhe ſails on an oblique courſe, with her yards braced up on either ſide, ſhe ſuſtains a preſſure in the direction CI (fig. 5.) perpendicular to the ſail. This, by giving her a lateral preſſure LI, as well as a preſſure CL ahead, cauſes her to make leeway, and to move in a line C b inclined to CB. By this means the balance of action on the two bows is deſtroyed; the general impulſe on the lee-bow is increaſed; and that on the weather-bow is diminiſhed.

miniſhed. The combined impulſe is therefore no longer in the direction BC, but (in the ſtate of uniform motion) in the direction IC.

Suppoſe that in an inſtant the whole ſails are annihilated, and the impelling preſſure CI, which preciſely balanced the reſiſting preſſure on the bows, removed. The ſhip tends, by her inertia, to proceed in the direction $C\,b$. This tendency produces a continuation of the reſiſtance in the oppoſite direction IC, which is not directly oppoſed to the tendency of the ſhip in the direction $C\,b$; therefore the ſhip's head would immediately come up to the wind. The experienced ſeamen will recollect ſomething like this when the ſails are ſuddenly lowered when coming to anchor. It does not happen ſolely from the obliquity of the action on the bows: It would happen to the parallelepiped of fig. 2. which was ſuſtaining a lateral impulſion $B \cdot \text{ſin.}^2 x$, and a direct impulſion $A \cdot \text{coſ.}^2 x$. Theſe are continued for a moment after the annihilation of the ſail: but being no longer oppoſed by a force in the direction CD, but by a force in the direction $C\,b$, the force $B \cdot \text{ſin.}^2 x$ muſt prevail, and the body is not only retarded in its motion, but its head turns towards the wind. But this effect of the leeway is greatly increaſed by the curved form of the ſhip's bows. This occaſions the centre of effort of all the impulſions of the water on the leeſide of the ſhip to be very far forward, and this ſo much the more remarkably as ſhe is ſharper afore. It is in general not much abaft the foremaſt. Now the centre of the ſhip's tendency to continue her motion is the ſame with her centre of gravity, and this is generally but a little before the mainmaſt. She is therefore in the ſame condition nearly as if ſhe were puſhed at the mainmaſt in a direction parallel to $C\,b$, and at the foremaſt by a force parallel to IC. The evident conſequence of this is a tendency to come up to the wind. This is independent of all ſituation of the ſails, provided only that they have been trimmed obliquely.

44 Griping.

This tendency of the ſhip's head to windward is called GRIPING in the ſeaman's language, and is greateſt in ſhips which are ſharp forward, as we have ſaid already. This circumſtance is eaſily underſtood. Whatever is the direction of the ſhip's motion, the abſolute impulſe on that part of the bow immediately contiguous to B is perpendicular to that very part of the ſurface. The more acute, therefore, that the angle of the bow is, the more will the impulſe on that part be perpendicular to the keel, and the greater will be its energy to turn the head to windward.

45 Propriety of the diſpoſition of the ſails of a ſhip.

Thus we are enabled to underſtand or to ſee the propriety of the diſpoſition of the ſails of a ſhip. We ſee her crowded with ſails forward, and even many ſails extended far before her bow, ſuch as the ſpritſail, the bowſprit-topſail, the fore-topmaſt ſtayſail, the jib, and flying jib. The ſails abaft are comparatively ſmaller. The ſails on the mizenmaſt are much ſmaller than thoſe on the foremaſt. All the ſtayſails hoiſted on the mainmaſt may be conſidered as headſails, becauſe their centres of effort are conſiderably before the centre of gravity of the ſhip: and notwithſtanding this diſpoſition, it generally requires a ſmall action of the rudder to counteract the windward tendency of the lee-bow. This is conſidered as a good quality when moderate; becauſe it enables the ſeaman to throw the ſails aback, and ſtop the ſhip's way in a moment, if ſhe be in danger from any thing a-head; and the ſhip which does not carry a little of a weather helm, is always a dull ſailer.

46 Action of the water and the ſails. Fig 9.

In order to judge ſomewhat more accurately of the action of the water and ſails, ſuppoſe the ſhip AB (fig. 9.) to have its ſails on the mizenmaſt D, the mainmaſt E, and foremaſt F, braced up or trimmed alike, and that the three lines $D\,i$, $E\,e$, $F\,f$, perpendicular to the ſails, are in the proportion of the impulſes on the ſails. The ſhip is driven a-head and to leeward, and moves in the path $a\,C\,b$. This path is ſo inclined to the line of the keel that the medium direction of the reſiſtance of the water is parallel to the direction of the impulſe. A line CI may be drawn parallel to the lines $D\,i$, $E\,e$, $F\,f$, and equal to their ſum: and it may be drawn from ſuch a point C, that the actions on all the parts of the hull between C and B may balance the *momenta* of all the actions on the hull between C and A. This point may juſtly be called the *centre of effort*, or the *centre of reſiſtance*. We cannot determine this point for want of a proper theory of the reſiſtance of fluids. Nay, although experiments like thoſe of the Pariſian academy ſhould give us the moſt perfect knowledge of the intenſity of the oblique impulſes on a ſquare foot, we ſhould hardly be benefited by them: for the action of the water on a ſquare foot of the hull at p, for inſtance, is ſo modified by the intervention of the ſtream of water which has ſtruck the hull about B, and glided along the bow $B\,o\,p$, that the preſſure on p is totally different from what it would have been were it a ſquare foot or ſurface detached from the reſt, and preſented in the ſame poſition to the water moving in the direction $b\,C$. For it is found, that the reſiſtances given to planes joined ſo as to form a wedge, or to curved ſurfaces, are widely different from the accumulated reſiſtances, calculated for their ſeparate parts, agreeably to the experiments of the academy on ſingle ſurfaces. We therefore do not attempt to aſcertain the point C by theory; but it may be accurately determined by the experiments which we have ſo ſtrongly recommended; and we offer this as an additional inducement for proſecuting them.

47 Centre of effort

48 to be determined by experiments.

Draw through C a line perpendicular to CI, that is, parallel to the ſails; and let the lines of impulſe of the three ſails cut it in the points i, k, and m. This line $i\,m$ may be conſidered as a lever, moveable round C, and acted on at the points i, k, and m, by three forces. The rotatory momentum of the ſails on the mizenmaſt is $D\,i \times i\,C$; that of the ſails on the mainmaſt is $E\,e \times k\,C$; and the momentum of the ſails on the foremaſt is $F\,f \times m\,C$. The two firſt tend to preſs forward the arm $C\,i$, and then to turn the ſhip's head towards the wind. The action of the ſails on the foremaſt tends to pull the arm $C\,m$ forward, and produce a contrary rotation. If the ſhip under theſe three ſails keeps ſteadily in her courſe, without the aid of the rudder, we muſt have $D\,i \times i\,C + E\,e \times k\,C = F\,f \times m\,C$. This is very poſſible, and is often ſeen in a ſhip under her mizen topſail, main topſail, and fore topſail, all parallel to one another, and their ſurfaces duly proportioned by reefing. If more ſails are ſet, we muſt always have a ſimilar equilibrium. A certain number of them will have their efforts directed from the larboard arm of the lever $i\,m$ lying to leeward of CI, and a certain number will have their efforts directed from the ſtarboard arm lying to windward of CI. The ſum of the products of each of the firſt ſet, by their diſtances from C, muſt be equal

49 Equilibrium preſerved by the poſition of the ſails.

equal to the ſum of the ſimilar products of the other ſet. As this equilibrium is all that is neceſſary for preſerving the ſhip's poſition, and the ceſſation of it is immediately followed by a converſion; and as theſe ſtates of the ſhip may be had by means of the three ſquare ſails only, when their ſurfaces are properly proportioned—it is plain that every movement may be executed and explained by their means. This will greatly ſimplify our future diſcuſſions. We ſhall therefore ſuppoſe in future that there are only the three topſails ſet, and that their ſurfaces are ſo adjuſted by reefing, that their actions exactly balance each other round that point C of the middle line AB, where the actions of the water on the different parts of her bottom in like manner balance each other. This point C may be differently ſituated in the ſhip according to the leeway ſhe makes, depending on the trim of the ſails; and therefore although a certain proportion of the three ſurfaces may balance each other in one ſtate of leeway, they may happen not to do ſo in another ſtate. But the equilibrium is evidently attainable in every caſe, and we therefore ſhall always ſuppoſe it.

50
Conſequence of deſtroying it.

It muſt now be obſerved, that when this equilibrium is deſtroyed, as, for example, by turning the edge of the mizen-topſail to the wind, which the ſeamen call *ſhivering* the mizen-topſail, and which may be conſidered as equivalent to the removing the mizen-topſail entirely, it does not follow that the ſhip will round the point C, this point remaining fixed. The ſhip muſt be conſidered as a free body, ſtill acted on by a number of forces, which no longer balance each other; and ſhe muſt therefore *begin* to turn round a ſpontaneous axis of converſion, which muſt be determined in the way ſet forth in the article ROTATION. It is of importance to point out in general where this axis is ſituated. Therefore let G (fig. 10.) be the centre of gravity of the ſhip. Draw the line q G v parallel to the yards, cutting D d in q, E e in r, CI in t, and F f in v. While the three ſails are ſet, the line $q\,v$ may be conſidered as a lever acted on by four forces, *viz.* D d, impelling the lever forward perpendicularly in the point q; E e, impelling it forward in the point r; F f, impelling it forward in the point v; and CI, impelling it backward in the point t. Theſe forces balance each other both in reſpect of progreſſive motion and of rotatory energy: for CI was taken equal to the ſum of D d, E e, and F f; ſo that no acceleration or retardation of the ſhip's progreſs in her courſe is ſuppoſed.

Fig. 10.

But by taking away the mizen-topſail, both the equilibriums are deſtroyed. A part D d of the accelerating force is taken away; and yet the ſhip, by her inertia or inherent force, tends, for a moment, to proceed in the direction C p with her former velocity; and by this tendency exerts for a moment the ſame preſſure CI on the water, and ſuſtains the ſame reſiſtance IC. She muſt therefore be retarded in her motion by the exceſs of the reſiſtance IC over the remaining impelling forces E e and F f, that is, by a force equal and oppoſite to D d. She will therefore be retarded in the ſame manner as if the mizen-topſail were ſtill ſet, and a force equal and oppoſite to its action were applied to G the centre of gravity, and ſhe would ſoon acquire a ſmaller velocity, which would again bring all things into equilibrium; and ſhe would ſtand on in the ſame courſe, without changing either her leeway or the poſition of her head.

But the equilibrium of the lever is alſo deſtroyed. It is now acted on by three forces only, *viz.* E e and F f, impelling it forward in the points r and v, and IC impelling it backward in the point t. Make $r\,v : r\,o = \mathrm{E}\,e + \mathrm{F}\,f : \mathrm{F}\,f$, and make $o\,p$ parallel to CI and equal to $\mathrm{E}\,e = \mathrm{F}\,f$. Then we know, from the common principles of mechanics, that the force $o\,p$ acting at o will have the ſame momentum or energy to turn the lever round *any* point whatever as the two forces E e and F f applied at r and v; and now the lever is acted on by two forces, *viz.* IC, urging it backwards in the point t, and $o\,p$ urging it forwards in the point o. It muſt therefore turn round like a floating log, which gets two blows in oppoſite directions. If we now make $\mathrm{IC}-o\,p : o\,p = t\,o : t\,x$, or $\mathrm{IC}-o\,p : \mathrm{IC} = t\,o : o\,x$, and apply to the point x a force equal to $\mathrm{IC}-o\,p$ in the direction IC; we know by the common principles of mechanics, that this force $\mathrm{IC}-o\,p$ will produce the ſame rotation round any point as the two forces IC and $o\,p$ applied in their proper directions at t and o. Let us examine the ſituation of the point x.

The force $\mathrm{IC}-o\,p$ is evidently $=\mathrm{D}\,d$, and $o\,p$ is $=\mathrm{E}\,e+\mathrm{F}\,f$. Therefore $o\,t : t\,x = \mathrm{D}\,d : o\,p$. But becauſe, when all the ſails were filled, there was an equilibrium round C, and therefore round t, and becauſe the force $o\,p$ acting at o is equivalent to E e and F f acting at r and v, we muſt ſtill have the equilibrium; and therefore we have the momentum $\mathrm{D}\,d \times q\,t = o\,p \times o\,t$. Therefore $o\,t : t\,q = \mathrm{D}\,d : o\,p$, and $t\,q = t\,x$. Therefore the point x is the ſame with the point q.

51
By ſhivering the mizen-topſail.

Therefore, when we ſhiver the mizen-topſail, the rotation of the ſhip is the ſame as if the ſhip were at reſt, and a force equal and oppoſite to the action of the mizen-topſail were applied at q or at D, or at any point in the line D q.

This might have been ſhown in another and ſhorter way. Suppoſe all ſails filled, the ſhip is in equilibrio. This will be diſturbed by applying to D a force oppoſite to D d; and if the force be alſo equal to D d, it is evident that theſe two forces deſtroy each other, and that this application of the force d D is equivalent to the taking away of the mizen-topſail. But we choſe to give the whole mechanical inveſtigation; becauſe it gave us an opportunity of pointing out to the reader, in a caſe of very eaſy comprehenſion, the preciſe manner in which the ſhip is acted on by the different ſails and by the water, and what ſhare each of them has in the motion ultimately produced. We ſhall not repeat this manner of procedure in other caſes, becauſe a little reflection on the part of the reader will now enable him to trace the *modus operandi* through all its ſteps.

We now ſee that, in reſpect both of progreſſive motion and of converſion, the ſhip is affected by ſhivering the ſail D, in the ſame manner as if a force equal and oppoſite to D d were applied at D, or at any point in the line D d. We muſt now have recourſe to the principles eſtabliſhed under the article ROTATION.

Let p repreſent a particle of matter, r its radius vector, or its diſtance p G from an axis paſſing through the centre of gravity G, and let M repreſent the whole quantity of matter of the ſhip. Then its momentum of inertia is $=\int p \cdot r$ (ſee ROTATION, N° 18.). The ſhip, impelled in the point D by a force in the direction d D, will begin to turn round a ſpontaneous vertical axis, paſſing through a point S of the line q G, which

which is drawn through the centre of gravity G, perpendicular to the direction d D of the external force, and the diſtance GS of this axis from the centre of gravity is $= \frac{\int p \cdot r^2}{M \cdot G q}$ (ſee Rotation, N° 96.), and it is taken on the oppoſite ſide of G from q, that is, S and q are on oppoſite ſides of G.

Let us expreſs the external force by the ſymbol F. It is equivalent to a certain number of pounds, being the preſſure of the wind moving with the velocity V and inclination a on the ſurface of the ſail D; and may therefore be computed either by the theoretical or experimental law of oblique impulſes. Having obtained this, we can aſcertain the angular velocity of the rotation and the abſolute velocity of any given point of the ſhip by means of the theorems eſtabliſhed in the article Rotation.

52 Action of the rudder. Fig. 11.

But before we proceed to this inveſtigation, we ſhall conſider the action of the rudder, which operates preciſely in the ſame manner. Let the ſhip AB (fig. 11.) have her rudder in the poſition AD, the helm being hard a-ſtarboard, while the ſhip ſailing on the ſtarboard tack, and making leeway, keeps on the courſe $a\,b$. The lee ſurface of the rudder meets the water obliquely. The very foot of the rudder meets it in the direction DE parallel to $a\,b$. The parts farther up meet it with various obliquities, and with various velocities, as it glides round the bottom of the ſhip and falls into the wake. It is abſolutely impoſſible to calculate the accumulated impulſe. We ſhall not be far miſtaken in the deflection of each contiguous filament, as it quits the bottom and glides along the rudder; but we neither know the velocity of theſe filaments, nor the deflection and velocity of the filaments gliding without them. We therefore imagine that all computations on this ſubject are in vain. But it is enough for our purpoſe that we know the direction of the abſolute preſſure which they exert on its ſurface. It is in the direction Dd, perpendicular to that ſurface. We alſo may be confident that this preſſure is very conſiderable, in proportion to the action of the water on the ſhip's bows, or of the wind on the ſails; and we may ſuppoſe it to be nearly in the proportion of the ſquare of the velocity of the ſhip in her courſe; but we cannot affirm it to be accurately in that proportion, for reaſons that will readily occur to one who conſiders the way in which the water falls in behind the ſhip.

53 Greateſt in a fine ſailer.

It is obſerved, however, that a fine ſailer always ſteers well, and that all movements by means of the rudder are performed with great rapidity when the velocity of the ſhip is great. We ſhall ſee by and by, that the ſpeed with which the ſhip performs the angular movements is in the proportion of her progreſſive velocity: For we ſhall ſee that the ſquares of the times of performing the evolution are as the impulſes inverſely, which are as the ſquares of the velocities. There is perhaps no force which acts on a ſhip that can be more accurately determined by experiment than this. Let the ſhip ride in a ſtream or tideway whoſe velocity is accurately meaſured; and let her ride from two moorings, ſo that her bow may be a fixed point. Let a ſmall tow-line be laid out from her ſtern or quarter at right angles to the keel, and connected with ſome apparatus fitted up on ſhore or on board another ſhip, by which the ſtrain on it may be accurately meaſured; a perſon converſant with mechanics will ſee many ways in which this can be done.

54 How to determine it.

Perhaps the following may be as good as any: Let the end of the tow-line be fixed to ſome point as high out of the water as the point of the ſhip from which it is given out, and let this be very high. Let a block with a hook be on the rope, and a conſiderable weight hung on this hook. Things being thus prepared, put down the helm to a certain angle, ſo as to cauſe the ſhip to ſheer off from the point to which the far end of the tow-line is attached. This will ſtretch the rope, and raiſe the weight out of the water. Now heave upon the rope, to bring the ſhip back again to her former poſition, with her keel in the direction of the ſtream. When this poſition is attained, note carefully the form of the rope, that is, the angle which its two parts make with the horizon. Call this angle a. Every perſon acquainted with theſe ſubjects knows that the horizontal ſtrain is equal to half the weight multiplied by the cotangent of a, or that 2 is to the cotangent of a as the weight to the horizontal ſtrain. Now it is this ſtrain which balances and therefore meaſures the action of the rudder, or De in fig. 11. Therefore, to have the abſolute impulſe Dd, we muſt increaſe De in the proportion of radius to the ſecant of the angle b which the rudder makes with the keel. In a great ſhip ſailing ſix miles in an hour, the impulſe on the rudder inclined 30° to the keel is not leſs than 3000 pounds. The ſurface of the rudder of ſuch a ſhip contains near 80 ſquare feet. It is not, however, very neceſſary to know this abſolute impulſe Dd, becauſe it is its part De alone which meaſures the energy of the rudder in producing a converſion. Such experiments, made with various poſitions of the rudder, will give its energies correſponding to theſe poſitions, and will ſettle that long diſputed point, which is the beſt poſition for turning a ſhip. On the hypotheſis that the impulſions of fluids are in the duplicate ratio of the ſines of incidence, there can be no doubt that it ſhould make an angle of 54° 44′ with the keel. But the form of a large ſhip will not admit of this, becauſe a tiller of a length ſufficient for managing the rudder in ſailing with great velocity has not room to deviate above 30° from the direction of the keel; and in this poſition of the rudder the mean obliquity of the filaments of water to its ſurface cannot exceed 40° or 45°. A greater angle would not be of much ſervice, for it is never for want of a proper obliquity that the rudder fails of producing a converſion.

55 Why a ſhip miſſes ſtays, &c.

A ſhip miſſes ſtays in rough weather for want of a ſufficient progreſſive velocity, and becauſe her bows are beat off by the waves: and there is ſeldom any difficulty in wearing the ſhip, if ſhe has any progreſſive motion. It is, however, always deſirable to give the rudder as much influence as poſſible. Its ſurface ſhould be enlarged (eſpecially below) as much as can be done conſiſtently with its ſtrength and with the power of the ſteerſmen to manage it; and it ſhould be put in the moſt favourable ſituation for the water to get at it with great velocity; and it ſhould be placed as far from the axis of the ſhip's motion as poſſible. Theſe points are obtained by making the ſtern-poſt very upright, as has always been done in the French dockyards. The Britiſh ſhips have a much greater rake; but our builders are gradually adopting the French forms, experience having taught us that their ſhips, when in our poſſeſſion, are much more obedient to the helm than our own.—In order to aſcertain the motion produced by the action of the rudder, draw from the centre of gravity a line G q perpendicular to D d (D d being drawn through the centre of effort of the rudder). Then, as in the conſideration of the action of the ſails, we may conceive the line q G as a lever connected with the ſhip, and impelled by a force D d acting perpendicularly at q. The conſequence of this will be, an incipient converſion of the ſhip about a vertical axis paſſing through ſome point S in the line q G, lying on the other ſide of G from q; and we have, as in the former caſe, $\mathrm{GS} = \frac{\int p \cdot r^2}{\mathrm{M} \cdot \mathrm{G}q}$.

56 The action of the rudder ſimilar to that of the ſails, and very great.

Thus the action and effects of the ſails and of the rudder are perfectly ſimilar, and are to be conſidered in the ſame manner. We ſee that the action of the rudder, though of a ſmall ſurface in compariſon of the ſails, muſt be very great: For the impulſe of water is many hundred times greater than that of the wind; and the arm q G of the lever, by which it acts, is incomparably greater than that by which any of the impulſions on the ſails produces its effect; accordingly the ſhip yields much more rapidly to its action than ſhe does to the lateral impulſe of a ſail.

Obſerve here, that if G were a fixed or ſupported axis, it would be the ſame thing whether the abſolute force D d of the rudder acts in the direction D d, or its tranſverſe part D e acts in the direction D e, both would produce the ſame rotation; but it is not ſo in a free body. The force D d both tends to retard the ſhip's motion and to produce a rotation: It retards it as much as if the ſame force D d had been immediately applied to the centre. And thus the real motion of the ſhip is compounded of a motion of the centre in a direction parallel to D d, and of a motion round the centre. Theſe two conſtitute the motion round S.

57 Employed as an example of the motions of converſion.

As the effects of the action of the rudder are both more remarkable and ſomewhat more ſimple than thoſe of the ſails, we ſhall employ them as an example of the mechaniſm of the motions of converſion in general; and as we muſt content ourſelves in a work like this with what is very general, we ſhall ſimpliſy the inveſtigation by attending only to the motion of converſion. We can get an accurate notion of the whole motion, if wanted for any purpoſe, by combining the progreſſive or retrograde motion parallel to D d with the motion of rotation which we are about to determine.

In this caſe, then, we obſerve, in the firſt place, that the angular velocity (ſee ROTATION, N° 22.) is $\frac{\mathrm{D}h \cdot q\mathrm{G}}{\int p\, r^2}$; and, as was ſhown in that article, this velocity of rotation increaſes in the proportion of the time of the forces uniform action, and the rotation would be uniformly accelerated if the forces did really act uniformly. This, however, cannot be the caſe, becauſe, by the ſhip's change of poſition and change of progreſſive velocity, the direction and intenſity of the impelling force is continually changing. But if two ſhips are performing ſimilar evolutions, it is obvious that the changes of force are ſimilar in ſimilar parts of the evolution. Therefore the conſideration of the momentary evolution is ſufficient for enabling us to compare the motions of ſhips actuated by ſimilar forces, which is all we have in view at preſent. The velocity v, generated in any time t by the continuance of an invariable momentary acceleration (which is all that we mean by ſaying that it is produced by the action of a conſtant accelerating force), is as the acceleration and the time jointly. Now what we call the *angular velocity* is nothing but this momentary acceleration. Therefore the velocity v generated in the time t is $= \frac{\mathrm{F} \cdot q\mathrm{G}}{\int p\, r^2}\, t$.

58 Angular velocity.

The expreſſion of the angular velocity is alſo the expreſſion of the velocity v of a point ſituated at the diſtance 1 from the axis G.

Let z be the ſpace or arch of revolution deſcribed in the time t by this point, whoſe diſtance from G is $= 1$. Then $\dot{z} = v\, \dot{t} = \frac{\mathrm{F} \cdot q\mathrm{G}}{\int p\, r^2}\, t\, \dot{t}$, and taking the fluent $z = \frac{\mathrm{F} \cdot q\mathrm{G}}{\int p\, r^2}\, t^2$. This arch meaſures the whole angle of rotation accompliſhed in the time t. Theſe are therefore as the ſquares of the times from the beginning of the rotation.

Thoſe evolutions are equal which are meaſured by equal arches. Thus two motions of 45 degrees each are equal. Therefore becauſe z is the ſame in both, the quantity $\frac{\mathrm{F} \cdot q\mathrm{G}}{\int p\, r}\, t^2$ is a conſtant quantity, and t^2 is reciprocally proportional to $\frac{\mathrm{F} \cdot q\mathrm{G}}{\int p\, r^2}$, or is proportional to $\frac{\int p\, r^2}{\mathrm{F} \cdot q\mathrm{G}}$, and t is proportional to $\frac{\sqrt{\int p\, r^2}}{\sqrt{\mathrm{F} \cdot q\mathrm{G}}}$. That is to ſay, the times of the ſimilar evolutions of two ſhips are as the ſquare root of the momentum of inertia directly, and as the ſquare root of the momentum of the rudder or ſail inverſely. This will enable us to make the compariſon eaſily. Let us ſuppoſe the ſhips perfectly ſimilar in form and rigging, and to differ only in length L and l; $\int \mathrm{P} \cdot \mathrm{R}^2$ is to $\int p\, r^2$ as L^5 to l^5. For the ſimilar particles P and p contain quantities of matter which are as the cubes of their lineal dimenſions, that is, as L^3 to l^3. And becauſe the particles are ſimilarly ſituated, R^2 is to r^2 as L^2 to l^2. Therefore $\mathrm{P} \cdot \mathrm{R}^2 : p \cdot r^2 = \mathrm{L}^5 : l^5$. Now F is to f as L^2 to l^2. For the ſurfaces of the ſimilar rudders or ſails are as the ſquares of their lineal dimenſions, that is, as L^2 to l^2. And, laſtly, G q is to $g\, q$ as L to l, and therefore $\mathrm{F} \cdot \mathrm{G}\, q : f \cdot g\, q = \mathrm{L}^3 : l^3$. Therefore we have $\mathrm{T}^2 : t^2 = \frac{\int \mathrm{P} \cdot \mathrm{R}^2}{\mathrm{F} \cdot \mathrm{G}\, q} : \frac{\int p \cdot r^2}{f \cdot g\, q} = \frac{\mathrm{L}^5}{\mathrm{L}^3}\ \frac{l^5}{l^3} = \mathrm{L}^2 : l^2$, and $\mathrm{T} : t = \mathrm{L} : l$.

59 Times of ſimilar evolutions with ſimilar ſhips.

Therefore the times of performing ſimilar evolutions with ſimilar ſhips are proportional to the lengths of the ſhips when both are ſailing equally faſt; and ſince the evolutions are ſimilar, and the forces vary ſimilarly in their

their different parts, what is here demonſtrated of the ſmalleſt incipient evolutions is true of the whole. They therefore not only deſcribe equal angles of revolution, but alſo ſimilar curves.

A ſmall ſhip, therefore, works in leſs time and in leſs room than a great ſhip, and this in the proportion of its length. This is a great advantage in all caſes, particularly in wearing, in order to ſail on the other tack cloſe-hauled. In this caſe ſhe will always be to windward and a-head of the large ſhip, when both are got on the other tack. It would appear at firſt ſight that the large ſhip will have the advantage in tacking. Indeed the large ſhip is farther to windward when again trimmed on the other tack than the ſmall ſhip when ſhe is juſt trimmed on the other tack. But this happened before the large ſhip had completed her evolution, and the ſmall ſhip, in the mean time, has been going forward on the other tack, and going to windward. She will therefore be before the large ſhip's beam, and perhaps as far to windward.

We have ſeen that the velocity of rotation is proportional, *cæteris paribus*, to $F \times G q$. F means the abſolute impulſe on the rudder or ſail, and is always perpendicular to its ſurface. This abſolute impulſe on a ſail depends on the obliquity of the wind to its ſurface. The uſual theory ſays, that it is as the ſquare of the ſine of incidence: but we find this not true. We muſt content ourſelves with expreſſing it by ſome as yet unknown function φ of the angle of incidence a, and call it φa; and if S be the ſurface of the ſail, and V the velocity of the wind, the abſolute impulſe is $n V^2 S \times \varphi a$. This acts (in the caſe of the mizen-topſail, (fig. 10.) by the lever $q G$, which is equal to $DG \times \text{coſ.}\, DG q$, and $DG q$ is equal to the angle of the yard and keel; which angle we formerly called b. Therefore its energy in producing a rotation is $n V^2 S \times \varphi a \times DG \times \text{coſ.}\, b$. Leaving out the conſtant quantities n, V^2, S, and DG, its energy is proportional to $\varphi a \times \text{coſ.}\, b$. In order, therefore, that any ſail may have the greateſt power to produce a rotation round G, it muſt be ſo trimmed that $\varphi a \times \text{coſ.}\, b$ may be a maximum. Thus, if we would trim the ſails on the foremaſt, ſo as to pay the ſhip off from the wind right a-head with the greateſt effect, and if we take the experiments of the French academicians as proper meaſures of the oblique impulſes of the wind on the ſail, we will brace up the yard to an angle of 48 degrees with the keel. The impulſe correſponding to 48 is 615, and the coſine of 48° is 669. Theſe give a product of 411435. If we brace the ſail to 54.44, the angle aſſigned by the theory, the effective impulſe is 405274. If we make the angle 45°, the impulſe is 408774. It appears then that 48° is preferable to either of the others. But the difference is inconſiderable, as in all caſes of maximum a ſmall deviation from the beſt poſition is not very detrimental. But the difference between the theory and this experimental meaſure will be very great when the impulſes of the wind are of neceſſity very oblique. Thus, in tacking ſhip, as ſoon as the headſails are taken aback, they ſerve to aid the evolution, as is evident: But if we were now to adopt the maxim inculcated by the theory, we ſhould immediately round in the weather-braces, ſo as to increaſe the impulſe on the ſail, becauſe it is then very ſmall; and although we by this means make yard more ſquare, and therefore diminiſh the rotatory momentum of this impulſe, yet the impulſe is more increaſed (by the theory) than its vertical lever is diminiſhed.—

60 A nice point of ſeamanſhip.

Let us examine this a little more particularly, becauſe it is reckoned one of the niceſt points of ſeamanſhip to aid the ſhip's coming round by means of the headſails; and experienced ſeamen differ in their practice in this manœuvre. Suppoſe the yard braced up to 40°, which is as much as can be uſually done, and that the ſail ſhivers (the bowlines are uſually let go when the helm is put down), the ſail immediately takes aback, and in a moment we may ſuppoſe an incidence of 6 degrees. The impulſe correſponding to this is 400 (by experiment), and the coſine of 40° is 766. This gives 306400 for the effective impulſe. To proceed according to the theory, we ſhould brace the yard to 70°, which would give the wind (now 34° on the weather-bow) an incidence of nearly 36°, and the ſail an inclination of 20° to the intended motion, which is perpendicular to the keel. For the tangent of 20° is about $\frac{1}{2}$ of the tangent of 36°. Let us now ſee what effective impulſe the experimental law of oblique impulſions will give for this adjuſtment of the ſails. The experimental impulſe for 36° is 480; the coſine of 70° is 342; the product is 164160, not much exceeding the half of the former. Nay, the impulſe for 36°, calculated by the theory, would have been only 346, and the effective impulſe only 118332. And it muſt be farther obſerved, that this theoretical adjuſtment would tend greatly to check the evolution, and in moſt caſes would entirely mar it, by checking the ſhip's motion a-head, and conſequently the action of the rudder, which is the moſt powerful agent in the evolution; for here would be a great impulſe directed almoſt aftern.

We were juſtifiable, therefore, in ſaying, in the beginning of this article, that a ſeaman would frequently find himſelf baffled if he were to work a ſhip according to the rules deduced from M. Bouguer's work; and we ſee by this inſtance of what importance it is to have the oblique impulſions of fluids aſcertained experimentally. The practice of the moſt experienced ſeaman is directly the oppoſite to this theoretical maxim, and its ſucceſs greatly confirms the uſefulneſs of theſe experiments of the academicians ſo often praiſed by us.

We return again to the general conſideration of the rotatory motion. We found the velocity $v = \frac{F \cdot q G}{\int p r^2}$. It is therefore proportional, *cæteris paribus*, to q^{G}. We have ſeen in what manner q G depends on the poſition and ſituation of the ſail or rudder when the point G is fixed. But it alſo depends on the poſition of G. With reſpect to the action of the rudder, it is evident that it is ſo much the more powerful as it is more remote from G. The diſtance from G may be increaſed either by moving the rudder farther aft or G farther forward. And as it is of the utmoſt importance that a ſhip anſwer her helm with the greateſt promptitude, thoſe circumſtances have been attended to which diſtinguiſhed fine ſteering ſhips from ſuch as had not this quality; and it is in a great meaſure to be aſcribed to this, that, in the gradual improvement of naval architecture, the centre of gravity has been placed far forward. Perhaps the notion of a centre of gravity did not come into the thoughts of the rude builders in early times; but they obſerved that thoſe boats and ſhips ſteered beſt which had their extreme breadth before the middle point, and conſequently the bows not ſo acute as the ſtern. This is ſo contrary to what one would expect, that it attracted attention more forcibly; and, being ſomewhat myſterious, it might prompt to attempts of improvement, by exceeding in this ſingular maxim. We believe that it has been carried as far as is compatible with other eſſential requiſites in a ſhip.

61 Of importance to determine the beſt place for a ſhip's centre of gravity.

We believe that this is the chief circumſtance in what is called the trim of a ſhip; and it were greatly to be wiſhed that the beſt place for the centre of gravity could be accurately aſcertained. A practice prevails, which is the oppoſite of what we are now advancing. It is uſual to load a ſhip ſo that her keel is not horizontal, but lower abaft. This is found to improve her ſteerage. The reaſon of this is obvious. It increaſes the acting ſurface of the rudder, and allows the water to come at it with much greater freedom and regularity; and it generally diminiſhes the griping of the ſhip forward, by removing a part of the bows out of the water. It has not always this effect; for the form of the harping aloft is frequently ſuch, that the tendency to gripe is diminiſhed by immerſing more of the bow in the water.

But waving theſe circumſtances, and attending only to the rotatory energy of the rudder, we ſee that it is of advantage to carry the centre of gravity forward. The ſame advantage is gained to the action of the after ſails. But, on the other hand, the action of the headſails is diminiſhed by it; and we may call every ſail a headſail whoſe centre of gravity is before the centre of gravity of the ſhip; that is, all the ſails hoiſted on the bowſprit and foremaſt, and the ſtayſails hoiſted on the mainmaſt; for the centre of gravity is ſeldom far before the mainmaſt.

Suppoſe that when the rudder is put into the poſition AD (fig. 11.), the centre of gravity could be ſhifted to g, ſo as to increaſe q G, and that this is done without increaſing the ſum of the products $p\,r^2$. It is obvious that the velocity of converſion will be increaſed in the proportion of q G to qg. This is very poſſible, by bringing to that ſide of the ſhip parts of her loading which were ſituated at a diſtance from G on the other ſide. Nay, we can make this change in ſuch a manner that $\int p\,r^2$ ſhall even be leſs than it was before, by taking care that every thing which we ſhift ſhall be nearer to g than it was formerly to G. Suppoſe it all placed in one ſpot m, and that m is the quantity of matter ſo ſhifted, while M is the quantity of matter in the whole ſhip. It is only neceſſary that $m \cdot g\,\mathrm{G}^2$ ſhall be leſs than the ſum of the products $p\,r^2$ correſponding to the matter which has been ſhifted. Now, although the matter which is eaſily moveable is generally very ſmall in compariſon to the whole matter of the ſhip, and therefore can make but a ſmall change in the place of the centre of gravity, it may frequently be brought from places ſo remote that it may occaſion a very ſenſible diminution of the quantity $\int p\,r^2$, which expreſſes the whole momentum of inertia.

62 A practice of ſeamen in putting about explained.

This explains a practice of the ſeamen in ſmall wherries or ſkiffs, who in putting about are accuſtomed to place themſelves to leeward of the maſt. They even find that they can aid the quick motions of theſe light boats by the way in which they reſt on their two feet, ſometimes leaning all on one foot, and ſometimes on the other. And we have often ſeen this evolution very ſenſibly accelerated in a ſhip of war, by the crew running ſuddenly, as the helm is put down, to the lee-bow. And we have heard it aſſerted by very expert ſeamen, that after all attempts to wear ſhip (after lying-to in a ſtorm) have failed, they have ſucceeded by the crew collecting themſelves near the weather fore-ſhrouds the moment the helm was put down. It muſt be agreeable to the reflecting ſeaman to ſee this practice ſupported by undoubted mechanical principles.

63 The evolution accelerated by additional matter.

It will appear paradoxical to ſay that the evolution may be accelerated even by an addition of matter to the ſhip; and though it is only a piece of curioſity, our readers may wiſh to be made ſenſible of it. Let m be the addition, placed in ſome point m lying beyond G from q. Let S be the ſpontaneous centre of converſion before the addition. Let v be the velocity of rotation round g, that is, the velocity of a point whoſe diſtance from g is 1, and let ϱ be the radius vector, or diſtance of a particle from g. We have (ROTATION, N°22.) $v = \frac{\mathrm{F} \cdot qg}{\int p\,\varrho^2 + m \cdot mg^2}$. But we know (ROTATION, N° 23.) that $\int p\,\varrho^2 = \int p\,r^2 + \mathrm{M} \cdot \mathrm{G}\,g^2$. Therefore $v = \frac{\mathrm{F} \cdot qg}{\int p\,r^2 + \mathrm{M} \cdot \mathrm{G}\,g^2 + m \cdot m\,g^2}$. Let us determine G g and $m\,g$ and $q\,g$.

Let m G be called z. Then, by the nature of the centre of gravity, $\mathrm{M}+m : \mathrm{M} = \mathrm{G}\,m : g\,m = z : g\,m$, and $g\,m = \frac{\mathrm{M}}{\mathrm{M}+m} z$, and $m \cdot g\,m^2 = \frac{m\,\mathrm{M}^2}{\overline{\mathrm{M}+m}^2} z^2$. In like manner, $\mathrm{M} \cdot \mathrm{G}\,g^2 = \frac{\mathrm{M}\,m^2}{\overline{\mathrm{M}+m}^2} z^2$. Now $m\,\mathrm{M}^2 + \mathrm{M}\,m^2 = \mathrm{M}\,m \times \overline{\mathrm{M}+m}$. Therefore $\mathrm{M} \cdot \mathrm{G}\,g^2 + m \cdot g\,m^2 = \frac{\mathrm{M}\,m \times (\mathrm{M}+m)}{\overline{\mathrm{M}+m}^2} z^2, = \frac{\mathrm{M}\,m}{\mathrm{M}+m} z^2$. Let n be $= \frac{m}{\mathrm{M}+m}$, then $\mathrm{M} \cdot \mathrm{G}^2 + m \cdot g\,m^2 = \mathrm{M}\,n\,z^2$. Alſo G $g = n\,z$, being $= \frac{m}{\mathrm{M}+n} z$. Let q G be called c: then $q\,g = c + n\,z$. Alſo let SG be called e.

We have now for the expreſſion of the velocity $v = \frac{\mathrm{F}(c+n\,z)}{\int p\,r^2 + \mathrm{M}\,n\,z^2}$, or $v = \frac{\mathrm{F}}{\mathrm{M}} \times \frac{c+n\,z}{\frac{\int p\,r^2}{\mathrm{M}} + n\,z^2}$. But (ROTATION, N° 30) $\frac{\int p\,r^2}{\mathrm{M}} = ce$. Therefore, finally, $v = \frac{\mathrm{F}}{\mathrm{M}} \times \frac{c+n\,z}{ce+nz^2}$. Had there been no addition of matter made, we ſhould have had $v = \frac{\mathrm{F}}{\mathrm{M}} \times \frac{c}{c\,e}$. It remains to ſhow, that z may be ſo taken that $\frac{c}{c\,e}$ may be leſs than $\frac{c+n\,z}{ce+nz^2}$. Now, if c be to z as $c\,e$ to z^2, that is, if z be be taken equal to e, the two fractions will be equal. But if z be leſs than e, that is, if the additional matter is placed anywhere between S and G, the complex fraction will be greater than the fraction $\frac{c}{c\,e}$, and the velocity of rotation will be increaſed. There is a particular diſtance which will make it the greateſt poſſible, namely, when z is made $= \frac{1}{n}(\sqrt{c^2+n\,c\,e}-c)$, as will eaſily be found by treating the fraction $\frac{c+n\,z}{ce+n\,z^2}$, with z, conſidered as the variable quantity, for a maximum. In what we have been ſaying on this ſubject, we have conſidered the rotation only in as much as it is performed round the centre of gravity, although in every moment it is really performed round a ſpontaneous axis lying beyond that centre. This was done becauſe it afforded an eaſy inveſtigation, and any angular motion round the centre of gravity is equal to the angular motion round any other point. Therefore the extent and the time of the evolution are accurately defined.—From obſerving that the energy of the force F is proportional to qG, an inattentive reader will be apt to conceive the centre of gravity as the centre of motion, and the rotation as taking place, becauſe the momenta of the ſails and rudder, on the oppoſite ſides of the centre of gravity, do not balance each other. But we muſt always keep in mind that this is not the cauſe of the rotation. The cauſe is the want of equilibrium round the point C (fig. 10.), where the actions of the water balance each other. During the evolution, which conſiſts of a rotation combined with a progreſſive motion, this point C is continually ſhifting, and the unbalanced momenta which continue the rotation always reſpect the momentary ſituation of the point C. It is nevertheleſs always true that the energy of a force F is proportional (*cæteris paribus*) to qG, and the rotation is always made in the ſame direction as if the point G were really the centre of converſion. Therefore the mainſail acts always (when oblique) by puſhing the ſtern away from the wind, although it ſhould ſometimes act on a point of the vertical lever through C, which is a-head of C.

64 The rotation performed round a ſpontaneous axis.

Theſe obſervations on the effects of the ſails and rudder in producing a converſion, are ſufficient for enabling us to explain any caſe of their action which may occur. We have not conſidered the effects which they tend to produce by inclining the ſhip round a horizontal axis, viz. the motions of rolling and pitching. See Rolling and Pitching. To treat this ſubject properly would lead us into the whole doctrine of the equilibrium of floating bodies, and it would rather lead to maxims of conſtruction than to maxims of manœuvre. M. Bouguer's *Traité du Navire*, and Euler's *Scientia Navalis* are excellent performances on this ſubject, and we are not here obliged to have recourſe to any erroneous theory.

65 Different operations of the water on the ſhip and wind on the ſails balance each other.

It is eaſy to ſee that the lateral preſſure both of the wind on the ſails and of the water on the rudder tends to incline the ſhip to one ſide. The ſails alſo tend to preſs the ſhip's bows into the water, and, if ſhe were kept from advancing, would preſs them down conſiderably. But by the ſhip's motion, and the prominent form of her bows, the reſiſtance of the water to the fore part of the ſhip produces a force which is directed upwards. The ſails alſo have a ſmall tendency to raiſe the ſhip, for they conſtitute a ſurface which in general ſeparates from the plumb-line below. This is remarkably the caſe in the ſtayſails, particularly the jib and fore-topmaſt ſtayſail. And this helps greatly to ſoften the plunges of the ſhip's bows into the head ſeas. The upward preſſure alſo of the water on her bows, which we juſt now mentioned, has a great effect in oppoſing the immerſion of the bows which the ſails produce by acting on the long levers furniſhed by the maſts. M. Bouguer gives the name of *point velique* to the point V (fig. 12.) of the maſt, where it is cut by the line CV, which marks the mean place and direction of the whole impulſe of the water on the bows. And he obſerves, that if the mean direction of all the actions of the wind on the ſails be made to paſs alſo through this point, there will be a perfect equilibrium, and the ſhip will have no tendency to plunge into the water or to riſe out of it; for the whole action of the water on the bows, in the direction CV, is equivalent to, and may be reſolved into the action CE, by which the progreſſive motion is reſiſted, and the vertical action CD, by which the ſhip is raiſed above the water. The force CE muſt be oppoſed by an equal force VD, exerted by the wind on the ſails, and the force CD is oppoſed by the weight of the ſhip. If the mean effort of the ſails paſſes above the point V, the ſhip's bow will be preſſed into the water; and if it paſs below V, her ſtern will be preſſed down. But, by the union of theſe forces, ſhe will riſe and fall with the ſea, keeping always in a parallel poſition. We apprehend that it is of very little moment to attend to the ſituation of this point. Except when the ſhip is right afore the wind, it is a thouſand chances to one that the line CV of mean reſiſtance does not paſs through any maſt; and the fact is, that the ſhip cannot be in a ſtate of uniform motion on any other condition but the perfect union of the line of mean action of the ſails, and the line of mean action of the reſiſtance. But its place ſhifts by every change of leeway or of trim; and it is impoſſible to keep theſe lines in one conſtant point of interſection for a moment, on account of the inceſſant changes of the ſurface of the water on which ſhe floats. M. Bouguer's obſervations on this point are, however, very ingenious and original.

Fig. 12.

66 Chief evolutions deſcribed.

We conclude this diſſertation, by deſcribing ſome of the chief movements or evolutions. What we have ſaid hitherto is intended for the inſtruction of the artiſt, by making him ſenſible of the mechanical procedure. The deſcription is rather meant for the amuſement of the landſman, enabling him to underſtand operations that are familiar to the ſeaman. The latter will perhaps ſmile at the awkward account given of his buſineſs by one who cannot hand, reef, or ſteer.

To tack Ship.

The ſhip muſt firſt be kept full, that is, with a very ſenſible angle of incidence on the ſails, and by no means hugging the wind. For as this evolution is chiefly performed by the rudder, it is neceſſary to give the ſhip a good velocity. When the ſhip is obſerved to luff up of herſelf, that moment is to be catched for beginning the evolution, becauſe ſhe will by her inherent force continue this motion. The helm is then put down. When the officer calls out Helm's a-lee, the fore-ſheet, fore-top bowline, jib, and ſtay ſail ſheets forward

ward are let go. The jib is frequently hauled down. Thus the obſtacles to the ſhip's head coming up to the wind by the action of the rudder are removed. If the mainſail is ſet, it is not unuſual to clue up the weather ſide, which may be conſidered as a headſail, becauſe it is before the centre of gravity. The mizen muſt be hauled out, and even the ſail braced to windward. Its power in paying off the ſtern from the wind conſpires with the action of the rudder. It is really an aerial rudder. The ſails are immediately taken aback. In this ſtate the effect of the mizen-topſail would be to obſtruct the movement, by preſſing the ſtern the contrary way to what it did before. It is therefore either immediately braced about ſharp on the other tack, or lowered. Bracing it about evidently tends to pay round the ſtern from the wind, and thus aſſiſt in bringing the head up to the wind. But in this poſition it checks the progreſſive motion of the ſhip, on which the evolution chiefly depends. For a rapid evolution, therefore, it is as well to lower the mizen-topſail. Meantime, the headſails are all aback, and the action of the wind on them tends greatly to pay the ſhip round. To increaſe this effect, it is not unuſual to haul the fore-top bowline again. The ſails on the mainmaſt are now almoſt becalmed; and therefore when the wind is right ahead, or a little before, the mainſail is hauled round and braced up ſharp on the other tack with all expedition. The ſtayſail ſheets are now ſhifted over to their places for the other tack. The ſhip is now entirely under the power of the headſails and of the rudder, and their actions conſpire to promote the converſion. The ſhip has acquired an angular motion, and will preſerve it, ſo that now the evolution is ſecured, and ſhe falls off apace from the wind on the other tack. The farther action of the rudder is therefore unneceſſary, and would even be prejudicial, by cauſing the ſhip to fall off too much from the wind before the ſails can be ſhifted and trimmed for ſailing on the other tack. It is therefore proper to right the helm when the wind is right ahead, that is, to bring the rudder into the direction of the keel. The ſhip continues her converſion by her inherent force and the action of the headſails.

When the ſhip has fallen off about four points from the wind, the headſails are hauled round and trimmed ſharp on the other tack with all expedition; and although this operation was begun with the wind four points on the bow, it will be ſix before the ſails are braced up, and therefore the headſails will immediately fill. The after-ſails have filled already, while the headſails were inactive, and therefore immediately check the farther falling off from the wind. All ſails now draw, for the ſtayſail ſheets have been ſhifted over while they were becalmed or ſhaking in the wind. The ſhip now gathers way, and will obey the ſmalleſt motion of the helm to bring her cloſe to the wind.

Fig. 13.

We have here ſuppoſed, that during all this operation the ſhip preſerves her progreſſive motion. She muſt therefore have deſcribed a curve line, advancing all the while to windward. Fig. 13. is a repreſentation of this evolution when it is performed in the completeſt manner. The ſhip ſtanding on the courſe E *a*, with the wind blowing in the direction WF, has her helm put hard a-lee when ſhe is in the poſition A. She immediately deviates from her courſe, and deſcribing a curve, comes to the poſition B, with the wind blowing in the direction WF of the yards, and the ſquare-ſails now ſhiver. The mizen topſail is here repreſented braced ſharp on the other tack, by which its tendency to aid the angular motion (while it checks the progreſſive motion) is diſtinctly ſeen. The main and foreſails are now ſhivering, and immediately after are taken aback. The effect of this on the headſails is diſtinctly ſeen to be favourable to the converſion, by puſhing the point F in the direction F *i*; but for the ſame reaſon it continues to retard the progreſſive motion. When the ſhip has attained to the poſition C, the mainſail is hauled round and trimmed for the other tack. The impulſe in the direction F *i* ſtill aids the converſion and retards the progreſſive motion. When the ſhip has attained a poſition between C and D, ſuch that the main and mizen topſail yards are in the direction of the wind, there is nothing to counteract the force of the headſails to pay the ſhip's head off from the wind. Nay, during the progreſs of the ſhip to this intermediate poſition, if any wind gets at the main or mizen topſails, it acts on their anterior ſurfaces, and impels the after parts of the ſhip away from the curve *a b c d*, and thus aids the revolution. We have therefore ſaid, that when once the ſails are taken fully aback, and particularly when the wind is brought right ahead, it is ſcarce poſſible for the evolution to fail; as ſoon therefore as the main topſail (trimmed for the other tack) ſhivers, we are certain that the headſails will be filled by the time they are hauled round and trimmed. The ſtayſails are filled before this, becauſe their ſheets have been ſhifted, and they ſtand much ſharper than the ſquare-ſails; and thus every thing tends to check the falling off from the wind on the other tack, and this no ſooner than it ſhould be done. The ſhip immediately gathers way, and holds on in her new courſe *d* G.

But it frequently happens, that in this converſion the ſhip loſes her whole progreſſive motion. This ſometimes happens while the ſails are ſhivering before they are taken fully aback. It is evident, that in this caſe there is little hopes of ſucceſs, for the ſhip now lies like a log, and neither ſails nor rudder have any action. The ſhip drives to leeward like a log, and the water acting on the lee ſide of the rudder checks a little the driving of the ſtern. The head therefore falls off again, and by and by the ſails fill, and the ſhip continues on her former tack. This is called MISSING STAYS, and it is generally owing to the ſhip's having too little velocity at the beginning of the evolution. Hence the propriety of keeping the ſails well filled for ſome little time before. Rough weather, too, by raiſing a wave which beats violently on the weather-bow, frequently checks the firſt luffing of the ſhip, and beats her off again.

If the ſhip loſe all her motion after the headſails have been fully taken aback, and before we have brought the wind right ahead, the evolution becomes uncertain, but by no means deſperate; for the action of the wind on the headſails will preſently give her ſtern-way. Suppoſe this to happen when the ſhip is in the poſition C. Bring the helm over hard to windward, ſo that the rudder ſhall have the poſition repreſented by the ſmall dotted line *o f*. It is evident, that the reſiſtance of the water to the ſtern-way of the rudder acts in a favourable direction, puſhing the ſtern outwards. In the mean time, the action of the wind on the headſails puſhes the head in the oppoſite direction. Theſe actions

tions conſpire therefore in promoting the evolution; and if the wind is right ahead, it cannot fail, but may even be completed ſpeedily, becauſe the ſhip gathers ſternway, and the action of the rudder becomes very powerful; and as ſoon as the wind comes on the formerly lee-bow, the action of the water on the now lee-quarter will greatly accelerate the converſion. When the wind therefore has once been brought nearly right ahead, there is no riſk of being baffled.

But ſhould the ſhip have loſt all her headway conſiderably before this, the evolution is very uncertain: for the action of the water on the rudder may not be nearly equal to its contrary action on the lee-quarter; in which caſe, the action of the wind on the headſails may not be ſufficient to make up the difference. When this is obſerved, when the ſhip goes aftern without changing her poſition, we muſt immediately throw the headſails completely aback, and put the helm down again, which will pay off the ſhip's head from the wind enough to enable us to fill the ſails again on the ſame tack, to try our fortune again; or we muſt BOXHAUL the ſhip, in the manner to be deſcribed by and by.

Such is the ordinary proceſs of tacking ſhip; a proceſs in which all the different modes of action of the rudder and ſails are employed. To execute this evolution in the moſt expeditious manner, and ſo as to gain as much on the wind as poſſible, is conſidered as the teſt of an expert ſeaman. We have deſcribed the proceſs which is beſt calculated for *enſuring* the movement. But if the ſhip be ſailing very briſkly in ſmooth water, ſo that there is no danger of miſſing ſtays, we may gain more to windward conſiderably by keeping faſt the fore-top bowline and the jib and ſtay-ſail ſheets till the ſquare-ſails are all ſhivering: For theſe ſails, continuing to draw with conſiderable force, and balancing each other tolerably fore and aft, keep up the ſhip's velocity very much, and thus maintain the power of the rudder. If we now let all fly when the ſquare ſails are ſhivering, the ſhip may be conſidered as without ſails, but expoſed to the action of the water on the lee bow; from which ariſes a ſtrong preſſure of the bow to windward, which conſpires with the action of the rudder to aid the converſion. It evidently leaves all that tendency of the bow to windward which ariſes from leeway, and even what was counteracted by the formerly unbalanced action of theſe head-ſtayſails. This method lengthens the whole time of the evolution, but it advances the ſhip to windward. Obſerve, too, that keeping faſt the fore-top bowline till the ſail ſhivers, and then letting it go, inſures the taking aback of that ſail, and thus inſtantly produces an action that is favourable to the evolution.

The moſt expert ſeamen, however, differ among themſelves with reſpect to theſe two methods, and the firſt is the moſt generally practiſed in the Britiſh navy, becauſe the leaſt liable to fail. The forces which oppoſe the converſion are ſooner removed, and the production of a favourable action by the backing of the fore-top-ſail is alſo ſooner obtained, by letting go the fore-top bowline at the firſt.

Having entered ſo minutely into the deſcription and rationale of this evolution, we have ſufficiently turned the reader's attention to the different actions which co-operate in producing the motions of converſion. We ſhall therefore be very brief in our deſcription of the other evolutions.

To wear Ship.

WHEN the ſeaman ſees that his ſhip will not go about head to wind, but will miſs ſtays, he muſt change his tack the other way; that is, by turning her head away from the wind, going a little way before the wind, and then hauling the wind on the other tack. This is called WEARING or VEERING ſhip. It is moſt neceſſary in ſtormy weather with little ſail, or in very faint breezes, or in a diſabled ſhip.

The proceſs is exceedingly ſimple; and the mere narration of the procedure is ſufficient for ſhowing the propriety of every part of it.

Watch for the moment of the ſhip's falling off, and then haul up the mainſail and mizen, and ſhiver the mizen topſail, and put the helm a-weather. When the ſhip falls off ſenſibly (and not before), let go the bowlines. Eaſe away the fore-ſheet, raiſe the fore-tack, and gather aft the weather fore-ſheet, as the lee-ſheet is eaſed away. Round in the weather-braces of the fore and main-maſts, and keep the yards nearly biſecting the angle of the wind and keel, ſo that when the ſhip is before the wind the yards may be ſquare. It may even be of advantage to round in the weather-braces of the main-topſail more than thoſe of the head-ſails; for the mainmaſt is abaft the centre of gravity. All this while the mizen-topſail muſt be kept ſhivering, by rounding in the weather-braces as the ſhip pays off from the wind. Then the main top-ſail will be braced up for the other tack by the time that we have brought the wind on the weather-quarter. After this it will be full, and will aid the evolution. When the wind is right aft, ſhift the jib and ſtay-ſail ſheets. The evolution now goes on with great rapidity; therefore briſkly haul on board the fore and main tacks, and haul out the mizen, and ſet the mizen-ſtayſail as ſoon as they will take the wind the right way. We muſt now check the great rapidity with which the ſhip comes to the wind on the other tack, by righting the helm before we bring the wind on the beam; and all muſt be trimmed ſharp fore and aft by this time, that the headſails may take and check the coming to. All being trimmed, ſtand on cloſe by the wind.

We cannot help loſing much ground in this movement. Therefore, though it be very ſimple, it requires much attention and rapid execution to do it with as little loſs of ground as poſſible. One is apt to imagine at firſt that it would be better to keep the headſails braced up on the former tack, or at leaſt not to round in the weather-braces ſo much as is here directed. When the ſhip is right afore the wind, we ſhould expect aſſiſtance from the obliquity of the head-ſails; but the rudder being the principal agent in the evolution, it is found that more is gained by increaſing the ſhip's velocity than by a ſmaller impulſe in the headſails more favourably directed. Experienced ſeamen differ, however, in their practice in reſpect of this particular.

To boxhaul a Ship.

THIS is a proceſs performed only in critical ſituations, as when a rock, a ſhip, or ſome danger, is ſuddenly ſeen right ahead, or when a ſhip miſſes ſtays. It requires the moſt rapid execution.

The ſhip being cloſe-hauled on a wind, haul up the mainſail

mainſail and mizen, and ſhiver the topſails, and put the helm hard a-lee altogether. Raiſe the fore-tack, let go the head bowlines, and brace about the headſails ſharp on the other tack. The ſhip will quickly loſe her way, get ſtern-way, and then fall off, by the joint action of the headſails and of the inverted rudder. When ſhe has fallen off eight points, brace the after-ſails ſquare, which have hitherto been kept ſhivering. This will at firſt increaſe the power of the rudder, by increaſing the ſtern way, and at the ſame time it makes no oppoſition to the converſion which is going on. The continuation of her circular motion will preſently cauſe them to take the wind on their after ſurfaces. This will check the ſtern-way, ſtop it, and give the ſhip a little head-way. Now ſhift the helm, ſo that the rudder may again act in conjunction with the headſails in paying her off from the wind. This is the critical part of the evolution, becauſe the ſhip has little or no way through the water, and will frequently remain long in this poſition. But as there are no counteracting forces, the ſhip continues to fall off. Then the weather-braces of the after-ſails may be gently rounded in, ſo that the wind acting on their hinder ſurfaces may both puſh the ſhip a little a-head and her ſtern laterally in conjunction with the rudder. Thus the wind is brought upon the quarter, and the headſails ſhiver. By this time the ſhip has acquired ſome headway. A continuation of the rotation would now fill the headſails, and their action would be contrary to the intended evolution. They are therefore immediately braced the other way, nearly ſquare, and the evolution is now completed in the ſame manner with wearing ſhip.

Some ſeamen brace all the ſails aback the moment that the helm is put hard a-lee, but the after-ſails no more aback than juſt to ſquare the yards. This quickly gives the ſhip ſtern-way, and brings the rudder into action in its inverted direction; and they think that the evolution is accelerated by this method.

There is another problem of ſeamanſhip deſerving of our attention, which cannot properly be called an evolution. This is lying-to. This is done in general by laying ſome ſails aback, ſo as to ſtop the head-way produced by others. But there is a conſiderable addreſs neceſſary for doing this in ſuch a way that the ſhip ſhall lie eaſily, and under command, ready to proceed in her courſe, and eaſily brought under weigh.

To bring-to with the fore or main-topſail to the maſt, brace that ſail ſharp aback, haul out the mizen, and clap the helm hard a-lee.

Suppoſe the fore-topſail to be aback; the other ſails ſhoot the ſhip ahead, and the lee-helm makes the ſhip come up to the wind, which makes it come more perpendicularly on the ſail which is aback. Then its impulſe ſoon exceeds thoſe on the other ſails, which are now ſhivering, or almoſt ſhivering. The ſhip ſtands ſtill awhile, and then falls off, ſo as to fill the after-ſails, which again ſhoot her ahead, and the proceſs is thus repeated. A ſhip lying-to in this way goes a good deal ahead and alſo to leeward. If the main-topſail be aback, the ſhip ſhoots ahead, and comes up till the diminiſhed impulſe of the drawing ſails in the direction of the keel is balanced by the increaſed impulſe on the main-topſail. She lies a long while in this poſition, driving ſlowly to leeward; and ſhe at laſt falls off by the beating of the water on her weather-bow. She falls off but little, and ſoon comes up again.

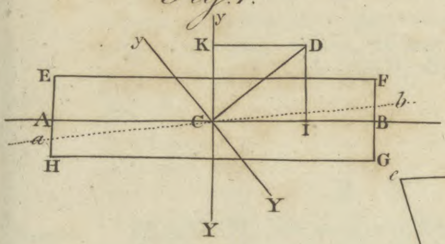
Thus a ſhip lying to is not like a mere log, but has a certain motion which keeps her under command. To get under weigh again, we muſt watch the time of falling off; and when this is juſt about to finiſh, brace about briſkly, and fill the ſail which was aback. To aid this operation, the jib and fore top maſt ſtay-ſail may be hoiſted, and the mizen brailed up: or, when the intended courſe is before the wind or large, back the fore-topſail ſharp, ſhiver the main and mizen topſail, brail up the mizen, and hoiſt the jib and fore-topmaſt ſtay-ſails altogether.

In a ſtorm with a contrary wind, or on a lee ſhore, a ſhip is obliged to lie-to under a very low ſail. Some ſail is abſolutely neceſſary, in order to keep the ſhip ſteadily down, otherwiſe ſhe would kick about like a cork, and roll ſo deep as to ſtrain and work herſelf to pieces. Different ſhips behave beſt under different ſails. In a very violent gale, the three lower ſtay-ſails are in general well adapted for keeping her ſteady, and diſtributing the ſtrain. This mode ſeems alſo well adapted for wearing, which may be done by hauling down the mizen-ſtayſail. Under whatever ſail the ſhip is brought-to in a ſtorm, it is always with a fitted ſail, and never with one laid aback. The helm is laſhed down hard a-lee; therefore the ſhip ſhoots ahead, and comes up till the ſea on her weather bow-beats her off again. Getting under weigh is generally difficult; becauſe the ſhip and rigging are lofty abaft, and hinder her from falling off readily when the helm is put hard a-weather. We muſt watch the falling off, and aſſiſt the ſhip by ſome ſmall headſail. Sometimes the crew get up on the weather fore-ſhrowds in a crowd, and thus preſent a ſurface to the wind.

These examples of the three chief evolutions will enable thoſe who are not ſeamen to underſtand the propriety of the different ſteps, and alſo to underſtand the other evolutions as they are deſcribed by practical authors. We are not acquainted with any performance in our language where the whole are conſidered in a connected and ſyſtematic manner. There is a book on this ſubject in French, called *Le Manœuvrier*, by M. Burdé de Ville-Huet, which is in great reputation in France. A tranſlation into Engliſh was publiſhed ſome years ago, ſaid to be the performance of the Chevalier de Sauſeuil a French officer. But this appears to be a bookſeller's puff; for it is undoubtedly the work of ſome perſon who did not underſtand either the French language, or the ſubject, or the mathematical principles which are employed in the ſcientific part. The blunders are not ſuch as could poſſibly be made by a Frenchman not verſant in the Engliſh language, but natural for an Engliſhman ignorant of French. No French gentleman or officer would have tranſlated a work of this kind (which he profeſſes to think ſo highly of) to ſerve the rivals and foes of his country. But indeed it can do no great harm in this way; for the ſcientific part of it is abſolutely unintelligible for want of ſcience in the tranſlator; and the practical part is full of blunders for want of knowledge of the French language.

We offer this account of the ſubject with all proper reſpect and diffidence. We do not profeſs to teach: but

Fig. 1.



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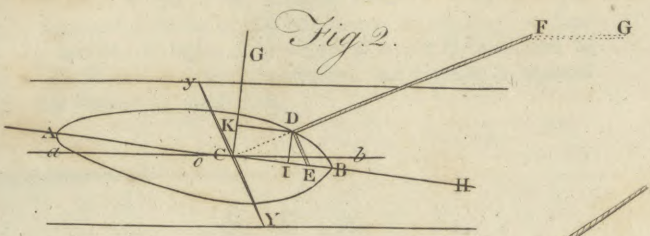

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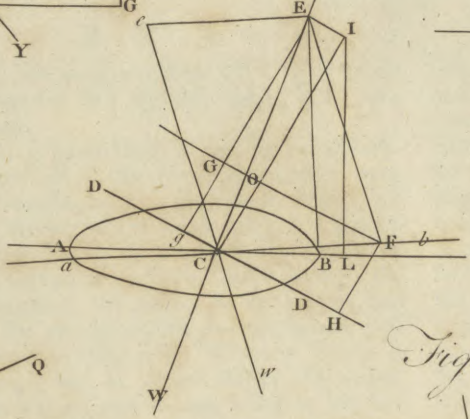

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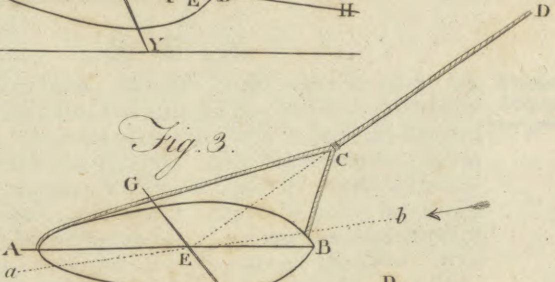

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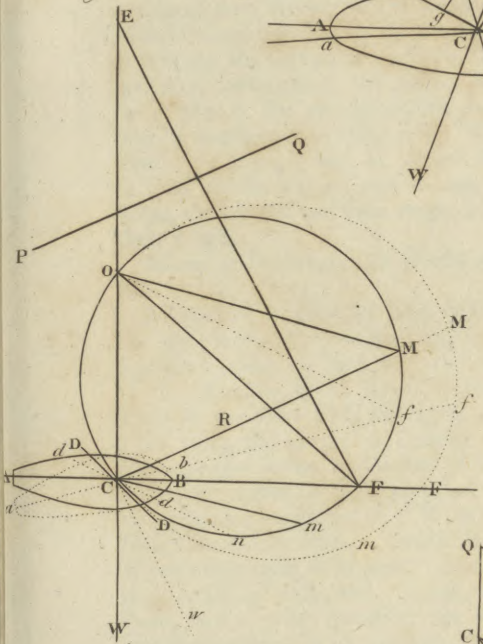

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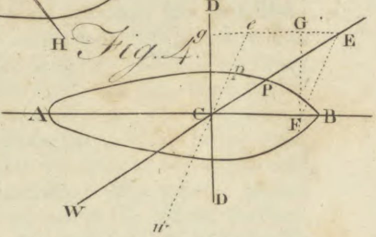

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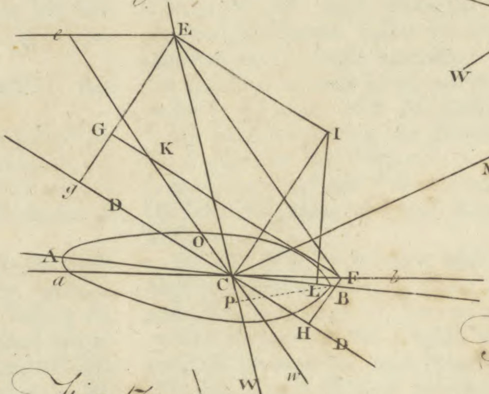

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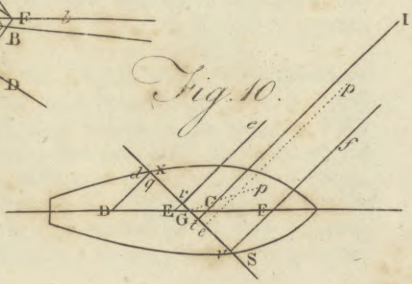

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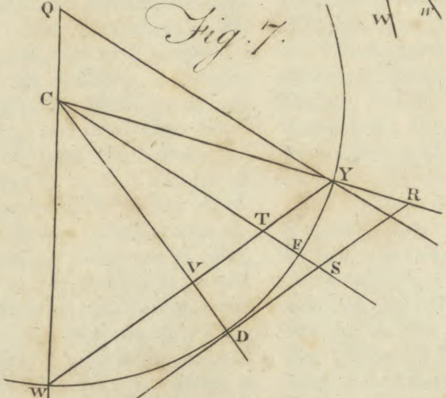


Fig. 9.

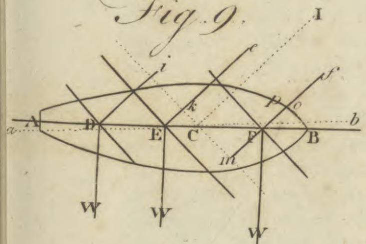


Fig. 13.

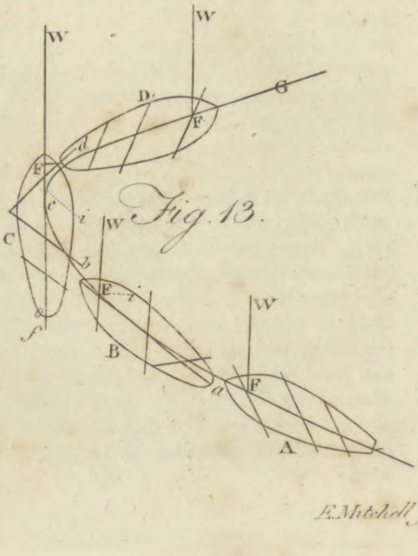


Fig. 11.

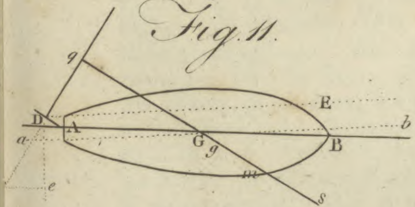
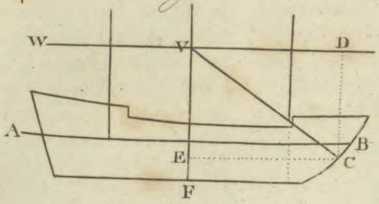


Fig. 12.



E. Mitchell sculpt.

but by pointing out the defects of the celebrated works of M. Bouguer, and the courſe which may be taken to remove them, while we preſerve much valuable knowledge which they contain, we may perhaps excite ſome perſons to apply to this ſubject, who, by a combination of what is juſt in M. Bouguer's theory, with an experimental doctrine of the impulſes of fluids, may produce a treatiſe of ſeamanſhip which will not be confined to the libraries of mathematicians, but become a manual for ſeamen by profeſſion.

SEAMEN, ſuch perſons as ſerve the king or others at ſea by navigation and fighting ſhips, &c. See *MARITIME State.*

Seamen fighting, quarrelling, or making any diſturbance, may be puniſhed by the commiſſioners of the navy with fine and impriſonment. Regiſtered ſeamen are exempted from ſerving in any pariſh office, &c. and are allowed bounty-money beſide their pay. By the law of merchants, the ſeamen of a veſſel are accountable to the maſter or commander, the maſter to the owners, and the owners to the merchants, for damage ſuſtained either by negligence or otherwiſe. Where a ſeaman is hired for a voyage, and he deſerts before it is ended, he ſhall loſe his wages; and in caſe a ſhip be loſt in a ſtorm, the ſeamen loſe their wages, as well as the owners their freight.

Means of Preſerving the Health of SEAMEN. See MEDICINE, N° 351.

In addition to what has been ſaid on this ſubject in the place referred to, we ſhall ſubjoin ſome valuable obſervations which we have met with in the ſixth volume of the Memoirs of the Royal Society of Medicine at Paris for the years 1784 and 1785.

In 1783, the marſhal de Caſtries, intending to make ſome changes in the regulations of the navy, particularly with regard to diet, propoſed to the ſociety the two following queſtions: 1. "What are the moſt wholeſome aliments for ſeamen, conſidering the impoſſibility of procuring them freſh meat? And what kinds of ſalt meat or fiſh, of pulſe, and of drink, are moſt proper for them, and in what quantity, not omitting to inquire into the regimens in uſe amongſt other maritime nations for what may be adopted by us, and into what experience has evinced the utility of, from the accounts of the moſt celebrated navigators?" 2. "A number of patients labouring under different diſeaſes being aſſembled in naval hoſpitals, and different conſtitutions affected by the ſame diſeaſe requiring difference of diet, what general dietetic rules for an hoſpital would be beſt adapted to every exigence, dividing the patients into three claſſes; the firſt in which liquids alone are proper, the ſecond in which we begin to give ſolids in ſmall quantities, and the ſtate of convaleſcence in which a fuller diet is neceſſary?" A committee was appointed to draw up an anſwer to theſe, who inveſtigated the ſubject very minutely. The reſult of their labours is there given at large. The obſervations moſt worthy of notice are, that the ſcurvy of the Engliſh ſeamen, who live chiefly on ſalt-meat, is a putrid diſeaſe; whilſt that of the Dutch, who uſe farinaceous vegetables and dried pulſe in large quantities, has more of an hydropical tendency. A mixture of both, even at the ſame meal, is recommended. This is ſupported by philoſophical reaſoning, and the example of Captain Cook, who was partly indebted to this mixed regimen for the preſervation of his crew. Salt fiſh ſhould never be uſed: ſalt beef grows hard, and after boiling its fibrous parts only remain, which are more calculated to load the ſtomach than recruit the ſtrength. Salt bacon may be kept at ſea 18 months; it does not loſe its moiſt and nutrimental parts, and unites better with pulſe, but ſhould not be uſed when rancid. Live animals kept on board ſhips tend to produce diſeaſes amongſt the crew. Rice ſhould be uſed largely. Our puddings are bad food: the flour would be much better made into bread, which might be done at ſea, with no great trouble. Sour krout ſhould be uſed freely. Muſtard, vinegar, ſugar, melaſſes, and honey, are good antiſcorbutics. Of drinks, wine is the beſt: wort, ſpruce-beer, or the Ruſſian *quas*, are good ſubſtitutes. Spirits are only to be uſed in cold climates, and in ſmall quantity. The greater part of the excellent memoir in anſwer to the ſecond queſtion, perfectly coincides with M. Duhamel du Monceaux's "Means of Preſerving the Health of Seamen," and M. Poiſſonnier des Perrieres's treatiſes "On the Diſeaſes of Seamen," and "On the advantages of changing the Diet of Seamen," and his "Examination of Pringle's Diſſertation."

SEAPOYS, or SEPOYS, natives of Indoſtan ſerving in a military capacity under the European powers, and diſciplined after the European manner.

The Seapoys of the Engliſh Eaſt India Company compoſe perhaps the moſt numerous, regular, and beſt diſciplined body of black troops in the world. They are raiſed from among the natives of the country, and conſiſt of Moors or Mahometans, Raja-poots, Hindoos, Pariars, beſides many intermediate caſts peculiar to themſelves; the whole modelled in all correſponding particulars, and diſciplined in every reſpect as the army of Great Britain.

The military eſtabliſhments of Bengal, Madras, and Bombay, have each their reſpective numbers, that of Bengal exceeding the reſt. The Seapoys are formed into complete, uniform, and regular battalions, as our marching regiments at home, being intended to repreſent and anſwer fully to every purpoſe in India to the like troops in Europe. A battalion conſiſts of 700 men, of complete effective ſtrength. In each there are eight companies, including two flank ones or grenadiers. They are reſpectively commanded by their own black and European officers; to each company there is attached a ſubaltern, who takes the command, under whom are two native commiſſioned officers, bearing the rank of ſubidar and jimindar; of eight ſubalterns, ſix are lieutenants, the other enſigns; excluſive is a ſtaff, of adjutant and ſurgeon. The black non-commiſſioned officers anſwer to our ſerjeants and corporals, and are called *havildars* and *naigues*. There is alſo to each corps an Engliſh ſerjeant-major, drill and ſtore ſerjeant; to each battalion is a band of drums and fifes, and to each a pair of colours. A captain commands the whole.

Their jackets, which are made entirely after the European faſhion, are of a red colour with yellow facings (as worn by all the infantry of the company on the Coromandel coaſt). The remaining part of their attire reſembles more the country or Indian habit, and conſiſts of a dark blue turban, broad and round at top, deſcending deep to the bottom, the ſides of which, of a concave form, are croſſed by a white band, running in front, faſtened under a roſe above. As an under garment, they have a jacket of linen. A dark blue ſaſh girding, to anſwer the turban, goes round their middle. On the thighs they have ſhort drawers, faſtened by a ſcolloped band. Their legs are bare, which renders them more ready for action or ſervice. Their arms are a firelock and bayonet; their accoutrements or croſs belts black leather, with pouches the ſame.

A battalion drawn out cannot but ſtrike the ſpectators with a lively and fanciful military impreſſion, as they unite in their exterior traits reſpectively Indian and European.

They are brought to the utmoſt exactneſs of diſcipline; go through their evolutions and manœuvres with a regularity and preciſion equal to, and not ſurpaſſed by European troops. In action they are brave and ſteady, and have been known to ſtand where Europeans have given way.

Their diſcipline puts them on a footing with European troops, with whom they are always ready to act in concert.

Their utility and ſervices are evident: they ſecure to the company the internal good order and preſervation of their territorial diſtricts, which, though poſſible to be enforced with a ſtrong hand by Europeans, requires numbers, and can only be conducted with that eaſe and addreſs peculiar to the native forces of the country.

They are conſidered with reſpect in the eyes of the other natives, though they ſufficiently, and with a good grace, feel and aſſert their own conſequence. In large garriſons, where the duty is great, as Madras, Pondicherry, Trichinopoly, Vellore, &c. two or three battalions might be preſent together, excluſive of Europeans. If ſent ſingly up the country, they are liable to be detached, ſometimes by one or more companies being ſent, to a ſtation dependent on the chief garriſon or headquarters, otherwiſe they are diſperſed through the diſtricts, four or five together, with a non-commiſſioned officer (this is a part of the ſervice which is called *going on command*), on hills, or in villages, to preſerve order, convey intelligence, and aſſiſt the taſſildar, renter, or cutwall of the place, in caſes of emergency. They alſo enforce the police, and prevent in ſuch caſes the country from being infeſted with thieves, which otherwiſe have combined, forming a banditti, to rob paſſengers, and plunder cattle, of which there are ſo many inſtances upon record. As for ſuch Britiſh officers in the company's ſervice as are attached to battalions, they are obliged to follow the fortunes and deſtinations of their men, with their reſpective corps, leading a life often replete with adventures of a peculiar nature. An individual in ſuch caſes is frequently ſecluded from thoſe of his own colour when up the country, or detached upon command, where in a frontier garriſon or hill fort in the interior parts of India none but natives are to be found. Here he might live as he pleaſes, being perfectly abſolute within his juriſdiction. Such ſtations being lucrative, with management may produce great fortunes. Neither is the condition hard to a perſon converſant in the language of the country, or that of the Seapoys called *Moors* (which moſt officers in the company's ſervice acquire); otherwiſe the loſs of ſociety is not recompenſed by other advantages, as you forget your own language, grow melancholy, and paſs your days without comfort.

The peace eſtabliſhment at Madras conſiſts of 30 Seapoy battalions, but in time of war is augmented as occaſion requires; or frequently each corps is ſtrengthened by the addition of two companies, which are reduced again in time of peace, the officers remaining ſupernumeraries in the ſervice. In garriſon they are quartered in barracks: they live agreeably to the uſage of the country, ſleep on the ground on a mat or thin carpet. In their perſons they are cleanly, but appear to beſt advantage in their uniform. Off duty they go as the other natives in poor circumſtances; and have only a cloth round their middle and over their ſhoulders. As to the different caſts, the Moormen or Muſſulmen aſſert pre-eminence, as coming into the country by conqueſt. In their perſons they are rather robuſt, and in their tempers vindictive. Their religion and dreſs is diſtinct from the Hindoos, who are mild and paſſive in their temper, faithful, ſteady, and good ſoldiers. The Pariars are inferior to the others, live under different circumſtances, dwell in huts, and aſſociate not on equal terms with the reſt; they do all menial offices, are ſervants to Europeans, and think themſelves happy when by them employed, though they are equally good Seapoys.

Having thus treated of the company's Seapoys, we ſhall obſerve that they are kindly attentive to their officers when often in circumſtances requiring their aſſiſtance; are guilty of few vices; and have a ſtrong attachment for thoſe who have commanded them. That acute hiſtorian Dr Robertſon has remarked, as a proof that the ingenuity of man has recourſe in ſimilar ſituations to the ſame expedients, that the European powers, have, in forming the eſtabliſhment of theſe native troops, adopted the ſame maxims, and, probably without knowing it, have modelled their battalions of Seapoys upon the ſame principles as Alexander the Great did his phalanx of Perſians.

SEARCH-WARRANT, in *Law*, a kind of general warrant iſſued by juſtices of peace or magiſtrates of towns for ſearching all ſuſpected places for ſtolen goods. In Scotland this was often done formerly; and in ſome Engliſh law books there are precedents requiring the conſtable to ſearch all ſuch ſuſpected places as he and the party complaining ſhall think convenient; but ſuch practice is condemned by Lord Hale, Mr Hawkins, and the beſt authorities both among the Engliſh and Scotch lawyers. However, in caſe of a complaint, and oath made of goods ſtolen, and that the party ſuſpects that thoſe goods are in a particular houſe, and ſhows the cauſe of ſuch ſuſpicion, the juſtice may grant a warrant to ſearch not only that houſe but other ſuſpected places; and to attach the goods, and the party in whoſe cuſtody they are found, and bring them before him or ſome other juſtice, to give an account how he came by them, and to abide ſuch order as to law ſhall appertain; which

which warrant ſhould be directed to the conſtable or other public officer, who may enter a ſuſpected houſe and make ſearch.

SEARCHER, an officer in the cuſtoms, whoſe buſineſs it is to ſearch and examine ſhips outwards bound, if they have any prohibited goods on board, &c. (12 Car. II.). There are alſo ſearchers of leather, &c. See ALNAGER.

SEARCHER, in ordnance, is an iron ſocket with branches, from four to eight in number, a little bent outwards, with ſmall points at their ends; to this ſocket is fixed a wooden handle, from eight to twelve feet long, of about an inch and a quarter diameter. After the gun has been fired, this ſearcher is introduced into it, and turned round, in order to diſcover the cavities within. The diſtances of theſe cavities, if any be found, are then marked on the outſide with chalk, when another ſearcher that has only one point, about which a mixture of wax and tallow is put, is introduced to take the impreſſion of the holes; and if there be any hole, a quarter of an inch deep, or of any conſiderable length, the gun is rejected as unſerviceable.

SEARCLOTH, or CERECLOTH, in *Surgery*, a form of external remedy ſomewhat harder than an unguent, yet ſofter than an emplaſter, though it is frequently uſed both for the one and the other. The cerecloth is always ſuppoſed to have wax in its compoſition, which diſtinguiſhes and even denominates it. In effect, when a liniment or unguent has wax enough in it, it does not differ from a cerecloth.

SEASIN, in a ſhip, the name of a rope by which the boat rides by the ſhip's ſide when in harbour, &c.

Moſeley on Tropical Diſeaſes.

SEASONING, the firſt illneſs to which perſons habituated to colder climates are ſubject on their arrival in the Weſt Indies. This ſeaſoning, unleſs they live very temperately, or are in a proper habit of body (though ſome people are unmoleſted for many months), ſeldom ſuffers them to remain long before it makes its appearance in ſome mode or other; particularly if at firſt they expoſe themſelves in a ſhower of rain, or too long in the ſun, or in the night-air; or when the body is much heated, if they drink large draughts of cold liquors, or bathe in cold water; or uſe much exerciſe; or commit exceſs in drinking wine or ſpirits; or by heating the body and inflaming the blood; or by ſubjecting themſelves to any cauſe that may ſuddenly check perſpiration, which at firſt is generally exceſſive.

Some people, from a favourable ſtate of body, have no ſeaſoning. Thin people, and very young people, are moſt likely to eſcape it. Women generally do from their temperance, and perhaps their menſtruation contributes to their ſecurity; indeed hot climates are favourable to the delicacy of their habits, and ſuitable to their modes of life. Some eſcape by great regularity of living; ſome by the breaking out of the raſh, called the *prickly-heat*; ſome by a great degree of perſpiration; and ſome by obſerving a cooling regimen. The diſorders are various that conſtitute this ſeaſoning of *new-comers* as they are called; depending on age, conſtitution, and habit of body. But all ſeaſoning diſeaſes are of the inflammatory kind; and yield to antiphlogiſtic treatment proportioned to their violence. When all precaution to guard againſt ſickneſs has failed, and prudence proved abortive to new-comers, they will have this comfort at leaſt for their pains, that their diſorders will ſeldom be ſevere or expenſive, and will generally have a ſpeedy termination; and that their ſeaſoning, as it is emphatically called, will be removed by bleeding, a doſe of ſalts, reſt, and a cooling regimen.

SEASONING of Timber. See TIMBER.

SEASONS, in *Coſmography*, certain portions or quarters of the year, diſtinguiſhed by the ſigns which the ſun then enters, or by the meridian altitudes of the ſun; conſequent on which are different temperatures of the air, different works in tillage, &c. See WEATHER.

The year is divided into four ſeaſons, ſpring, ſummer, autumn, and winter. The beginnings and endings of each whereof, ſee under its proper article. It is to be obſerved, the ſeaſons anciently began differently from what they now do: witneſs the old verſes,

Dat Clemens hyemem; dat Petrus ver cathedratu
Æſtuat Urbanus; autumnat Bartholomæus.

SEAT, in the manege, is the poſture or ſituation of a horſeman upon the ſaddle.

SEATON, a ſmall fiſhing town on the ſouth coaſt of Devon, between Lyme and Sidmouth. Riſdon ſays "our learned antiquarians would have it to be that *Maridunum* whereof Antonine ſpake, placed between Dunnovaria and Iſea;" for *Maridunum* in Britiſh is the ſame with *Seaton* in Engliſh, "a town upon a hill by the ſea-ſide." This place is memorable for the Daniſh princes landing there in the year 937.

SEBACIC ACID, ſo called, becauſe it is procured from fat. For an account of its preparation and properties, ſee CHEMISTRY, page 540. and N° 802.

ST SEBASTIAN, a handſome, populous, and ſtrong town of Spain, in the province of Guipuſcoa, with a good and well frequented harbour. It is ſeated at the foot of a mountain; and the harbour ſecured by two moles, and a narrow entrance for the ſhips. The town is ſurrounded with a double wall, and to the ſea-ſide is fortified with baſtions and half moons. The ſtreets are long, broad, and ſtraight, and paved with white flagſtones. At the top of the mountain is a citadel, with a garriſon well furniſhed with cannon. The town carries on a conſiderable trade, the greateſt part of which conſiſts of iron and ſteel, which ſome reckon to be the beſt in Europe. They alſo deal in wood, which comes from Old Caſtile. W. Long. 1. 59. N. Lat. 43. 23.—The capital of Braſil in South America is likewiſe called *Sebaſtian*.

SEBASTIANO, called *Del Piombo*, from an office in the lead mines given him by Pope Clement VII. was an eminent Venetian painter, born in 1485. He was firſt a diſciple of old Giovanni Bellino; continued his ſtudies under Giorgione; and having attained an excellent manner of colouring, went to Rome, where he inſinuated himſelf into the favour of Michael Angelo. He has the name of being the firſt who invented the art of preparing plaſter-walls for oil-painting; but was ſo ſlow and lazy in his work, that other hands were often employed to finiſh what he began. He died in 1547.

SEBESTEN. See CORDIA, BOTANY *Index*.

SEBUÆI, a ſect among the ancient Samaritans, whom St Epiphanius accuſes of changing the time expreſſed in the law, for the celebration of the great annual feaſts of the Jews.

SEBURAI, SEBURÆI, a name which the Jews give to ſuch of their rabbins or doctors as lived and taught ſome time after the finiſhing of the Talmud.

SECACUL, in the *Materia Medica* of the ancients, a name given by Avicenna, Serapion, and others, to a root which was like ginger, and was brought from the Eaſt Indies, and uſed as a provocative to venery. The interpreters of their works have rendered this word *iringo;* and hence ſome have ſuppoſed that our *eryngium* or *eryngo* was the root meant by it: but this does not appear to be the caſe on a ſtrict inquiry, and there is ſome reaſon to believe that the famous root, at this time called *ginſeng*, was what they meant.

SECALE, RYE, a genus of plants belonging to the triandria claſs; and in the natural method ranking under the 4th order, *Gramina*. See BOTANY and AGRICULTURE *Index*.

The *cereale*, or common rye, has glumes with rough fringes. It is a native of the iſland of Candia, was introduced into England many ages ago, and is the only ſpecies of rye cultivated in this kingdom. There are, however, two varieties, the winter and ſpring rye.

The winter rye, which is larger in the grain than the ſpring rye, is ſown in autumn at the ſame time with wheat, and ſometimes mixed with it; but as the rye ripens ſooner than the wheat, this method muſt be very exceptionable. The ſpring rye is ſown along with the oats, and uſually ripens as ſoon as the winter rye; but the grain produced is lighter, and it is therefore ſeldom ſown except where the autumnal crop has failed.

Rye is commonly ſown on poor, dry, limeſtone, or ſandy ſoils, where wheat will not thrive. By continuing to ſow it on ſuch a ſoil for two or three years, it will at length ripen a month earlier than that which has been raiſed for years on ſtrong cold ground.

Rye is commonly uſed for bread either alone or mixed with wheat. This mixture is called *meſlin*, and was formerly a very common crop in ſome parts of Britain. Mr Marſhall tells us, that the farmers in Yorkſhire believe that this mixed crop is never affected by mildew, and that a ſmall quantity of rye ſown among wheat will prevent this deſtructive diſeaſe. Rye is much uſed for bread in ſome parts of Sweden and Norway by the poor people. About a century ago rye-bread was alſo much uſed in England; but being made of a black kind of rye, it was of the ſame colour, clammy, very detergent, and conſequently not ſo nouriſhing as wheat,

Rye is ſubject to a diſeaſe which the French call *ergot*, and the Engliſh *horned rye;* which ſometimes happens when a very hot ſummer ſucceeds a rainy ſpring. According to Tiſſot, horned rye is ſuch as ſuffers an irregular vegetation in the middle ſubſtance between the grain and the leaf, producing an excreſcence of a browniſh colour, about an inch and a half long, and two-tenths of an inch broad. Bread made of this kind of rye has a nauſeous acrid taſte, and produces ſpaſmodic and grangrenous diſorders. In 1596, an epidemic diſeaſe prevailed in Heſſe, which the phyſicians aſcribed to bread made of horned rye. Some, we are told, were ſeized with an epilepſy, and theſe ſeldom ever recovered; others became lunatic, and continued ſtupid the reſt of their lives: thoſe who apparently recovered had annual returns of their diſorder in January and February; and the diſeaſe was ſaid to be contagious at leaſt in a certain degree. The facts which we have now mentioned are taken from a work of Tiſſot, which was never printed. The ſame diſeaſe was occaſioned by the uſe of this bread in ſeveral parts of the continent in the years 1648, 1675, 1702, 1716, 1722, and 1736; and has been very minutely deſcribed by Hoffman, A. O. Goelicke, Vater Burghart, and J. A. Srink.

In the year 1709, one fourth part of all the rye raiſed in the province of Salonia in France was horned, and the ſurgeon to the hoſpital of Orleans had no leſs than 500 patients under his care that were diſtempered by eating it: They were called *ergots*, from *ergot*(A), the French name for horned rye; they conſiſted chiefly of men and boys, the number of women and girls being very ſmall. The firſt ſymptom was a kind of drunkenneſs, then the local diſorder began in the toes, and thence extended ſometimes to the thigh, and the trunk itſelf, even after amputation, which is a good argument againſt that operation before the gangrene is ſtopped.

In the year 1710, the celebrated Fontenelle deſcribes a caſe in the Hiſtory of the Academy of Sciences of France, which exactly reſembles that of the poor family at Wattiſham. A peaſant at Blois, who had eaten horned rye in bread, was ſeized with a mortification which firſt cauſed all the toes of one foot to fall off, then the toes of the other, afterwards the remainder of the feet, and, laſtly, it ate off the fleſh of both his legs and thighs, leaving the bones bare.

Horned rye is not only hurtful to man, but to other animals; it has been known to deſtroy even the flies that ſettled upon it; ſheep, dogs, deer, geeſe, ducks, ſwine, and poultry, that were fed with it for experiment, died miſerably, ſome convulſed, others mortified and ulcerated.

SECANT, in *Geometry*, a line that cuts another or divides it into parts. The ſecant of a circle is a line drawn from the circumference on one ſide to a point without the circumference on the other; and it is demonſtrated by geometers, that of ſeveral ſecants drawn to the ſame point, that is the longeſt which paſſes through the centre of the circle. The portions, however, of theſe ſeveral ſecants that are without the circle are ſo much the greater as they recede from the centre, and the leaſt external portion is of that ſecant which paſſes through it.

SECANT, in *Trigonometry*, denotes a right line drawn from the centre of a circle, which, cutting the circumference, proceeds till it meets with a tangent to the ſame circle. See GEOMETRY.

Line of SECANTS, one of thoſe lines or ſcales which are uſually put upon ſectors. See SECTOR, N° 12.

1 Seceders.

SECEDERS, a numerous body of Preſbyterians in Scotland, who have withdrawn from the communion of the eſtabliſhed church. As they take up their ground

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(A) *Ergot* is French for a cock's ſpur, and horned rye was called *ergot* from the reſemblance of its excreſcence to that part.

ground upon the eſtabliſhment of religion from 1638 to 1650, which they hold to be the pureſt period of the Scottiſh church, we ſhall introduce our account of them by a ſhort view of eccleſiaſtical hiſtory from that period to the era of their ſeceſſion. With our uſual candour and impartiality we mean to give a fair ſtatement of thoſe events with which, as they ſay, their ſeceſſion is connected.

James I. having for ſome time previous to his death entertained a wiſh to form the church of Scotland as much as poſſible upon the model of that in England, his ſon Charles, with the aſſiſtance of Archbiſhop Laud, endeavoured to carry the deſign into execution, by eſtabliſhing canons for eccleſiaſtical diſcipline, and introducing a liturgy into the public ſervice of the church.—Numbers of the clergy and laity of all ranks took the alarm at what they conſidered to be a bold and dangerous innovation; and after frequent applications to the throne, they at laſt obtained the royal proclamation for a free parliament and general aſſembly. The aſſembly met in 1638, and began their labours with a repeal of all the acts of the ſix preceding parliaments, which had favoured the deſigns of James. They condemned the liturgy, together with every branch of the hierarchy. They cited all the Scottiſh biſhops to their bar; and after having excommunicated nine of them, and depoſed five from their epiſcopal office, they reſtored kirk-ſeſſions, preſbyteries, and ſynods provincial as well as national. See PRESBYTERIANS.

Theſe proceedings were ratified by the parliament which met in 1640. The law of patronage was in full force for ſeveral years after this period; yet great care was taken that no miniſter ſhould be obtruded on the Chriſtian people contrary to their inclinations; and in 1649 it was aboliſhed as an oppreſſive grievance.

The reſtoration of Charles II. in 1660 changed the face of affairs in the church of Scotland. All that the general aſſembly had done from 1638 to 1650 was rendered null and void, the covenants were pronounced to be unlawful, epiſcopacy was reſtored, and the king was declared to be the ſupreme head of the church in all cauſes civil and eccleſiaſtical. During this period the Preſbyterians were ſubjected to fines and impriſonment, while numbers of them were publicly executed for their adherence to their political and religious tenets.

The Revolution in 1688 gave a different turn to the affairs of the church. The firſt parliament which met after that event, aboliſhed prelacy and the king's ſupremacy in eccleſiaſtical affairs. They ratified the Weſtminſter Confeſſion of Faith, together with the Preſbyterian form of church-government and diſcipline, "as agreeable to the word of God, and moſt conducive to the advancement of true piety and godlineſs, and the eſtabliſhment of peace and tranquillity within theſe realms." That ſame parliament aboliſhed patronage, and lodged the election of miniſters in the hands of heritors and elders, with the conſent of the congregation.

In the reign of Queen Anne the true Proteſtant religion was ratified and eſtabliſhed, together with the Preſbyterian form of church-government and diſcipline; and the unalterable continuance of both was declared to be an eſſential condition of the union of the two kingdoms in all time coming. In 1712 the law reſpecting patronage was revived, in reſentment, it has been ſaid, of that warm attachment which the church of Scotland diſcovered to the family of Hanover; but the ſeverity of that law was greatly mitigated by the firſt parliament of George I. ſtat. 50. by which it is enacted, that, if the preſentee do not ſignify his acceptance, the preſentation ſhall become void and null in law. The church, however, did not avail herſelf of this ſtatute; and an event which happened not many years afterwards gave riſe to the *ſeceſſion*.

2
Origin of

In 1732 more than 40 miniſters preſented an addreſs to the general aſſembly, ſpecifying in a variety of inſtances what they conſidered to be great defections from the eſtabliſhed conſtitution of the church, and craving a redreſs of theſe grievances. A petition to the ſame effect, ſubſcribed by ſeveral hundreds of elders and private Chriſtians, was offered at the ſame time; but the aſſembly refuſed a hearing to both, and enacted, that the election of miniſters to vacant charges, where an accepted preſentation did not take place, ſhould be competent only to a conjunct meeting of elders and heritors, being Proteſtants. To this act many objections were made by numbers of miniſters and private Chriſtians. They aſſerted that more than thirty to one in every pariſh were not poſſeſſed of landed property, and were on that account deprived of what they deemed their natural right to chooſe their own paſtors. It was alſo ſaid, that this act was extremely prejudicial to the honour and intereſt of the church, as well as to the edification of the people; and, in fine, that it was directly contrary to the appointment of Jeſus Chriſt, and the practice of the apoſtles, when they filled up the firſt vacancy in the apoſtolic college, and appointed the election of deacons and elders in the primitive church.—Many of thoſe alſo who were thought to be the beſt friends of the church expreſſed their fears that this act would have a tendency to overturn the eccleſiaſtical conſtitution which was eſtabliſhed at the Revolution.

3
They oppoſe the meaſures of the general aſſembly;

Mr Ebenezer Erſkine, miniſter at Stirling, diſtinguiſhed himſelf by a bold and determined oppoſition to the meaſures of the aſſembly in 1732. Being at that time moderator of the ſynod of Perth and Stirling, he opened the meeting at Perth with a ſermon from Pſalm cxviii. 22. "The ſtone which the builders rejected is become the head ſtone of the corner." In the courſe of his ſermon he remonſtrated with no ſmall degree of freedom againſt the act of the preceding aſſembly with regard to the ſettlement of miniſters, and alleged that it was contrary to the word of God and the eſtabliſhed conſtitution of the church. A formal complaint was lodged againſt him for uttering ſeveral offenſive expreſſions in his ſermon before the ſynod. Many of the members declared that they heard him utter nothing but ſound and ſeaſonable doctrine; but his accuſers inſiſting on their complaint, obtained an appointment of a committee of ſynod to collect what were called the offenſive expreſſions, and to lay them before the next diet in writing. This was done accordingly; and Mr Erſkine gave in his anſwers to every article of the complaint. After three days warm reaſoning on this affair, the ſynod by a majority of ſix found him
cenſurable; againſt which ſentence he proteſted, and 4 for which their miniſters are cenſured.
appealed to the next general aſſembly. When the aſſembly met in May 1733, it affirmed the ſentence of the ſynod, and appointed Mr Erſkine to be rebuked
and

and admoniſhed from the chair. Upon which he proteſted, that, as the aſſembly had found him cenſurable, and had rebuked him for doing what he conceived to be agreeable to the word of God and the ſtandards of the church, he ſhould be at liberty to preach the ſame truths, and to teſtify againſt the ſame or ſimilar evils, on every proper occaſion. To this proteſt Meſſrs William Wilſon miniſter at Perth, Alexander Moncrief miniſter at Abernethy, and James Fiſher miniſter at Kinclaven, gave in a written adherence, under the form of inſtrument; and theſe four withdrew, intending to return to their reſpective charges, and act agreeably to their proteſt whenever they ſhould have an opportunity. Had the affair reſted here, there never would have been a ſeceſſion; but the aſſembly reſolving to carry on the proceſs, cited them by their officer to compear next day. They obeyed the citation; and a committee was appointed to retire with them, in order to perſuade them to withdraw their proteſt. The committee having reported that they ſtill adhered to their proteſt, the aſſembly ordered them to appear before the commiſſion in Auguſt following and retract their proteſt; and if they ſhould not comply and teſtify their ſorrow for their conduct, the commiſſion was empowered to ſuſpend them from the exerciſe of their miniſtry, with certification that if they ſhould act contrary to ſaid ſentence, the commiſſion ſhould proceed to an higher cenſure.

5 Suſpended from the exerciſe of their office,

The commiſſion met in Auguſt accordingly; and the four miniſters ſtill adhering to their proteſt, were ſuſpended from the exerciſe of their office, and cited to the next meeting of the commiſſion in November following. From this ſentence ſeveral miniſters and elders, members of the commiſſion, diſſented. The commiſſion met in November, and the ſuſpended miniſters compeared. Addreſſes, repreſentations, and letters from ſeveral ſynods and preſbyteries, relative to the buſineſs now before the commiſſion, were received and read. The ſynods of Dumfries, Murray, Roſs, Angus and Mearns, Perth and Stirling, craved that the commiſſion would delay proceeding to a higher cenſure. The ſynods of Galloway and Fife, as alſo the preſbytery of Dornoch, addreſſed the commiſſion for lenity, tenderneſs, and forbearance, towards the ſuſpended miniſters; and the preſbytery of Aberdeen repreſented, that in their judgment, the ſentence of ſuſpenſion inflicted on the foreſaid miniſters was too high, and that it was a ſtretch of eccleſiaſtical authority. Many members of the commiſſion reaſoned in the ſame manner, and alleged that the act and ſentence of laſt aſſembly did not oblige them to proceed to an higher cenſure at this meeting of the commiſſion. The queſtion, however, was put, Proceed to an higher cenſure, or not? and the votes being numbered, were found equal on both ſides: upon which Mr John Goldie the moderator gave his caſting vote to proceed to a higher cenſure; which ſtands in their minutes in theſe words: "The commiſſion did and hereby do looſe the relation of Mr Ebenezer Erſkine miniſter at Stirling, Mr William Wilſon miniſter at Perth, Mr Alexander Moncrief miniſter at Abernethy, and Mr James Fiſher miniſter at Kinclaven, to their reſpective charges, and declare them no longer miniſters of this church; and do hereby prohibit all miniſters of this church to employ them, or any of them, in any miniſterial function. And the commiſſion do declare the churches of the ſaid miniſters vacant from and after the date of this ſentence."

6 deprived of their livings;

This ſentence being intimated to them, they proteſted, that their miniſterial office and relation to their reſpective charges ſhould be held *as* valid as if no ſuch ſentence had paſſed; and that they were now obliged to make a *ſeceſſion* from the prevailing party in the eccleſiaſtical courts; and that it ſhall be lawful and warrantable for them to preach the goſpel, and diſcharge every branch of the paſtoral office, according to the word of God and the eſtabliſhed principles of the church of Scotland. Mr Ralph Erſkine miniſter at Dunfermline, Mr Thomas Mair miniſter at Orwel, Mr John M'Laren miniſter at Edinburgh, Mr John Currie miniſter at Kinglaſſie, Mr James Wardlaw miniſter at Dunfermline, and Mr Thomas Nairn miniſter at Abbotſhal, proteſted againſt the ſentence of the commiſſion, and that it ſhould be lawful for them to complain of it to any ſubſequent general aſſembly of the church.

The ſeceſſion properly commenced at this date. And accordingly the ejected miniſters declared in their proteſt that they were laid under the diſagreeable neceſſity of ſeceding, not from the principles and conſtitution of the church of Scotland, to which, they ſaid, they ſtedfaſtly adhered, but from the preſent church-courts, which had thrown them out from miniſterial communion. The aſſembly, however, which met in May 1734 did ſo far modify the above ſentence, that they empowered the ſynod of Perth and Stirling to receive the ejected miniſters into the communion of the church, and reſtore them to their reſpective charges; but with this expreſs direction, "that the ſaid ſynod ſhould not take upon them to judge of the legality or formality of the former procedure of the church judicatories in relation to this affair, or either approve or cenſure the ſame." As this appointment neither condemned the act of the preceding aſſembly nor the conduct of the commiſſion, the ſeceding miniſters conſidered it to be rather an act of grace than of juſtice, and therefore they ſaid they could not return to the church-courts upon this ground; and they publiſhed to the world the reaſons of their refuſal, and the terms upon which they were willing to return to the communion of the eſtabliſhed church. They now erected themſelves into an eccleſiaſtical court, which they called the *Aſſociated Preſbytery*, and preached occaſionally to numbers of the people who joined them in different parts of the country. They alſo publiſhed what they called an *Act, Declaration, and Teſtimony*, to the doctrine, worſhip, government, and diſcipline of the church of Scotland, and againſt ſeveral inſtances, as they ſaid, of defection from theſe, both in former and in the preſent times. Some time after this ſeveral miniſters of the eſtabliſhed church joined them, and the Aſſociated Preſbytery now conſiſted of eight miniſters. But the general aſſembly which met in 1738 finding that the number of Seceders was much increaſed, ordered the eight miniſters to be ſerved with a libel, and to be cited to the next meeting of the aſſembly in 1739. They now appeared at the bar as a conſtituted preſbytery, and having formally declined the aſſembly's authority, they immediately withdrew. The aſſembly which met next year depoſed them from the office of the miniſtry; which, however, they continued to exerciſe in their reſpective congregations, who ſtill adhered to them, and erected meeting houſes, where they preached till their

7 and degraded.

their death. Mr James Fiſher, the laſt ſurvivor of them, was, by an unanimous call in 1741, tranſlated from Kinclaven to Glaſgow, where he continued in the exerciſe of his miniſtry among a numerous congregation, reſpected by all ranks in that large city, and died in 1775 much regretted by his people and friends. In 1745 the ſeceding miniſters were become ſo numerous, that they were erected into three different preſbyteries, under one ſynod, when a very unprofitable diſpute divided them into two parties.

8
They divide among themſelves about the legality of the burgeſs oath,

9
and form ſeparate communions.

The burgeſs oath in ſome of the royal boroughs of Scotland contains the following clauſe: "I profeſs and allow with my heart the true religion preſently profeſſed within this realm, and authorized by the laws thereof. I will abide at and defend the ſame to my life's end, renouncing the Romiſh religion called *Papiſtry*." Meſſrs Ebenezer and Ralph Erſkine, James Fiſher, and others, affirmed that this clauſe was no way contrary to the principles on which the ſeceſſion was formed, and that therefore every Seceder might lawfully ſwear it. Meſſrs Alexander Moncrief, Thomas Mair, Adam Gib, and others, contended on the other hand that the ſwearing of the above clauſe was a virtual renunciation of their teſtimony. And this controverſy was ſo keenly agitated, that they ſplit into two different parties, and now met in different ſynods. Thoſe of them who aſſert the lawfulneſs of ſwearing the burgeſs oath are called *Burghers*, and the other party who condemn it are called *Antiburgher Seceders*. Each party claiming to itſelf the lawful conſtitution of the *Aſſociate Synod*, the Antiburghers after ſeveral previous ſteps, excommunicated the Burghers on the ground of their ſin and of their contumacy in it. This rupture took place in 1747, ſince which period no attempts to effect a reunion have been ſucceſsful. They remain under the juriſdiction of different ſynods, and hold ſeparate communion, although much of their former hoſtility has been laid aſide. The Antiburghers conſider the Burghers as too lax and not ſufficiently ſtedfaſt to their teſtimony. The Burghers on the other hand contend that the Antiburghers are too rigid, in that they have introduced new terms of communion into the ſociety. The Antiburghers having adopted ideas with regard to what they call *covenanting*, which the Burghers never approved (A), have been in uſe of renewing in their ſeveral congregations the Scottiſh Covenant, by cauſing their people formally ſwear to maintain it. In other reſpects the differences between the two parties are not material. The Antiburghers are moſt numerous on the north of the Tay, and the Burghers on the ſouth of it.

10
Hiſtory of the Burgher Seceders.

What follows in this article is a further account of thoſe who are commonly called the *Burgher Seceders*. Theſe have a greater number of people in their communion than the Antiburghers, and for ſome years paſt they have greatly increaſed in the ſouthern and weſtern diſtricts of Scotland. As there were among them from the commencement of their ſeceſſion ſeveral ſtudents who had been educated at one or other of the univerſities, they appointed one of their miniſters to give lectures in theology, and train up candidates for the miniſtry. Meſſrs William Wilſon miniſter at Perth, and Alexander Moncrief miniſter at Abernethy, were their profeſſors of theology before their ſeparation from the Antiburghers.

Since that period Mr Ebenezer Erſkine miniſter at Stirling, Mr James Fiſher miniſter at Glaſgow, Mr John Swanſton miniſter at Kinroſs, and Mr John Brown miniſter at Haddington, have ſucceeded each other in this office. At preſent Mr George Lawſon miniſter at Selkirk is their profeſſor of theology, and there are between thirty and forty ſtudents who attend his lectures annually. The number of their miniſters is about an hundred, and each of their congregations contains from two hundred and fifty to three thouſand perſons; and there are among them at preſent more than twenty vacant charges. Where a congregation is very numerous, as in Stirling, Dunfermline, and Perth, it is formed into a collegiate charge, and provided with two miniſters. They are erected into ſix different preſbyteries, united in one general ſynod, which commonly meets at Edinburgh in May and September (B). They have alſo a ſynod in Ireland compoſed of three or four different preſbyteries. They are legally tolerated in Ireland; and government ſome years ago granted 500l. per annum, and of late an additional 500l. which, when divided among them, affords to each miniſter about 20l. over and above the ſtipend which he receives from his hearers. Theſe have beſides a preſbytery in Nova Scotia; and ſome years ago, it is ſaid, that the Burgher and the Antiburgher miniſters reſiding in the United States formed a coalition, and joined in a general ſynod, which they call the *Synod of New York* and *Pennſylvania*. They all preach the doctrines contained in the Weſtminſter Confeſſion of Faith and Catechiſms, as they believe theſe to be founded on the ſacred ſcriptures. They catechiſe their hearers publicly, and viſit them from houſe to houſe once every year.

(A) This is the account which the Burghers give of their own notions reſpecting the covenant. One of the moſt enlightened of their opponents, however, aſſures us that they acknowledge covenanting to be a *moral duty*, and that the ſolemn vows of our anceſtors are obligatory. But ſince the breach in the ſynod they have never engaged in this work; giving as their reaſon, that this is not the proper ſeaſon.

(B) The conſtitution of the Antiburgher church differs very little from that of the Burghers. The ſupreme court among them is deſigned *The General Aſſociate Synod*, having under its juriſdiction three provincial ſynods in Scotland and one in Ireland. In the former country there are eleven preſbyteries; in the latter, four. They have a few congregations in England, and a preſbytery in connection with them in North America. The number of miniſters belonging to the general ſynod is a hundred and thirty-ſeven; and in Scotland there are nineteen vacancies. They, as well as the Burgher Seceders, have a profeſſor of theology, whoſe lectures every candidate for the office of a preacher is obliged to attend, we have been told for no leſs than five or ſix ſeſſions! Surely the ſeſſion muſt be of ſhort duration.

year. They will not give the Lord's ſupper to thoſe who are ignorant of the principles of the goſpel, nor to ſuch as are ſcandalous and immoral in their lives. They condemn private baptiſm, nor will they admit thoſe who are groſsly ignorant and profane to be ſponſors for their children. Believing that the people have a natural right to chooſe their own paſtors, the ſettlement of their miniſters always proceeds upon a popular election; and the candidate who is elected by the majority is ordained among them. Convinced that the charge of ſouls is a truſt of the greateſt importance, they carefully watch over the morals of their ſtudents, and direct them to ſuch a courſe of reading and ſtudy as they judge moſt proper to qualify them for the profitable diſcharge of the paſtoral duties. At the ordination of their miniſters they uſe a *formula* of the ſame kind with that of the eſtabliſhed church, which their miniſters are bound to ſubſcribe when called to it; and if any of them teach doctrines contrary to the Scriptures or the Weſtminſter Confeſſion of Faith, they are ſure of being thrown out of their communion. By this means uniformity of ſentiment is preſerved among them; nor has any of their miniſters, excepting one, been proſecuted for error in doctrine ſince the commencement of their ſeceſſion.

11 Their rules of faith,

They believe that the holy ſcriptures are the ſole criterion of truth, and the only rule to direct mankind to glorify and enjoy God, the chief and eternal good; and that "the Supreme Judge, by which all controverſies of religion are to be determined, and all the decrees of councils, opinions of ancient writers, doctrines of men and private ſpirits, are to be examined, and in whoſe ſentence we are to reſt, can be no other but the Holy Spirit ſpeaking in the Scriptures." They are fully perſuaded, however, that the ſtandards of public authority in the church of Scotland exhibit a juſt and conſiſtent view of the meaning and deſign of the holy ſcriptures with regard to doctrine, worſhip, government, and diſcipline; and they in ſo far differ from the diſſenters in England, in that they hold theſe ſtandards to be not only articles of peace and a teſt of orthodoxy, but as a bond of union and fellowſhip. They conſider a ſimple declaration of adherence to the ſcriptures as too equivocal a proof of unity in ſentiment, becauſe Arians, Socinians, and Arminians, make ſuch a confeſſion of their faith, while they retain ſentiments which they (the Seceders) apprehend are ſubverſive of the great doctrines of the goſpel. They believe that Jeſus Chriſt is the only King and Head of the Church, which is his body; that it is his ſole prerogative to enact laws for the government of his kingdom, which is not of this world; and that the church is not poſſeſſed of a legiſlative, but only of an executive power, to be exerciſed in explaining and applying to their proper objects and ends thoſe laws which Chriſt hath publiſhed in the ſcriptures. Thoſe doctrines which they teach relative to faith and practice are exhibited at great length in an explanation of the Weſtminſter Aſſembly's Shorter Catechiſm, by way of queſtion and anſwer, in two volumes, compoſed chiefly by Mr James Fiſher late of Glaſgow, and publiſhed by deſire of their ſynod.

For theſe 50 years paſt, the grounds of their ſeceſſion, they allege, have been greatly enlarged by the public adminiſtrations of the eſtabliſhed church, and particularly by the uniform execution of the law reſpecting patronage, which, they ſay, has obliged many thouſands of private Chriſtians to withdraw from the pariſh-churches and join their ſociety.

It is certain, however, that their number has rapidly increaſed of late, eſpecially in the large cities of the kingdom. They have three different congregations in Edinburgh, two in Glaſgow, and two in London, beſides ſeveral others in the north of England. In moſt of their congregations they celebrate the Lord's ſupper twice in the year, and they catechiſe their young people concerning their knowledge of the principles of religion previouſly to their admiſſion to that ſacrament. When any of them fall into the ſin of fornication or adultery, the ſcandal is regularly purged according to the form of proceſs in the eſtabliſhed church; and thoſe of the delinquents who do not ſubmit to adequate cenſure are publicly declared to be fugitives from diſcipline, and are expelled the ſociety. They never accept a ſum of money as a commutation for the offence. They condemn all clandeſtine and irregular marriages, nor will they marry any perſons unleſs they have been proclaimed in the pariſh-church on two different Lord's days at leaſt.

12 and political principles.

When they ſeparated from the eſtabliſhed church, they remained firm in their attachment to the ſtate; and they were not many years formed into a diſtinct ſociety, when they expelled from their communion a Mr Thomas Nairn miniſter at Kirkcaldy, who had taught doctrines inimical to the civil government of the nation. In 1745 there was not one of their number who joined the pretender to the Britiſh crown. They are ſtill of the ſame ſentiments; and in their public aſſemblies they always pray for our ſovereign King George, with the royal family, and for all who are in authority under them. They are ſo far from wiſhing the overthrow of the preſent civil government, that when the nation was lately in danger of being thrown into a fermentation by the circulation of inflammatory and ſeditious writings, they warmly recommended peace and order in ſociety. The ſame remarks, we believe, are equally applicable to the Antiburgher ſeceders. No legal diſqualifications, as in the caſe of the diſſenters in England, exclude them from any place of public truſt in the municipal government of the country; and ſome of them are frequently in the magiſtracy of the royal boroughs. They are not, however, legally tolerated, but are ſupported by the mildneſs of adminiſtration and the liberal ſpirit of the times. Avowing their adherence to the doctrines contained in the public ſtandards of the church of Scotland, together with the preſbyterian form of government, from which they never intended to ſecede, they deny that they are either ſchiſmatics or ſectaries, as they have been frequently called: and when they withdrew from the eccleſiaſtical courts, they did not, they ſay, conſtitute a church of their own, different from the national church, but profeſs to be a part of that church, endeavouring to hold by her reformed principles, in oppoſition to thoſe deviations from them which they have ſpecified in their *Act and Teſtimony*.

13 Their moderation.

Moſt of them live in habits of friendſhip and intimacy with their brethren of the eſtabliſhment, and they profeſs an affectionate regard for all thoſe of every denomination who love Jeſus Chriſt in ſincerity and truth. In the late re-exhibition of their teſtimony, they have declared to the world, that, were the grounds of their ſeceſſion happily removed, they would account it one of the moſt ſingular felicities of their time to return with pleaſure to the communion of the eſtabliſhed church.

SECHIUM, a genus of plants belonging to the monœcia claſs; and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

SECKENDORF, GUY LEWIS DE, a very learned German, deſcended from an ancient and noble family, was born at Aurach in Franconia in 1626. He was a good linguiſt, learned in law, hiſtory, and divinity; and is ſaid to have been a tolerable painter and engraver. He was honourably employed by ſeveral of the German princes; and died counſellor of ſtate to Frederic III. elector of Brandenburg, and chancellor of the univerſity of Halle, in 1692. He wrote many books, particularly "A hiſtory and defence of the Lutheran religion," 2 vols folio, Frankfort, 1602, in Latin.

SECKER, THOMAS, a learned and reſpectable prelate of the church of England, was born, in 1693, at a village called *Sibthorp*, in the vale of Belvoir, in Nottinghamſhire. His father was a Proteſtant diſſenter, a pious, virtuous, and ſenſible man; who, having a ſmall paternal fortune, followed no profeſſion. His mother was the daughter of Mr Brough, a ſubſtantial gentleman farmer of Shelton in the ſame county. He received his education at ſeveral private ſchools and academies in the country, being obliged, by various accidents, frequently to change his maſters.

Notwithſtanding this diſadvantage, he had at the age of 19 not only made conſiderable progreſs in Greek and Latin, and read the beſt writers in both languages, but had acquired a knowledge of French, Hebrew, Chaldee, and Syriac; had learned geography, logic, algebra, geometry, conic ſections, and gone through a courſe of lectures on Jewiſh antiquities and other points, preparatory to the critical ſtudy of the Bible. He had been deſtined by his father for orders among the Diſſenters. With this view, during the latter years of his education, his ſtudies were chiefly turned towards divinity, in which he had made ſuch quick advances, that by the time he was 23 he had carefully read over a great part of the Scriptures, particularly the New Teſtament, in the original, and the beſt comments upon it; Euſebius's Eccleſiaſtical Hiſtory, The Apoſtolical Fathers, Whiſton's Primitive Chriſtianity, and the principal writers for and againſt Miniſterial and Lay Conformity.—But though the reſult of theſe inquiries was a well-grounded belief of the Chriſtian revelation, yet not being at that time able to decide on ſome abſtruſe ſpeculative doctrines, nor to determine abſolutely what communion he ſhould embrace; he reſolved, like a wiſe and honeſt man, to purſue ſome profeſſion, which ſhould leave him at liberty to weigh thoſe things more maturely in his thoughts, and not oblige him to declare or teach publicly opinions which were not yet thoroughly ſettled in his own mind.

In 1716, therefore, he applied himſelf to the ſtudy of phyſic, and after gaining all the medical knowledge he could, by reading the uſual preparatory books, and attending the beſt lectures during that and the following winter in London, in order to improve himſelf farther, in January 1718-19 he went to Paris. There he lodged in the ſame houſe with the famous anatomiſt Mr Winſlow, whoſe lectures he attended, as he did thoſe of the materia medica, chemiſtry, and botany, at the king's gardens. He ſaw the operations of ſurgery at the *Hotel Dieu*, and attended alſo for ſome time M. Gregoire, the accoucheur, but without any deſign of ever practiſing that or any other branch of ſurgery. Here he became acquainted with Mr Martin Benſon, afterwards biſhop of Glouceſter, one of the moſt agreeable and virtuous men of his time; with whom he quickly became much connected, and not many years after was united to him by the ſtricteſt bonds of affinity as well as affection.

During the whole of Mr Secker's continuance at Paris, he kept up a conſtant correſpondence with Mr Joſeph Butler, afterwards biſhop of Durham, with whom he became acquainted at the academy of one Mr Jones, kept firſt at Glouceſter, and afterward at Tewkſbury. Mr Butler having been appointed preacher at the Rolls on the recommendation of Dr Clarke and Mr Edward Talbot, ſon to Biſhop Talbot, he now took occaſion to mention his friend Mr Secker, without Secker's knowledge, to Mr Talbot, who promiſed, in caſe he choſe to take orders in the church of England, to engage the biſhop his father to provide for him. This was communicated to Mr Secker in a letter from Mr Butler about the beginning of May 1720. He had not at that time come to any reſolution of quitting the ſtudy of phyſic; but he began to foreſee many obſtacles to his purſuing that profeſſion; and having never diſcontinued his application to theology, his former difficulties both with regard to conformity and ſome other doubtful points had gradually leſſened, as his judgment became ſtronger and his reading and knowledge more extenſive. It appears alſo from two of his letters ſtill in being, written from Paris to a friend in England, (both of them prior to the date of Mr Butler's above mentioned), that he was greatly diſſatisfied with the diviſions and diſturbances which at that particular period prevailed among the Diſſenters.

In this ſtate of mind Mr Butler's unexpected propoſal found him; which he was therefore very well diſpoſed to take into conſideration; and after deliberating on the ſubject of ſuch a change for upwards of two months, he reſolved at length to embrace the offer, and for that purpoſe quitted France about the beginning of Auguſt 1720.

On his arrival in England, he was introduced to Mr Talbot, with whom he cultivated a cloſe acquaintance; but it was unfortunately of very ſhort duration; for in the month of December that gentleman died of the ſmallpox. This was a great ſhock to all his friends, who had juſtly conceived the higheſt expectations of him; but eſpecially to an amiable lady whom he had lately married, and who was very near ſinking under ſo ſudden and grievous a ſtroke. Mr Secker, beſide ſharing largely in the common grief, had peculiar reaſon to lament an accident that ſeemed to put an end to all his hopes; but he had taken his reſolution, and he determined to perſevere. It was ſome encouragement to him to find that Mr Talbot had, on his deathbed, recommended him, together with Mr Benſon and Mr Butler, to his father's notice. Thus did that excellent young man (for he was but 29 when he died), by his nice diſcernment of characters, and his conſiderate good nature, provide moſt effectually, in a few ſolemn moments, for the welfare of that church from which he himſelf was ſo prematurely ſnatched away; and at the ſame time raiſed up, when he leaſt thought of it, the trueſt friend and protector to his wife and unborn daughter; who afterwards found in Mr Secker all that tender care and aſſiſtance which they could have hoped for from the neareſt relation.

It being judged neceſſary by Mr Secker's friends that he ſhould have a degree at Oxford; and having been informed, that if he ſhould previouſly take the degree of Doctor in Phyſic at Leyden, it would probably help him in obtaining the other, he went over and took his degree there in March 1721: and, as part of his exerciſe for it, he compoſed and printed a diſſertation *de Medicina Statica*, which is ſtill extant, and is thought by the gentlemen of that profeſſion to be a ſenſible and learned performance.

In April the ſame year, he entered himſelf a gentleman commoner of Exeter college, Oxford; after which he obtained the degree of Bachelor of Arts, in conſequence of the chancellor's recommendatory letter to the convocation.

He now ſpent a conſiderable part of his time in London, where he quickly gained the eſteem of ſome of the moſt learned and ingenious men of thoſe days, particularly of Dr Clarke, rector of St James's, and the celebrated Dean Berkeley, afterwards biſhop of Cloyne, with whom he every day became more delighted, and more cloſely connected. He paid frequent viſits of gratitude and friendſhip to Mrs Talbot, widow of Mr Edward Talbot, by whom ſhe had a daughter five months after his deceaſe. With her lived Mrs Catharine Benſon, ſiſter to Biſhop Benſon, whom in many reſpects ſhe greatly reſembled. She had been for ſeveral years Mrs Talbot's inſeparable companion, and was of unſpeakable ſervice to her at the time of her huſband's death, by exerting all her courage, activity, and good ſenſe (of which ſhe poſſeſſed a large ſhare), to ſupport her friend under ſo great an affliction, and by afterwards attending her ſickly infant with the utmoſt care and tenderneſs, to which, under Providence, was owing the preſervation of a very valuable life.

Biſhop Talbot being in 1721 appointed to the ſee of Durham, Mr Secker was in 1722 ordained deacon by him in St James's church, and prieſt not long after in the ſame place, where he preached his firſt ſermon March 28. 1723. The biſhop's domeſtic chaplain at that time was Dr Rundle, a man of warm fancy and very brilliant converſation, but apt ſometimes to be carried by the vivacity of his wit into indiſcreet and ludicrous expreſſions, which created him enemies, and, on one occaſion, produced diſagreeable conſequences.—With him Mr Secker was ſoon after aſſociated in the biſhop's family, and both taken down by his lordſhip to Durham in July 1723.

In the following year the biſhop gave Mr Secker the rectory of Houghton-le-Spring. This preferment putting it in his power to fix himſelf in the world, in a manner agreeable to his inclinations, he ſoon after made a propoſal of marriage to Mrs Benſon; which being accepted, they were married by Biſhop Talbot in 1725. At the earneſt requeſt of both, Mrs Talbot and her daughter conſented to live with them, and the two families from that time became one.

About this time Biſhop Talbot alſo gave preferments to Mr Butler and Mr Benſon, whoſe riſe and progreſs in the church are here interwoven with the hiſtory of Mr Secker. In the winter of 1725-6, Mr Butler firſt publiſhed his incomparable ſermons; on which, as Dr Beilby Porteous and Dr Stinton inform us, Mr Secker took pains to render the ſtyle more familiar, and the author's meaning more obvious: yet they were at laſt by many called obſcure. Mr Secker gave his friend the ſame aſſiſtance in that noble work the Analogy of Religion, &c.

He now gave up all the time he poſſibly could to his reſidence at Houghton, applying himſelf with alacrity to all the duties of a country clergyman, and ſupporting that uſeful and reſpectable character throughout with the ſtricteſt propriety. He omitted nothing which he thought would be of uſe to the ſouls and bodies of the people entruſted to his care. He brought down his converſation and his ſermons to the level of their underſtandings; he viſited them in private, he catechiſed the young and ignorant, he received his country neighbours and tenants very kindly and hoſpitably, and was of great ſervice to the poorer ſort of them by his ſkill in phyſic, which was the only uſe he ever made of it. Though this place was in a very remote part of the world, yet the ſolitude of it perfectly ſuited his ſtudious diſpoſition, and the income ariſing from it bounded his ambition. Here he would have been content to live and die; here, as he has often been heard to declare, he ſpent ſome of the happieſt hours of his life: and it was no thought or choice of his own that removed him to a higher and more conſpicuous ſituation; but Mrs Secker's health, which now began to decline, and was thought to be injured by the dampneſs of the ſituation, obliged him to think of exchanging it for a more healthy one. Accordingly, an exchange was made through the friendly interpoſition of Mr Benſon (who generouſly ſacrificed his own intereſt on this occaſion, by relinquiſhing a prebend of his own to ſerve his friend) with Dr Finney, prebendary of Durham, and rector of Ryton; and Mr Secker was inſtituted to Ryton and the prebend June 3. 1727. For the two following years he lived chiefly at Durham, going every week to officiate at Ryton, and ſpending there two or three months together in the ſummer.

In July 1732 he was appointed chaplain to the king; for which favour he was indebted to Dr Sherlock, who having heard him preach at Bath, had conceived the higheſt opinion of his abilities, and thought them well worthy of being brought forward into public notice. From that time an intimacy commenced between them, and he received from that great prelate many ſolid proofs of eſteem and friendſhip.

His month of waiting at St James's happened to be Auguſt, and on Sunday the 27th of that month he preached before the queen, the king being then abroad. A few days after, her majeſty ſent for him into her cloſet, and held a long converſation with him; in the courſe of which he took an opportunity of mentioning to her his friend Mr Butler. He alſo, not long after this, on Mr Talbot's being made lord chancellor, found means to have Mr Butler effectually recommended to him for his chaplain. The queen alſo appointed him clerk of her cloſet; from whence he roſe, as his talents became more known, to thoſe high dignities which he afterwards attained.

Mr Secker now began to have a public character, and ſtood high in the eſtimation of thoſe who were allowed to be the beſt judges of merit: he had already given proofs of abilities that plainly indicated the eminence to which he muſt one day riſe, as a preacher and a divine; and it was not long before an opportunity offered of placing him in an advantageous point of view. Dr Tyrrwhit, who ſucceeded Dr Clarke as rector of St James's in 1729, found that preaching in ſo large a church endangered his health. Biſhop Gibſon, therefore, his father-in-law, propoſed to the crown that he ſhould be made reſidentiary of St Paul's, and that Mr Secker ſhould ſucceed him in the rectory. This arrangement was ſo acceptable to thoſe in power, that it took place without any difficulty. Mr Secker was inſtituted rector the 18th of May 1733; and in the beginning of July went to Oxford to take his degree of Doctor of Laws, not being of ſufficient ſtanding for that of divinity. On this occaſion it was that he preached his celebrated Act Sermon, on the advantages and duties of academical education, which was univerſally allowed to be a maſterpiece of ſound reaſoning and juſt compoſition: it was printed at the deſire of the heads of houſes, and quickly paſſed through ſeveral editions. It is now to be found in the ſecond collection of Occaſional Sermons, publiſhed by himſelf in 1766.

It was thought that the reputation he acquired by this ſermon, contributed not a little toward that promotion which very ſoon followed its publication. For in December 1734, he received a very unexpected notice from Biſhop Gibſon, that the king had fixed on him to be biſhop of Briſtol. Dr Benſon was about the ſame time appointed to the ſee of Glouceſter, as was Dr Fleming to that of Carliſle; and the three new biſhops were all conſecrated together in Lambeth Chapel, Jan. 19. 1734-5, the conſecration-ſermon being preached by Dr Thomas, afterwards biſhop of Wincheſter.

The honours to which Dr Secker was thus raiſed in the prime of life did not in the leaſt abate his diligence and attention to buſineſs; for which, indeed, there was now more occaſion than ever. His learned biographers, Meſſrs Porteous and Stinton, now relate the manner in which he ſet about the viſitation of his dioceſe, and the ceremony of confirmation, which he performed in a great number of places; he alſo preached in ſeveral churches, ſometimes twice a-day. The affairs of his pariſh of St James's being likewiſe in great diſorder, he took extraordinary pains to regulate and adjuſt every thing, particularly the management of the poor; and thus even in a temporal view became of ſignal ſervice to his pariſhioners. But, ſay our authors, "it was their ſpiritual welfare which engaged, as it ought to do, his chief attention. As far as the circumſtances of the times, and the populouſneſs of that part of the metropolis allowed, he omitted not even thoſe private admonitions and perſonal applications which are often attended with the happieſt effects. He allowed out of his own income a ſalary for reading early and late prayers, which had formerly been paid out of the offertory money. He held a confirmation once every year, examined the candidates ſeveral weeks before in the veſtry, and gave them religious tracts, which he alſo diſtributed at other times very liberally to thoſe that needed them. He drew up, for the uſe of his pariſhioners, that admirable courſe of *Lectures on the Church Catechiſm* which hath been lately publiſhed, and not only read them once every week on the uſual days, but alſo every Sunday evening, either at the church or one of the chapels belonging to it."

The ſermons which at the ſame time, we are told, he ſet himſelf to compoſe, "were truly excellent and original. His faculties were now in their full vigour, and he had an audience to ſpeak before that rendered the utmoſt exertion of them neceſſary. He did not, however, ſeek to gratify the higher part, by amuſing them with refined ſpeculations, or ingenious eſſays, unintelligible to the lower part, and unprofitable to both; but he laid before them all, with equal freedom and plainneſs, the great Chriſtian duties belonging to their reſpective ſtations, and reproved the follies and vices of every rank among them, without diſtinction or palliation. He ſtudied human nature thoroughly in all its various forms, and knew what ſort of arguments would have moſt weight with each claſs of men. He brought the ſubject home to their boſoms, and did not ſeem to be merely ſaying uſeful things in their preſence, but addreſſing himſelf perſonally to every one of them. Few ever poſſeſſed, in a higher degree, the rare talent of touching on the moſt delicate ſubjects with the niceſt propriety and decorum, of ſaying the moſt familiar things without being low, the plaineſt without being feeble, the boldeſt without giving offence. He could deſcend with ſuch ſingular eaſe and felicity into the minuteſt concerns of common life, could lay open with ſo much addreſs the various workings, artifices, and evaſions of the human mind, that his audience often thought their own particular caſes alluded to, and heard with ſurpriſe their private ſentiments and feelings, their ways of reaſoning and principles of acting, exactly ſtated and deſcribed. His preaching was, at the ſame time, highly rational and truly evangelical. He explained with perſpicuity, he aſſerted with dignity, the peculiar characteriſtic doctrines of the goſpel. He inculcated the utility, the neceſſity of them, not merely as ſpeculative truths, but as actual inſtruments of moral goodneſs, tending to purify the hearts and regulate the lives of men; and thus, by God's gracious appointment, as well as by the inſeparable connection between true faith and right practice, leading them to ſalvation.

"Theſe important truths he taught with the authority, the tenderneſs, the familiarity, of a parent inſtructing his children. Though he neither poſſeſſed nor affected the artificial eloquence of an orator who wants to amuſe or to miſlead, yet he had that of an honeſt man who wants to convince, of a Chriſtian preacher who wants to reform and to ſave thoſe that hear him. Solid argument, manly ſenſe, uſeful directions, ſhort, nervous, ſtriking ſentences, awakening queſtions, frequent and pertinent applications of ſcripture; all theſe following each other in quick ſucceſſion, and coming evidently from the ſpeaker's heart, enforced by his elocution, his figure, his action, and above all, by the correſponding ſanctity of his example, ſtamped conviction on the minds of his hearers, and ſent them home with impreſſions not eaſy to be effaced. It will readily be imagined that with theſe powers he quickly became one of the moſt admired and popular preachers of his time."

In 1737, he ſucceeded to the ſee of Oxford, on the promotion of Dr Potter to that of Canterbury, then vacant by the death of Archbiſhop Wake.

In the ſpring of 1748. Mrs Secker died of the gout in her ſtomach. She was a woman of great ſenſe and merit, but of a weak and ſickly conſtitution. The biſhop's affection and tenderneſs for her were ſuited to his character. In 1750, he was inſtalled dean of St Paul's, for which he gave in exchange the rectory of St James's and his prebend of Durham. "It was no wonder (ſay our authors) that, after preſiding over ſo extenſive and populous a pariſh for upwards of 17 years, he ſhould willingly conſent to be releaſed from a burden which began now to grow too great for his ſtrength. When he preached his farewel ſermon, the whole audience melted into tears: he was followed with the prayers and good wiſhes of thoſe whom every honeſt man would be moſt ambitious to pleaſe; and there are numbers ſtill living who retain a ſtrong and grateful remembrance of his inceſſant and tender ſolicitude for their welfare. Having now more leiſure both to proſecute his own ſtudies and to encourage thoſe of others, he gave Dr Church conſiderable aſſiſtance in his *Firſt and Second Vindication of the Miraculous Powers*, &c. againſt Mr Middleton, and he was of equal uſe to him in his *Analyſis of Lord Bolingbroke's Works*. About the ſame time began the late Archdeacon Sharp's controverſy with the followers of Mr Hutchinſon, which was carried on to the end of the year 1755." Biſhop Secker, we are told, read over all Dr Sharp's papers, amounting to three volumes 8vo, and corrected and improved them throughout. But the eaſe which this late change of ſituation gave him was ſoon diſturbed by a heavy and unexpected ſtroke, the loſs of his three friends, Biſhops Butler, Benſon, and Berkeley, who were all cut off within the ſpace of one year.

Our authors next give an account of the part which Dr Secker bore, in the houſe of lords, in reſpect to the famous repeal of the Jew bill; for which the duke of Newcaſtle moved, and was ſeconded by the Biſhop, in a ſpeech which, we are told, was remarkably well received. At length his diſtinguiſhed merit prevailed over all the political obſtacles to his advancement, and placed him, without any efforts or application of his own, in that important ſtation which he had ſhown himſelf ſo well qualified to adorn. On the death of Archbiſhop Hutton, he was promoted to the ſee of Canterbury, and was confirmed at Bow-church, April 21. 1758; on which occaſion our authors obſerve, that in accepting this high and burdenſome ſtation, Dr Secker acted on that principle which influenced him through life; that he ſacrificed his own eaſe and comfort to conſiderations of public utility; that the mere ſecular advantages of grandeur were objects below his ambition; and were, as he knew and felt, but poor compenſations for the anxiety and difficulties attending them. He had never once through his whole life aſked preferment for himſelf, nor ſhown any unbecoming eagerneſs for it; and the uſe he made of his newly-acquired dignity very clearly ſhowed, that rank, and wealth, and power, had in no other light any charms for him, than as they enlarged the ſphere of his active and induſtrious benevolence.

He ſought out and encouraged men of real genius or extenſive knowledge; he expended 300l. in arranging and improving the manuſcript library at Lambeth; and obſerving with concern, that the library of printed books in that palace had received no additions ſince the time of Archbiſhop Tenniſon, he made it his buſineſs to collect books in all languages from moſt parts of Europe at a very great expence, with a view of ſupplying that chaſm; which he accordingly did, by leaving them to the library at his death, and thereby rendered that collection one of the nobleſt and moſt uſeful in the kingdom.

All deſigns and inſtitutions which tended to advance good morals and true religion, he patronized with zeal and generoſity: he contributed largely to the maintenance of ſchools for the poor; to rebuilding or repairing parſonage houſes and places of worſhip; and gave no leſs than 600l. towards erecting a chapel in the pariſh of Lambeth. To the ſociety for promoting Chriſtian knowledge he was a liberal benefactor; and to that for propagating the goſpel in foreign parts, of which he was the preſident, he paid much attention; was conſtant at all the meetings of its members, even ſometimes when his health would but ill permit, and ſuperintended their deliberations with conſummate prudence and temper.

Whenever any publications came to his knowledge that were manifeſtly calculated to corrupt good morals, or ſubvert the foundations of Chriſtianity, he did his utmoſt to ſtop the circulation of them; yet the wretched authors themſelves he was ſo far from wiſhing to treat with any undue rigour, that he has more than once extended his bounty to them in diſtreſs. And when their writings could not properly be ſuppreſſed (as was too often the caſe) by lawful authority, he engaged men of abilities to anſwer them, and rewarded them for their trouble. His attention was everywhere. Even the falſehoods and miſrepreſentation of writers in the newſpapers, on religious or eccleſiaſtical ſubjects, he generally took care to have contradicted; and when they ſeemed likely to injure, in any material degree, the cauſe of virtue and religion, or the reputation of eminent and worthy men, he would ſometimes take the trouble of anſwering them himſelf. One inſtance of this kind, which does him honour, and deſerves mention, was his defence of Biſhop Butler, who, in a pamphlet publiſhed in 1767, was accuſed of having died a Papiſt. The conduct which he obſerved towards the ſeveral diviſions and denominations of Chriſtians in this kingdom was ſuch as ſhowed his way of thinking to be truly liberal and catholic. The dangerous ſpirit of popery, indeed, he thought ſhould always be kept under proper legal reſtraints, on account of its natural oppoſition not only to the religious but the civil rights of mankind. He therefore obſerved its movements with care, and exhorted his clergy to do the ſame, eſpecially thoſe who were ſituated in the midſt of Roman Catholic families; againſt whoſe influence they were charged to be upon their guard, and were furniſhed with proper books or inſtructions for that purpoſe. He took all fit opportunities of combating the errors of the church of Rome in his own writings (A); and the beſt anſwers that were publiſhed to ſome of the late bold apologies for popery were written at his inſtance, and under his direction.

(A) See particularly his ſermons on the rebellion in 1745; on the Proteſtant working ſchools in Ireland; on the

With the Diſſenters his Grace was ſincerely deſirous of cultivating a good underſtanding. He conſidered them, in general, as a conſcientious and valuable claſs of men. With ſome of the moſt eminent of them, Watts, Doddridge, Leland, Chandler, Lardner, he maintained an intercourſe of friendſhip or civility. By the moſt candid and conſiderate part of them he was highly reverenced and eſteemed; and to ſuch among them as needed help he ſhowed no leſs kindneſs and liberality than to thoſe of his own communion.

Nor was his concern for the Proteſtant cauſe confined to his own country. He was well known as the great patron and protector of it in various parts of Europe; from whence he had frequent applications for aſſiſtance, which never failed of being favourably received. To ſeveral foreign Proteſtants he allowed penſions, to others he gave occaſional relief, and to ſome of their univerſities was an annual benefactor.

In public affairs, his Grace acted the part of an honeſt citizen, and a worthy member of the Britiſh legiſlature. From his firſt entrance into the houſe of peers, his parliamentary conduct was uniformly upright and noble. He kept equally clear from the extremes of factious petulance and ſervile dependence; never wantonly thwarting adminiſtration from motives of party zeal or private pique, or perſonal attachment, or a paſſion for popularity; nor yet going every length with every miniſter from views of intereſt or ambition. He admired and loved the conſtitution of his country, and wiſhed to preſerve it unaltered and unimpaired. So long as a due regard to this was maintained, he thought it his duty to ſupport the meaſures of government; but whenever they were evidently inconſiſtent with the public welfare, he oppoſed them with freedom and firmneſs. Yet his oppoſition was always tempered with the utmoſt fidelity, reſpect, and decency, to the excellent prince upon the throne; and the moſt candid allowances for the unavoidable errors and infirmities even of the very beſt miniſters, and the peculiarly difficult ſituation of thoſe who govern a free and high-ſpirited people. He ſeldom ſpoke in parliament, except where the intereſts of religion and virtue ſeemed to require it; but whenever he did, he ſpoke with propriety and ſtrength, and was heard with attention and deference. Though he never attached himſelf blindly to any ſet of men, yet his chief political connections were with the late duke of Newcaſtle and Lord Chancellor Hardwicke. To theſe he principally owed his advancement; and he had the good fortune to live long enough to ſhow his gratitude to them or their deſcendants.

For more than ten years, during which Dr Secker enjoyed the ſee of Canterbury, he reſided conſtantly at his archiepiſcopal houſe at Lambeth. A few months before his death, the dreadful pains he felt had compelled him to think of trying the Bath waters: but that deſign was ſtopped by the fatal accident which put an end to his life.

His Grace had been for many years ſubject to the gout, which, in the latter part of his life, returned with more frequency and violence, and did not go off in a regular manner, but left the parts affected for a long time very weak, and was ſucceeded by pains in different parts of the body. About a year and a half before he died, after a fit of the gout, he was attacked with a pain in the arm, near the ſhoulder, which having continued about 12 months, a ſimilar pain ſeized the upper and outer part of the oppoſite thigh, and the arm ſoon became eaſier. This was much more grievous than the former, as it quickly diſabled him from walking, and kept him in almoſt continual torment, except when he was in a reclining poſition. During this time he had two or three fits of the gout; but neither the gout nor the medicines alleviated theſe pains, which, with the want of exerciſe, brought him into a general bad habit of body.

On Saturday July 30. 1768, he was ſeized, as he ſat at dinner, with a ſickneſs at his ſtomach. He recovered before night; but the next evening, while his phyſicians were attending, and his ſervants raiſing him on his couch, he ſuddenly cried out that his thigh-bone was broken. The ſhock was ſo violent, that the ſervants perceived the couch to ſhake under him, and the pain ſo acute and unexpected, that it overcame the firmneſs he ſo remarkably poſſeſſed. He lay for ſome time in great agonies; but when the ſurgeons arrived, and diſcovered with certainty that the bone was broken, he was perfectly reſigned, and never afterwards aſked a queſtion about the event. A fever ſoon enſued. On Tueſday he became lethargic, and continued ſo till about five o'clock on Wedneſday afternoon, when he expired with great calmneſs, in the 75th year of his age.

On examination, the thigh-bone was found to be carious about four inches in length, and at nearly the ſame diſtance from its head. The diſeaſe took its riſe from the internal part of the bone, and had ſo entirely deſtroyed its ſubſtance, that nothing remained at the part where it was broken but a portion of its outward integument; and even this had many perforations, one of which was large enough to admit two fingers, and was filled with a fungous ſubſtance ariſing from within the bone. There was no appearance of matter about the caries, and the ſurrounding parts were in a ſound ſtate. It was apparent that the torture which he underwent during the gradual corroſion of this bone muſt have been inexpreſſibly great. Out of tenderneſs to his family he ſeldom made any complaints to them, but to his phyſicians he frequently declared his pains were ſo excruciating, that unleſs ſome relief could be procured he thought it would be impoſſible for human nature to ſupport them long. Yet he bore them for upwards of ſix months with aſtoniſhing patience and fortitude; ſat up generally the greater part of the day, admitted his particular friends to ſee him, mixed with his family at the uſual hours, ſometimes with his uſual cheerfulneſs; and, except ſome very ſlight defects of memory, retained all his faculties and ſenſes in their full vigour till within a few days of his death. He was buried, purſuant

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5th of November; and a great number of occaſional paſſages to the ſame purpoſe, in various parts of his lectures, ſermons, and other works.

Secker, Second.

ſuant to his own directions, in a covered paſſage, leading from a private door of the palace to the north door of Lambeth church; and he forbade any monument or epitaph to be placed over him.

By his will he appointed the Rev. Dr Daniel Burton, canon of Chriſt-church, and Mrs Catherine Talbot, already mentioned in the courſe of theſe memoirs, his executors; and left 13,000l. in truſt to the Drs Porteous and Stinton, his chaplains; to pay the intereſt thereof to Mrs Talbot and her daughter during their joint lives, or the life of the ſurvivor; and after the deceaſe of both thoſe ladies, 11,000l. of the ſaid 13,000l. are to be transferred to charitable purpoſes; amongſt which are 1000l. to the Society for the Propagation of the Goſpel, and 1000l. to the ſame ſociety for a biſhop or biſhops in the king's dominions in America.

The following deſcription is given of his perſon: He was tall and comely; in the early part of his life ſlender, and rather conſumptive; but as he advanced in years his conſtitution gained ſtrength, and his ſize increaſed, yet never to a degree of corpulency that was diſproportionate or troubleſome.

The dignity of his form correſponded with the greatneſs of his mind, and inſpired at all times reſpect and awe; but peculiarly ſo when he was engaged in any of the more ſolemn functions of religion, into which he entered with ſuch devout earneſtneſs and warmth, with ſo juſt a conſciouſneſs of the place he was in, and the buſineſs he was about, as ſeemed to raiſe him above himſelf, and added new life and ſpirit to the natural gracefulneſs of his appearance.

His countenance was open, ingenuous, and expreſſive of every thing right. It varied eaſily with his ſpirits and his feelings, ſo as to be a faithful interpreter of his mind, which was incapable of the leaſt diſſimulation. It could ſpeak dejection, and, on occaſion, anger, very ſtrongly; but when it meant to ſhow pleaſure or approbation, it ſoftened into a moſt gracious ſmile, and diffuſed over all his features the moſt benevolent and reviving complacency that can be imagined.

SECOND, in *Geometry*, *Chronology*, &c. the 60th part of a prime or minute, whether of a degree or of an hour.

SECOND, in *Muſic*, one of the muſical intervals; being only the difference between any ſound and the next neareſt ſound, whether above or below it.

SECOND Major, in *Muſic*. See INTERVAL.

SECOND Minor, in *Muſic*. See INTERVAL.

SECOND Sight, in Erſe called *Taiſch*, is a mode of ſeeing ſuperadded to that which nature generally beſtows. This gift or faculty, which is neither voluntary nor conſtant, is in general rather troubleſome than agreeable to the poſſeſſors of it, who are chiefly found among the inhabitants of the highlands of Scotland, thoſe of the Weſtern iſles, of the iſle of Man, and of Ireland. It is an impreſſion made either by the mind upon the eye, or by the eye upon the mind, by which things diſtant or future are perceived, and ſeen as if they were preſent. A man on a journey far from home falls from his horſe; another, who is perhaps at work about the houſe, ſees him bleeding on the ground, commonly with a landſcape of the place where the accident befals him. Another ſeer, driving home his cattle, or wandering in idleneſs, or muſing in the ſunſhine, is ſuddenly ſurpriſed by the appearance of a bridal ceremony, or funeral proceſſion, and counts the mourners or attendants, of whom, if he knows them, he relates the names; if he knows them not, he can deſcribe the dreſſes. Things diſtant are ſeen at the the inſtant they happen.

Second.

Of things future, Johnſon ſays that he knows no rule pretended to for determining the time between the ſight and the event; but we are informed by Mr Groſe, that in general the time of accompliſhment bears ſome relation to the time of the day in which the impreſſions are received. Thus viſions ſeen early in the morning (which ſeldom happens) will be much ſooner accompliſhed than thoſe appearing at noon; and thoſe ſeen at noon will take place in a much ſhorter time than thoſe happening at night; ſometimes the accompliſhment of the laſt does not fall out within a year or more.

Theſe viſions are not confined to ſolemn or important events: nor is it true, as is commonly reported, that to the ſecond ſight nothing is preſented but phantoms of evil. The future viſit of a mountebank, or piper; a plentiful draught of fiſh; the arrival of common travellers; or, if poſſible, ſtill more trifling matters than theſe,—are foreſeen by the ſeers. A gentleman told Dr Johnſon, that when he had once gone far from his own iſland, one of his labouring ſervants predicted his return, and deſcribed the livery of his attendant, which he had never worn at home; and which had been, without any previous deſign, occaſionally given him.

As many men eminent for ſcience and literature have admitted the reality of this apparently uſeleſs gift, we ſhall, without interpoſing our own opinion, give the reflections of two of the firſt characters of the age upon it, and leave our readers to form their own judgment. By Dr Beattie of Aberdeen it is thus accounted for.

The Highlands of Scotland are a pictureſque but a melancholy country. Long tracts of mountainous deſert, covered with dark heath, and often obſcured by miſty weather; narrow valleys, thinly inhabited, and bounded by precipices reſounding with the fall of torrents; a ſoil ſo rugged, and a climate ſo dreary, as in many parts to admit neither the amuſements of paſturage nor the labours of agriculture; the mournful daſhing of waves along the friths and lakes that interſect the country; the portentous noiſes which every change of the wind and every increaſe or diminution of the waters is apt to raiſe in a lonely region full of echoes and rocks and caverns; the groteſque and ghaſtly appearance of ſuch a landſcape by the light of the moon: objects like theſe diffuſe a gloom over the fancy, which may be compatible enough with occaſional and ſocial merriment, but cannot fail to tincture the thoughts of a native in the hour of ſilence and ſolitude. If theſe people, notwithſtanding their reformation in religion, and more frequent intercourſe with ſtrangers, do ſtill retain many of their old ſuperſtitions, we need not doubt but in former times they muſt have been much more enſlaved to the horrors of imagination, when beſet with the bugbears of Popery and Paganiſm. Moſt of their ſuperſtitions are of a melancholy caſt. That of *ſecond ſight*, by which ſome are ſtill ſuppoſed to be haunted, is conſidered by themſelves as a misfortune, on account of the many dreadful images it is ſaid to obtrude upon the fancy. It is ſaid that ſome of the Alpine regions do likewiſe lay claim to a ſort of ſecond ſight.

Nor is it wonderful, that perſons of a lively imagination, immured in deep ſolitude, and ſurrounded with the ſtupendous ſcenery of clouds, precipices, and torrents, ſhould dream (even when they think themſelves awake) of thoſe few ſtriking ideas with which their lonely lives are diverſified: of corpſes, funeral proceſſions, and other ſubjects of terror; or of marriages, and the arrival of ſtrangers, and ſuch like matters of more agreeable curioſity.

Let it be obſerved alſo, that the ancient Highlanders of Scotland had hardly any other way of ſupporting themſelves than by hunting, fiſhing, or war; profeſſions that are continually expoſed to fatal accidents. And hence, no doubt, additional horrors would often haunt their ſolitude, and a deeper gloom overſhadow the imagination even of the hardieſt native.

A ſufficient evidence can hardly be found for the reality of the *ſecond ſight*, or at leaſt of what is commonly underſtood by that term. A treatiſe on the ſubject was publiſhed in the year 1762, in which many tales were told of perſons whom the author believed to have been favoured, or haunted, with theſe illuminations; but moſt of the tales were trifling and ridiculous: and the whole work betrayed, on the part of the compiler, ſuch extreme credulity, as could not fail to prejudice many readers againſt his ſyſtem.

That any of theſe viſionaries are apt to be ſwayed in their declarations by ſiniſter views, we will not ſay: but this may be ſaid with confidence, that none but ignorant people pretend to be gifted in this way. And in them it may be nothing more, perhaps, than ſhort fits of ſudden ſleep or drowſineſs, attended with lively dreams, and ariſing from ſome bodily diſorder, the effect of idleneſs, low ſpirits, or a gloomy imagination. For it is admitted, even by the moſt credulous Highlanders, that as knowledge and induſtry are propagated in their country, the ſecond ſight diſappears in proportion; and nobody ever laid claim to the faculty who was much employed in the intercourſe of ſocial life (A). Nor is it at all extraordinary, that one ſhould have the appearance of being awake, and ſhould even think one's ſelf ſo, during thoſe fits of doſing; that they ſhould come on ſuddenly, and while one is engaged in ſome buſineſs. The ſame thing happens to perſons much fatigued, or long kept awake, who frequently fall aſleep for a moment, or for a long ſpace, while they are ſtanding, or walking, or riding on horſeback. Add but a lively dream to this ſlumber, and (which is the frequent effect of diſeaſe) take away the conſciouſneſs of having been aſleep, and a ſuperſtitious man may eaſily miſtake his dream for a waking viſion; which, however, is ſoon forgotten when no ſubſequent occurrence recals it to his memory; but which, if it ſhall be thought to reſemble any future event, exalts the poor dreamer into a Highland prophet. This conceit makes him more recluſe and more melancholy than ever; and ſo feeds his diſeaſe, and multiplies his viſions: which, if they are not diſſipated by buſineſs or ſociety, may continue to haunt him as long as he lives; and which, in their progreſs through the neighbourhood, receive ſome new tinctures of the marvellous from every mouth that promotes their circulation. As to the prophetical nature of this ſecond ſight, it cannot be admitted at all. That the Deity ſhould work a miracle in order to give intimation of the frivolous things that theſe tales are made up of, the arrival of a ſtranger, the nailing of a coffin, or the colour of a ſuit of clothes; and that theſe intimations ſhould be given for no end, and to thoſe perſons only who are idle and ſolitary, who ſpeak Gaelic, or who live among mountains and deſerts—is like nothing in nature or providence that we are acquainted with; and muſt therefore, unleſs it were confirmed by ſatisfactory proof (which is not the caſe), be rejected as abſurd and incredible.

Theſe viſions, ſuch as they are, may reaſonably enough be aſcribed to a diſtempered fancy. And that in them, as well as in our ordinary dreams, certain appearances ſhould, on ſome rare occaſions, reſemble certain events, is to be expected from the laws of chance; and ſeems to have in it nothing more marvellous or ſupernatural, than that the parrot, who deals out his ſcurrilities at random, ſhould ſometimes happen to ſalute the paſſenger by his right appellation.

To the confidence of theſe objections Dr Johnſon replies, that by preſuming to determine what is fit, and what is beneficial, they preſuppoſe more knowledge of the univerſal ſyſtem than man has attained; and therefore depend upon principles too complicated and extenſive for our comprehenſion; and that there can be no ſecurity in the conſequence when the premiſes are not underſtood; that the ſecond ſight is only wonderful becauſe it is rare, for, conſidered in itſelf, it involves no more difficulty than dreams, or perhaps than the regular exerciſe of the cogitative faculty; that a general opinion of communicative impulſes, or viſionary repreſentations, has prevailed in all ages and all nations; that particular inſtances have been given with ſuch evidence, as neither Bacon nor Bayle has been able to reſiſt; that ſudden impreſſions, which the event has verified, have been felt by more than own or publiſh them; that the ſecond ſight of the Hebrides implies only the local frequency of a power, which is nowhere totally unknown; and that where we are unable to decide by antecedent reaſon, we muſt be content to yield to the force of teſtimony. By pretenſion to ſecond ſight, no profit was ever ſought or gained. It is an involuntary affection, in which neither hope nor fear are known to have any part. Thoſe who profeſs to feel it do not boaſt of it as a privilege, nor are conſidered by others as advantageouſly diſtinguiſhed. They have no temptation to feign, and their hearers have no motive to encourage the impoſture.

SECOND Terms, in *Algebra*, thoſe where the unknown quantity has a degree of power leſs than it has in the term where it is raiſed to the higheſt. The art of throwing theſe ſecond terms out of an equation, that is,

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(A) This, however, is denied by Johnſon, who affirms that the Iſlanders of all degrees, whether of rank or underſtanding, univerſally admit it except the miniſters, who, according to him, reject it, in conſequence of a ſyſtem, againſt conviction. He affirms, too, that in 1773, there was in the Hebrides a ſecond-ſighted gentleman, who complained of the terrors to which he was expoſed.

is, of forming a new equation where they have no place, is one of the moſt ingenious and uſeful inventions in all algebra.

SECONDARY, in general, ſomething that acts as ſecond or in ſubordination to another.

SECONDARY or *Secundary*, an officer who acts as ſecond or next to the chief officer. Such are the ſecondaries of the courts of king's bench and common pleas; the ſecondaries of the compters, who are next the ſheriffs of London in each of the two compters; two ſecondaries of the pipe; ſecondaries to the remembrancers, &c.

SECONDARY Circles of the Ecliptic are circles of longitude of the ſtars; or circles which, paſſing through the poles of the ecliptic, are at right angles to the ecliptic. See *CIRCLES of Latitude*.

SECONDARY Qualities of Bodies. See METAPHYSICS, N° 153.

SECONDAT. See MONTESQUIEU.

SECRETARIES BIRD, the falco ſerpentarius and ſagittarius of Linnæus, but claſſed by Latham under the genus VULTUR. See ORNITHOLOGY *Index*.

SECRETARY, an officer who, by his maſter's orders, writes letters, diſpatches, and other inſtruments, which he renders authentic by his ſignet. Of theſe there are ſeveral kinds; as, 1. Secretaries of ſtate, who are officers that have under their management and direction the moſt important affairs of the kingdom, and are obliged conſtantly to attend on the king: they receive and diſpatch whatever comes to their hands, either from the crown, the church, the army, private grants, pardons, diſpenſations, &c. as likewiſe petitions to the ſovereign, which, when read, are returned to them; all which they diſpatch according to the king's direction. They have authority to commit perſons for treaſon, and other offences againſt the ſtate, as conſervators of the peace at common law, or as juſtices of the peace throughout the kingdom. They are members of the privy-council, which is ſeldom or never held without one of them being preſent. As to the buſineſs and correſpondence in all parts of this kingdom, it is managed by either of the ſecretaries without any diſtinction; but with reſpect to foreign affairs, the buſineſs is divided into two provinces or departments, the ſouthern and the northern, comprehending all the kingdoms and ſtates that have any intercourſe with Great Britain; each ſecretary receiving all letters and addreſſes from, and making all diſpatches to, the ſeveral princes and ſtates comprehended in his province. Ireland and the Plantations are under the direction of the elder ſecretary, who has the ſouthern province, which alſo comprehends, France, Italy, Switzerland, Spain, Portugal, and Turkey; the northern province includes the Low Countries, Germany, Denmark, Sweden, Poland, and Muſcovy. Each of the ſecretaries has an apartment in all the royal houſes, both for their own accommodation and their officers; they have alſo a table at the king's charge, or elſe board-wages. The two ſecretaries for Britain have each two under ſecretaries, and one chief clerk; with an uncertain number of other clerks and tranſlators, all wholly depending on them. To the ſecretaries of ſtate belong the cuſtody of that ſeal properly called the *ſignet*, and the direction of two other offices, one called the *paper-office*, and the other the *ſignet-office*. In addition to theſe, there is a ſecretary for the war department, whoſe office muſt be temporary. 2. Secretary of an embaſſy, a perſon attending an ambaſſador, for writing diſpatches relating to the negociation. There is a great difference between the ſecretaries of an embaſſy and the ambaſſador's ſecretary; the laſt being a domeſtic or menial of the ambaſſador, and the firſt a ſervant or miniſter of the prince. 3. The ſecretary of war, an officer of the war office, who has two chief clerks under him, the laſt of which is the ſecretary's meſſenger. There are alſo ſecretaries in moſt of the other offices.

SECRETION, in the animal economy. See PHYSIOLOGY *Index*.

SECT, a collective term, comprehending all ſuch as follow the doctrines and opinions of ſome famous divine, philoſopher, &c.

SECTION, in general, denotes a part of a divided thing, or the diviſion itſelf. Such, particularly, are the ſubdiviſions of a chapter; called alſo *paragraphs* and *articles*: the mark of a ſection is §.

SECTION, in *Geometry*, denotes a ſide or ſurface of a body or figure cut off by another; or the place where lines, planes, &c. cut each other.

SECTOR, in *Geometry*, is a part of a circle comprehended between two radii and the arch: or it is a mixed triangle, formed by two radii and the arch of a circle.

1 Sector

SECTOR, is alſo a mathematical inſtrument, of great uſe in finding the proportion between quantities of the ſame kind: as between lines and lines, ſurfaces and ſurfaces, &c. whence the French call it the *compaſs of proportion*. The great advantage of the ſector above the common ſcales, &c. is, that it is made ſo as to fit all radii and all ſcales. By the lines of chords, ſines, &c. on the ſector, we have lines of chords, ſines, &c. to any radius betwixt the length and breadth of the ſector when open.

The real inventor of this valuable inſtrument is unknown; yet of ſo much merit has the invention appeared, that it was claimed by Galileo, and diſputed by nations.

The ſector is founded on the fourth propoſition of the ſixth book of Euclid; where it is demonſtrated, that ſimilar triangles have their homologous ſides proportional. An idea of the theory of its conſtruction may be conceived thus. Let the lines AB, AC (Plate CCCCLXXVIII. fig. 1.) repreſent the legs of the ſector; and AD, AE, two equal ſections from the centre: if, now the points CB and DE be connected, the lines CB and DE will be parallel; therefore the triangles ADE, ACB will be ſimilar; and conſequently the ſides AD, DE, AB, and BC, proportional; that is, as AD : DE : : AB : BC: whence, if AD be the half, third, or fourth part of AB; DE will be a half, third, or fourth part of CB: and the ſame holds of all the reſt. If, therefore, AD be the chord, ſine, or tangent, of any number of degrees to the radius AB; DE will be the ſame to the radius BC.

Plate cccclxxviii. fig. 1.

2 deſcribed.

Deſcription of the Sector. The inſtrument conſiſts of two rules or legs, of braſs or ivory, or any other matter, repreſenting the radii, moveable round an axis or joint, the middle of which expreſſes the centre; whence are drawn on the faces of the rulers ſeveral ſcales, which may be diſtinguiſhed into ſingle and double.

Fig. 3. & 4.

The double ſcales, or lines graduated upon the faces of the inſtrument, and which are to be uſed as ſectoral lines, proceed from the centre; and are, 1. Two ſcales of equal parts, one on each leg, marked LIN. or L.; each of theſe ſcales, from the great extenſiveneſs of its uſe is called the *line of lines*. 2. Two lines of chords marked CHO. or C. 3. Two lines of ſecants marked SEC. or S. A line of polygons marked POL. Upon the other face the ſectoral lines are, 1. Two lines of ſines marked SIN. or S. 2. Two lines of tangents marked TAN. or T. 3. Between the line of tangents and ſines there is another line of tangents to a leſſer radius, to ſupply the defect of the former, and extending from 45° to 75°, marked *t*.

Each pair of theſe lines (except the line of polygons) is ſo adjuſted as to make equal angles at the centre; and conſequently at whatever diſtance the ſector be opened, the angles will be always reſpectively equal. That is, the diſtance between 10 and 10 on the line of lines, will be equal to 60 and 60 on the line of chords, 90 and 90 on the line of ſines, and 45 and 45 on the line of tangents.

Beſides the ſectoral ſcales, there are others on each face, placed parallel to the outward edges, and uſed as thoſe of the common plane ſcale. 1. Theſe are a line of inches. 2. A line of latitudes. 3. A line of hours. 4. A line of inclination of meridians. 5. A line of chords. Three logarithmic ſcales, namely, one of numbers, one of ſines, and one of tangents. Theſe are uſed when the ſector is fully opened, the legs forming one line (A).

3
To read and eſtimate the diviſions on the ſector and lines.

The value of the diviſions on moſt of the lines is determined by the figures adjacent to them; theſe proceed by tens, which conſtitute the diviſions of the firſt order, and are numbered accordingly; but the value of the diviſions on the line of lines, that are diſtinguiſhed by figures, is entirely arbitrary, and may repreſent any value that is given to them; hence the figures, 1, 2, 3, 4, &c. may denote either 10, 20, 30, 40, or 100, 200, 300, 400, and ſo on.

The line of lines is divided into ten equal parts, numbered 1, 2, 3, to 10; theſe may be called *diviſions of the firſt order*; each of theſe is again ſubdivided into 10 other equal parts, which may be called *diviſions of the ſecond order*; each of theſe is divided into two equal parts, forming *diviſions of the third order*. The diviſions on all the ſcales are contained between four parallel lines; thoſe of the firſt order extend to the moſt diſtant; thoſe of the third to the leaſt; thoſe of the ſecond to the intermediate parallel.

When the whole line of lines repreſents 100, the diviſions of the firſt order, or thoſe to which the figures are annexed, repreſent tens; thoſe of the ſecond order units; thoſe of the third order the halves of theſe units. If the whole line repreſent ten, then the diviſions of the firſt order are units; thoſe of the ſecond tenths; the thirds twentieths.

In the line of tangents, the diviſions to which the numbers are affixed, are the degrees expreſſed by thoſe numbers. Every fifth degree is denoted by a line ſomewhat longer than the reſt; between every number and each fifth degree, there are four diviſions longer than the intermediate adjacent ones, theſe are whole degrees; the ſhorter ones, or thoſe of the third order, are 30 minutes.

From the centre, to 60 degrees, the line of ſines is divided like the line of tangents, from 60 to 70; it is divided only to every degree, from 70 to 80, to every two degrees, from 80 to 90; the diviſion muſt be eſtimated by the eye.

The diviſions on the line of chords are to be eſtimated in the ſame manner as the tangents.

The leſſer line of tangents is graduated every two degrees, from 45 to 50; but from 50 to 60 to every degree; from 60 to the end, to half degrees.

The line of ſecants from 0 to 10 is to be eſtimated by the eye; from 20 to 50, it is divided to every two degrees; from 50 to 60, to every degree; from 60 to the end, to every half degree.

4
Diviſion of a given line by the line of equal parts.

Uſe of the Line of Equal Parts on the SECTOR. 1. To divide a given line into any number of equal parts, ſuppoſe ſeven. Take the given line in your compaſſes; and ſetting one foot in a diviſion of equal parts, that may be divided by ſeven, for example 70, whoſe ſeventh part is 10, open the ſector till the other point fall exactly on 70, in the ſame line on the other leg. In this diſpoſition, applying one point of the compaſſes to 10 in the ſame line; ſhut them till the other fall in 10 in the the ſame line on the other leg, and this opening will be the ſeventh part of the given line. Note, if the line to be divided be too long to be applied to the legs of the ſector, divide only one half or one fourth by ſeven, and the double or quadruple thereof will be the ſeventh part of the whole.

5
To meaſure the perimeter of a polygon.

2. To meaſure the lines of the perimeter of a polygon, one of which contains a given number of equal parts. Take the given line in your compaſſes, and ſet it parallel, upon the line of equal parts, to the number on each leg expreſſing its length. The ſector remaining thus, ſet off the length of each of the other lines parallel to the former, and the number each of them falls on will expreſs its length.

6
Subtraction.

4. A right line being given, and the number of parts it contains, ſuppoſe 120, to take from it a ſhorter line, containing any number of the ſame parts, ſuppoſe 25. Take the given line in your compaſſes, open the ſector till the two feet fall on 120 on each leg; then will the diſtance between 25 on one leg, and the ſame number on the other, give the line required.

7
Multiplication.

4. To multiply by the line of equal parts on the ſector. Take the lateral diſtance from the centre of the line to the given multiplicator; open the ſector till you fit that lateral diſtance to the parallel of 1 and 1, or 10 and 10, and keep the ſector in that diſpoſition; then take in the compaſſes the parallel diſtance of the multiplicand, which diſtance, meaſured laterally on the ſame line, will give the product required. Thus, ſuppoſe it were required to find the product of 8 multiplied by 4: take the lateral diſtance from the centre of the line to 4 in your compaſſes, i. e. place one foot of the compaſſes in the beginning of the diviſions, and extend the other along the line to 4. Open the ſector till you fit this lateral diſtance to the parallel of 1 and 1, or

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(A) The lines are placed in different orders on different ſectors, but they may eaſily be found by theſe general directions.

1, or 10 and 10. Then take the parallel diſtance of 8, the multiplicand; i. e. extend the compaſſes from 8, in this line, on one leg, to 8 in the ſame line on the other; and that extent, meaſured laterally, will give the product required.

8 Diviſion in general. 5. To divide by the line of equal parts on the ſector. Extend the compaſſes laterally from the beginning of the line to 1, and open the ſector till you fit that extent to the parallel of the diviſor; then take the parallel diſtance of the dividend, which extent, meaſured in a lateral direction, will give the quotient required. Thus, ſuppoſe it was required to divide 36 by 4: extend the compaſſes laterally, the beginning of the line to 1, and fit to that extent the parallel of 4, the diviſor; then extend the compaſſes parallel, from 36 on one leg to 36 on the other, and that extent, meaſured laterally, will give 9, the quotient required.

9 Proportion. 6. Proportion by the line of equal parts. Make the lateral diſtance of the ſecond term the parallel diſtance of the firſt term, the parallel diſtance of the third term is the fourth proportional. *Example.* To find a fourth proportional to 8, 4, and 6, take the lateral diſtance of 4, and make it the parallel diſtance of 8; then the parallel diſtance of 6, extended from the centre, ſhall reach to the fourth proportional 3.

In the ſame manner, a third proportional is found to two numbers. Thus, to find a third proportional to 8 and 4, the ſector remaining as in the former example, the parallel diſtance of 4, extended from the centre, ſhall reach to the third proportional 2. In all theſe caſes, if the number to be made a parallel diſtance be too great for the ſector, ſome aliquot part of it is to be taken, and the anſwer is to be multiplied by the number by which the firſt number was divided.

10 Line of chords. *Uſe of the Line of Chords on the* SECTOR. 1. To open the ſector ſo as the two lines of chords may make an angle or number of degrees, ſuppoſe 40. Take the diſtance from the joint to 40, the number of the degrees propoſed, on the line of chords; open the ſector till the diſtance from 60 to 60, on each leg, be equal to the given diſtance of 40; then will the two lines on the ſector form an angle of 40 degrees, as was required.

2. The ſector being opened, to find the degrees of its aperture. Take the extent from 60 to 60, and lay it off on the line of chords from the centre; the number whereon it terminates will ſhow the degrees, &c. required.

3. To lay off any number of degrees upon the circumference of a circle. Open the ſector till the diſtance between 60 and 60 be equal to the radius of the given circle; then take the parallel extent of the chord of the number of degrees on each leg of the ſector, and lay it off on the circumference of the given circle.—Hence any regular polygon may be eaſily inſcribed in a given circle.

11 Line of polygons. *Uſe of the Line of Polygons on the* SECTOR. 1. To inſcribe a regular polygon in a given circle. Take the ſemidiameter of the given circle in the compaſſes, and adjuſt it to the number 6, on the line of polygons, on each leg of the ſector: then, the ſector remaining thus opened, take the diſtance of the two equal numbers, expreſſing the number of ſides the polygon is to have; e. gr. the diſtance from 5 to 5 for a pentagon, from 7 to 7 for a heptagon, &c. Theſe diſtances carried about the circumference of the circle, will divide it into ſo many equal parts.

2. To deſcribe a regular polygon, e. g. a pentagon, on a given right line. Take the length of the line in the compaſſes, and apply it to the extent of the number 5, 5, on the lines of polygons. The ſector thus opened, upon the ſame lines take the extent from 6 to 6; this will be the ſemidiameter of the circle the polygon is to be inſcribed in. If then, with this diſtance, from the ends of the given line, you deſcribe two arches of a circle, their interſection will be the centre of the circle.

3. On a right line, to deſcribe an iſoſceles triangle, having the angles at the baſe double that at the vertex. Open the ſector, till the ends of the given line fall on 10 and 10 on each leg; then take the diſtance from 6 to 6. This will be the length of the two equal ſides of the triangle.

12 Sines, tangents, and ſecants. *Uſe of the Lines of Sines, Tangents, and Secants, on the* SECTOR. By the ſeveral lines diſpoſed on the ſector, we have ſcales to ſeveral radii; ſo that having a length or radius given, not exceeding the length of the ſector when opened, we find the chord, ſine, &c. thereto: e. gr. Suppoſe the chord, ſine, or tangent of 10 degrees, to a radius of 3 inches required; make 3 inches the aperture between 60 and 60, on the lines of chords of the two legs; then will the ſame extent reach from 45 to 45 on the line of tangents, and from 90 to 90 on the line of the ſines on the other ſide; ſo that to whatever radius the line of chords is ſet, to the ſame are all the others ſet. In this diſpoſition, therefore, if the aperture between 10 and 10, on the lines of chords, be taken with the compaſſes, it will give the chord of 10 degrees. If the aperture of 10 and 10 be in like manner taken on the lines of ſines, it will be the ſine of 10 degrees. Laſtly, if the aperture of 10 and 10 be in like manner taken on the lines of tangents, it gives the tangent of 10 degrees.

If the chord, or tangent, of 70 degrees were required; for the chord, the aperture of half the arch, viz. 35, muſt be taken, as before; which diſtance, repeated twice, gives the chord of 70 degrees. To find the tangent of 70 degrees to the ſame radius, the ſmall line of tangents muſt be uſed, the other only reaching to 45: making, therefore, 3 inches the aperture between 45 and 45 on the ſmall line; the extent between 70 and 70 degrees on the ſame, will be the tangent of 70 degrees to 3 inches radius.

To find the ſecant of an arch, make the given radius the aperture between 0 and 0 on the lines of ſecants: then will the aperture of 10 and 10, or 70 and 70, on the ſaid lines, give the tangent of 10° or 70°.

If the converſe of any of theſe things were required, that is, if the radius be required, to which a given line is the ſine, tangent, or ſecant, it is but making the given line, if a chord, the aperture on the line of chords between 10 and 10, and then the ſector will ſtand at the radius required; that is, the aperture between 60 and 60 on the ſaid line is the radius. If the given line were a ſine, tangent, or ſecant, it is but making it the aperture of the given number of degrees; then will the diſtance of 90 and 90 on the ſines, of 45 and 45 on the tangents, of 0 and 0 on the ſecants, be the radius.

SECTOR of an Ellipſe, of an Hyperbola, &c. is a part reſembling the circular ſector, being contained by three lines, two of which are radii, or lines drawn from the centre of the figure to the curve, and the intercepted arc or part of that curve.

SECTOR of a Sphere, is the ſolid generated by the revolution of the ſector of a circle about one of its radii; the other radius deſcribing the ſurface of a cone, and the circular arc a circular portion of the ſurface of the ſphere of the ſame radius. So that the ſpherical ſector conſiſts of a right cone, and of a ſegment of the ſphere having the ſame common baſe with the cone. Hence the ſolid content of it will be found by multiplying the baſe or ſpherical ſurface by the radius of the ſphere, and taking one third of the product.

Aſtronomical SECTOR. See *ASTRONOMICAL Sector*.

Dialing SECTOR. See DIALING.

SECULAR, that which relates to affairs of the preſent world, in which ſenſe the word ſtands oppoſed to *ſpiritual, eccleſiaſtical*: thus we ſay ſecular power, &c.

SECULAR, is more peculiarly uſed for a perſon who lives at liberty in the world, not ſhut up in a monaſtery, nor bound by vows, or ſubjected to the particular rules of any religious community; in which ſenſe it ſtands oppoſed to *regular*. The Romiſh clergy are divided into ſecular and regular, of which the latter are bound by monaſtic rules, the former not.

SECULAR Games, in antiquity, ſolemn games held among the Romans once in an age. Theſe games laſted three days and as many nights; during which time ſacrifices were performed, theatrical ſhews exhibited, with combats, ſports, &c. in the circus. The occaſion of theſe games, according to Valerius Maximus, was to ſtop the progreſs of a plague. Valerius Publicola was the firſt who celebrated them at Rome in the year of the city, 245. The ſolemnity was as follows: The whole world was invited by a herald to a feaſt which they had never ſeen already, nor ever ſhould ſee again. Some days before the games began, the quindecemviri in the Capitol and the Palatine temple, diſtributed to the people purifying compoſitions, of various kinds, as flambeaus, ſulphur, &c. From hence the populace paſſed to Diana's temple on the Aventine mount, with wheat, barley, and oats, as an offering. After this, whole nights were ſpent in devotion to the Deſtinies. When the time of the games was fully come, the people aſſembled in the Campus Martius, and ſacrificed to Jupiter, Juno, Apollo, Latona, Diana, the Parcæ, Ceres, Pluto, and Proſerpine. On the firſt night of the feaſt, the emperor, with the quindecemviri, cauſed three altars to be erected on the banks of the Tiber, which they ſprinkled with the blood of three lambs, and then proceeded to regular ſacrifice. A ſpace was next marked out for a theatre, which was illuminated with innumerable flambeaus and fires. Here they ſung hymns, and celebrated all kinds of ſports. On the day after, having offered victims at the Capitol, they went to the Campus Martius, and celebrated ſports to the honour of Apollo and Diana. Theſe laſted till next day, when the noble matrons, at the hour appointed by the oracle, went to the Capitol to ſing hymns to Jupiter. On the third day, which concluded the ſolemnity, twenty-ſeven boys, and as many girls, ſung in the temple of Palatine Apollo hymns and verſes in Greek and Latin, to recommend the city to the protection of thoſe deities whom they deſigned particularly to honour by their ſacrifices.

The inimitable Carmen Seculare of Horace was compoſed for this laſt day, in the Secular Games, held by Auguſtus.

It has been much diſputed whether theſe games were held every hundred, or every hundred and ten years. Valerius Antius, Varro, and Livy, are quoted in ſupport of the former opinion: In favour of the latter may be produced the quindecemviral regiſters, the edicts of Auguſtus, and the words of Horace in the Secular poem,

Cœtus undenos decies per annos.

It was a general belief, that the girls who bore a part in the ſong ſhould be ſooneſt married; and that the children who did not dance and ſing at the coming of Apollo, ſhould die unmarried, and at an early period of life.

SECULAR Poem, a poem ſung or rehearſed at the ſecular games: of which kind we have a very fine piece among the works of Horace, being a ſapphic ode at the end of his epodes.

SECULARIZATION, the act of converting a regular perſon, place, or benefice, into a ſecular one. Almoſt all the cathedral churches were anciently regular, that is, the canons were to be religious; but they have been ſince ſecularized. For the ſecularization of a regular church, there is required the authority of the pope, that of the prince, the biſhop of the place, the patron, and even the conſent of the people. Religious that want to be releaſed from their vow, obtain briefs of ſecularization from the pope.

SECUNDINES, in *Anatomy*, the ſeveral coats or membranes wherein the fœtus is wrapped up in the mother's womb; as the chorion and amnios, with the placenta, &c.

SECUNDUS, JOANNES NICOLAIUS, an elegant writer of Latin poetry, was born at the Hague in the year 1511. His deſcent was from an ancient and honourable family in the Netherlands; and his father Nicolaus Everardus, who was born in the neighbourhood of Middleburg, ſeems to have been high in the favour of the emperor Charles V. as he was employed by that monarch in ſeveral ſtations of conſiderable importance. We find him firſt a member of the grand parliament or council of Mechelen, afterwards preſident of the ſtates of Holland and Zealand at the Hague, and laſtly holding a ſimilar office at Mechelen, where he died, Auguſt 5. 1532, aged 70.

Theſe various employments did not occupy the whole of Everardus's time. Notwithſtanding the multiplicity of his buſineſs, he found leiſure to cultivate letters with great ſucceſs, and even to act as preceptor to his own children, who were five ſons and three daughters. They all took the name of Nicolaii from their father; but on what account our author was called *Secundus* is not known. It could not be from the order of his birth, for he was the youngeſt ſon. Perhaps the name was not given him till he became eminent; and then, according to the faſhion of the age, it might have its riſe from ſome pun, ſuch as his being *Poetarum nemini Secundus*. Poetry, however, was by no means the profeſſion which his father wiſhed him to follow. He intended him for the law, and when he could no longer direct his ſtudies himſelf, placed him under the care of

Jacobus Valeardus. This man is ſaid to have been every way well qualified to diſcharge the important truſt which was committed to him; and he certainly gained the affection of his pupil, who, in one of his poems, mentions the death of Valeardus with every appearance of unfeigned ſorrow. Another tutor was ſoon provided; but it does not appear that Secundus devoted much of his time to legal purſuits. Poetry and the ſiſter arts of painting and ſculpture had engaged his mind at a very early period; and the imagination, on which theſe have laid hold, can with difficulty ſubmit to the dry ſtudy of muſty civilians. Secundus is ſaid to have written verſes when but ten years old; and from the vaſt quantity which he left behind him, we have reaſon to conclude that ſuch writing was his principal employment. He found time, however, to carve figures of all his own family, of his miſtreſſes, of the emperor Charles V. of ſeveral eminent perſonages of thoſe times, and of many of his intimate friends; and in the laſt edition of his works publiſhed by Scriverius at Leyden, 1631, there is a print of one of his miſtreſſes with this inſcription round it; VATIS AMATORIS JULIA SCULPTA MANU.

Secundus having nearly attained the age of twenty-one, and being determined, as it would ſeem, to comply as far as poſſible with the wiſhes of his father, quitted Mechelen, and went to France, where at *Bourges*, a city in the *Orleanois*, he ſtudied the civil law under the celebrated *Andreas Alciatus*. Alciatus was one of the moſt learned civilians of that age; but what undoubtedly endeared him much more to our author was his general acquaintance with polite literature, and more particularly his taſte in poetry. Having ſtudied a year under this eminent profeſſor, and taken his degrees, Secundus returned to Mechelen, where he remained only a very few months. In 1533 he went into Spain with warm recommendations to the count of Naſſau and other perſons of high rank; and ſoon afterwards became ſecretary to the cardinal archbiſhop of Toledo, in a department of buſineſs which required no other qualifications than what he poſſeſſed in a very eminent degree, a facility in writing with elegance the Latin language. It was during his reſidence with this cardinal that he wrote his *Baſia*, a ſeries of wanton poems, of which the fifth, ſeventh, and ninth *carmina* of *Catullus* ſeem to have given the hint. Secundus was not, however, a ſervile imitator of Catullus. His expreſſions ſeem to be borrowed rather from *Tibullus* and *Propertius;* and in the warmth of his deſcriptions he ſurpaſſes every thing that has been written on ſimilar ſubjects by *Catullus*, *Tibullus*, *Propertius*, *C. Gallus*, *Ovid*, or *Horace*.

In 1535 he accompanied the emperor Charles V. to the ſiege of Tunis, but gained no laurels as a ſoldier. The hardſhips which were endured at that memorable ſiege were but little ſuited to the ſoft diſpoſition of a votary of Venus and the muſes; and upon an enterpriſe which might have furniſhed ample matter for an epic poem, it is remarkable that Secundus wrote nothing which has been deemed worthy of preſervation. Having returned from his martial expedition, he was ſent by the cardinal to Rome to congratulate the pope upon the ſucceſs of the emperor's arms; but was taken ſo ill on the road, that he was not able to complete his journey. He was adviſed to ſeek, without a moment's delay, the benefit of his native air; and that happily recovered him.

Having now quitted the ſervice of the archbiſhop of Toledo, Secundus was employed in the ſame office of ſecretary by the biſhop of Utrecht; and ſo much had he hitherto diſtinguiſhed himſelf by the claſſical elegance of his compoſitions, that he was ſoon called upon to fill the important poſt of private Latin ſecretary to the emperor, who was then in Italy. This was the moſt honourable office to which our author was ever appointed; but before he could enter upon it death put a ſtop to his career of glory. Having arrived at *Saint Amand* in the diſtrict of *Tournay*, in order to meet, upon buſineſs, with the biſhop of Utrecht, he was on the 8th of October 1536 cut off by a violent fever, in the very flower of his age, not having quite completed his twenty-fifth year. He was interred in the church of the Benedictines, of which his patron, the biſhop, was *abbot* or *pro-abbot;* and his near relations erected to his memory a marble monument, with a plain Latin inſcription.

The works of Secundus have gone through ſeveral editions, of which the beſt and moſt copious is that of Scriverius already mentioned. It conſiſts of JULIA, *Eleg.* lib. i.; AMORES, *Eleg.* lib. ii.; AD DIVERSOS *Eleg.* lib. iii.; BASIA, ſtyled by the editor *incomparabilis et divinus prorſus liber;* EPIGRAMMATA; ODARUM *liber unus;* EPISTOLARUM *liber unus Elegiaca;* EPISTOLARUM *liber alter, heroico carmine ſcriptus;* FUNERUM *liber unus;* SYLVÆ *et* CARMINUM *fragmenta;* POEMATA *nonnulla fratrum;* ITINERARIA *Secundi tria*, &c.; EPISTOLÆ *totidem, ſoluta oratione.* Of theſe works it would be ſuperfluous in us to give any character after the ample teſtimonies prefixed to them of *Lelius Greg. Gyraldus*, the elder *Scaliger*, *Theodore Beza*, and others equally celebrated in the republic of letters, who all ſpeak of them with rapture. A French critic, indeed, after having affirmed that the genius of Secundus never produced any thing which was not excellent in its kind, adds, with too much truth, *Mais ſa muſe eſt un peu trop laſcive.* For this fault our author makes the following apology in an epigram addreſſed to the grammarians:

Carmina cur ſpargam cunctis laſciva libellis,
   Queritis? Inſulſos arceo grammaticos.
Fortia magnanimi canerem ſi Cæſaris arma,
   Factave DIVORUM religioſa VIRUM:
Quot miſer exciperemque notas, patererque lituras?
   Quot fierem teneris ſupplicium pueris?
At nunc uda mihi dictant cum BASIA carmen,
   Pruriet et verſu mentula multa meo:
Me leget innuptæ juvenis placiturus amicæ,
   Et placitura nova blanda puella viro:
Et quemcunque juvat lepidorum de grege vatum
   Otia feſtivis ludere deliciis.
Luſibus et lætis procul hinc abſiſtite, SÆVI
   GRAMMATICI, injuſtas et cohibite manus.
Ne puer, ab malleis cæſus lacrymanſque leporis;
   DURAM FORTE MEIS OSSIBUS OPTET HUMUM.

SECURIDACA, a genus of plants belonging to the claſs diadelphia. See BOTANY *Index*.

SECUTORES, a ſpecies of gladiators among the Romans, whoſe arms were a helmet, a ſhield, and a ſword or a leaden bullet. They were armed in this manner, becauſe they had to contend with the retiarii, who were dreſſed in a ſhort tunic, bore a three-pointed lance in their left hand, and a net in their right. The retiarius attempted to caſt his net over the head of the ſecutor; and if he ſucceeded, he drew it together and ſlew him with his trident: but if he miſſed his aim, he immediately betook himſelf to flight till he could find a ſecond opportunity of entangling his adverſary with his net. He was purſued by the ſecutor, who endeavoured to diſpatch him in his flight.

Secutores was alſo a name given to ſuch gladiators as took the place of thoſe killed in the combat, or who engaged the conqueror. This poſt was uſually taken by lot.

SEDAN is a town in France, in the department of the Ardennes, in E. Long. 4. 45. N. Lat. 49. 46. This is the capital of a principality of the ſame name, ſituated on the Maeſe, ſix miles from Bouillon, and fifteen from Charleville. Its ſituation on the frontiers of the territory of Liege, Namur, and Limburg, formerly rendered it one of the keys of the kingdom. It is extremely well fortified, and defended by a ſtrong citadel. The caſtle is ſituated on a rock, ſurrounded with large towers and ſtrong walls; here you ſee a moſt beautiful magazine of ancient arms. The governor's palace is oppoſite the caſtle. From the ramparts you have a moſt agreeable proſpect of the Maeſe and the neighbouring country. Though the town is but ſmall, yet it is full of tradeſmen, as tanners, weavers, dyers, &c. the manufacture of fine cloth in this city employing a great number of hands. The principality of Sedan formerly belonged to the duke of Bouillon, who was obliged in the beginning of the laſt century to reſign it to the crown.

SEDAN-CHAIR is a covered vehicle for carrying a ſingle perſon, ſuſpended by two poles, and borne by two men, hence denominated *chairmen.* They were firſt introduced in London in 1634, when Sir Sanders Duncomb obtained the ſole privilege to uſe, let, and hire a number of the ſaid covered chairs for fourteen years.

SEDGMOOR, a large and rich tract of land in Somerſetſhire, memorable for the defeat of the duke of Monmouth, in 1685. It lies between Somerton and Bridgewater.

SEDITION, among civilians, is uſed for a factious commotion of the people, or an aſſembly of a number of citizens without lawful authority, tending to diſturb the peace and order of the ſociety. This offence is of different kinds: ſome ſeditions more immediately threatening the ſupreme power, and the ſubverſion of the preſent conſtitution of the ſtate; others tending only towards the redreſs of private grievances. Among the Romans, therefore, it was variouſly puniſhed, according as its end and tendency threatened greater miſchief. See lib. i. *Cod. de Seditioſis*, and *Mat. de Crimin.* lib. ii. n. 5. *de Læſa Majeſtate.* In the puniſhment, the authors and ringleaders were juſtly diſtinguiſhed from thoſe who, with leſs wicked intention, joined and made part of the multitude.

The ſame diſtinction holds in the law of England and in that of Scotland. Some kinds of ſedition in England amount to high treaſon, and come within the ſtat. 25 Edw. III. as levying war againſt the king. And ſeveral ſeditions are mentioned in the Scotch acts of parliament as treaſonable. *Bayne's Crim. Law of Scotland*, p. 33, 34. The law of Scotland makes riotous and tumultuous aſſemblies a ſpecies of ſedition. But the law there, as well as in England, is now chiefly regulated by the riot act, made 1 Geo. I. only it is to be obſerved, that the proper officers in Scotland, to make the proclamation thereby enacted, are ſheriffs, ſtewards, and bailies of regalities, or their deputies; magiſtrates of royal boroughs, and all other inferior judges and magiſtrates; high and petty conſtables, or other officers of the peace, in any county, ſtewartry, city, or town. And in that part of the iſland, the puniſhment of the offence is any thing ſhort of death which the judges, in their diſcretion, may appoint.

SEDATIVES, in *Medicine*, a general name for ſuch medicines as weaken the powers of nature, ſuch as blood-letting, cooling ſalts, purgatives, &c.

SE-DEFENDENDO, in *Law*, a plea uſed for him that is charged with the death of another, by alleging that he was under a neceſſity of doing what he did in his own defence: as that the other aſſaulted him in ſuch a manner, that if he had not done what he did, he muſt have been in hazard of his own life. See HOMICIDE and MURDER.

SEDIMENT, the ſettlement or dregs of any thing, or that groſs heavy part of a fluid body which ſinks to the bottom of the veſſel when at reſt.

SEDLEY, SIR CHARLES, an Engliſh poet and wit, the ſon of Sir John Sedley of Aylesford in Kent, was born about the year 1639. At the reſtoration he came to London to join the general jubilee; and commenced wit, courtier, poet, and gallant. He was ſo much admired, that he became a kind of oracle among the poets; which made King Charles tell him, that Nature had given him a patent to be Apollo's viceroy. The productions of his pen were ſome plays, and ſeveral delicately tender amorous poems, in which the ſoftneſs of the verſes was ſo exquiſite, as to be called by the duke of Buckingham *Sedley's witchcraft.* "There were no marks of genius or true poetry to be deſcried, (ſay the authors of the *Biographia Britannica*); the art wholly conſiſted in raiſing looſe thoughts and lewd deſires, without giving any alarm; and ſo the poiſon worked gently and irreſiſtibly. Our author, we may be ſure, did not eſcape the infection of his own art, or rather was firſt tainted himſelf before he ſpread the infection to others."—A very ingenious writer of the preſent day, however, ſpeaks much more favourably of Sir Charles Sedley's writings. "He ſtudied human nature; and was diſtinguiſhed for the art of making himſelf agreeable, particularly to the ladies; for the verſes of Lord Rocheſter, beginning with, *Sedley has that prevailing gentle art*, &c. ſo often quoted, allude not to his *writings*, but to his *perſonal addreſs*." [*Langhorn's Effuſions*, &c.]—But while he thus grew in reputation for wit and in favour with the king, he grew poor and debauched: his eſtate was impaired, and his morals were corrupted. One of his frolics, however, being followed by an indictment and a heavy fine, Sir Charles took a more ſerious turn, applied himſelf to buſineſs, and became a member of parliament, in which he was a frequent ſpeaker. We find him in the houſe of commons in the reign of James II. whoſe attempts upon the conſtitution he vigorouſly withſtood; and he was very active in bringing on the revolution. This was thought more extraordinary, as he had received favours from James. But that prince had taken a fancy to Sir Charles's

Charles's daughter (though it ſeems ſhe was not very handſome), and, in conſequence of his intrigues with her, he created Miſs Sedley counteſs of Dorcheſter. This honour, ſo far from pleaſing, greatly ſhocked Sir Charles. However libertine he himſelf had been, yet he could not bear the thoughts of his daughter's diſhonour; and with regard to her exaltation, he only conſidered it as rendering her more conſpicuouſly infamous. He therefore conceived a hatred for the king; and from this, as well as other motives, readily joined to diſpoſſeſs him of the throne. A witty ſaying of Sedley's, on this occaſion, is recorded. "I hate ingratitude, (ſaid Sir Charles); and therefore, as the king has made my daughter a counteſs, I will endeavour to make his daughter a queen;" meaning the princeſs Mary, married to the prince of Orange, who diſpoſſeſſed James of the throne at the revolution. He lived to the beginning of Queen Anne's reign; and his works were printed in two vols. 8vo. 1719.

SEDR, or SEDRE, the high-prieſt of the ſect of Ali among the Perſians. The ſedre is appointed by the emperor of Perſia, who uſually confers the dignity on his neareſt relation. The juriſdiction of the ſedre extends over all effects deſtined for pious purpoſes, over all moſques, hoſpitals, colleges, ſepulchres, and monaſteries. He diſpoſes of all eccleſiaſtical employments, and nominates all the ſuperiors of religious houſes. His deciſions in matters of religion are received as ſo many infallible oracles: he judges of all criminal matters in his own houſe without appeal. His authority is balanced by that of the mudſitehid, or firſt theologue of the empire.

SEDUCTION, is the act of tempting and drawing aſide from the right path, and comprehends every endeavour to corrupt any individual of the human race. This is the import of the word in its largeſt and moſt general ſenſe; but it is commonly employed to expreſs the act of tempting a virtuous woman to part with her chaſtity.

The *ſeducer* of female innocence practiſes the ſame ſtratagems of fraud to get poſſeſſion of a woman's perſon, that the *ſwindler* employs to get poſſeſſion of his neighbour's goods or money; yet the law of honour, which pretends to abhor *deceit*, and which impels its votaries to *murder* every man who preſumes, however juſtly, to ſuſpect them of fraud, or to queſtion their veracity, applauds the addreſs of a ſucceſsful intrigue, though it be well known that the ſeducer could not have obtained his end without ſwearing to the truth of a thouſand falſehoods, and calling upon God to witneſs promiſes which he never meant to fulfil.

The law of honour is indeed a very capricious rule, which accommodates itſelf to the pleaſures and conveniences of higher life; but the law of the land, which is enacted for the equal protection of high and low, may be ſuppoſed to view the guilt of ſeduction with a more impartial eye. Yet for this offence, even the laws of this kingdom have provided no other puniſhment than a pecuniary ſatisfaction to the injured family; which, in England, can be obtained only by one of the quainteſt fictions in the world, by the father's bringing his action againſt the ſeducer for the loſs of his daughter's ſervice during her pregnancy and nurturing. See Paley's *Moral Philoſophy*, Book III. Part iii. Chap. 3.

The moraliſt, however, who eſtimates the merit or demerit of actions, not by laws of human appointment, but by their general conſequences as eſtabliſhed by the laws of nature, muſt conſider the ſeducer as a criminal of the deepeſt guilt. In every civilized country, and in many countries where civilization has made but ſmall progreſs, the virtue of women is collected as it were into a ſingle point, which they are to guard above all things, as that on which their happineſs and reputation wholly depend. At firſt ſight this may appear a capricious regulation; but a moment's reflection will convince us of the contrary. In the married ſtate ſo much confidence is neceſſarily repoſed in the fidelity of women to the beds of their huſbands, and evils ſo great reſult from the violation of that fidelity, that whatever contributes in any degree to its preſervation, muſt be agreeable to him who, in eſtabliſhing the laws of nature, intended them to be ſubſervient to the real happineſs of all his creatures. But nothing contributes ſo much to preſerve the fidelity of wives to their huſbands, as the impreſſing upon the minds of women the higheſt veneration for the virtue of chaſtity. She who, when unmarried, has been accuſtomed to grant favours to different men, will not find it eaſy, if indeed poſſible, to reſiſt afterwards the allurements of variety. It is therefore a wiſe inſtitution, and agreeable to the will of Him who made us, to train up women ſo as that they may look upon the loſs of their chaſtity as the moſt diſgraceful of all crimes: as that which ſinks them in the order of ſociety, and robs them of all their value. In this light virtuous women actually look upon the loſs of chaſtity. The importance of that virtue has been ſo deeply impreſſed upon their minds, and is ſo cloſely aſſociated with the principle of honour, that they cannot think but with abhorrence upon the very deed by which it is loſt. He therefore who by fraud and falſehood perſuades the unſuſpecting girl to deviate in one inſtance from the honour of the ſex, weakens in a great degree her moral principle; and if he reconcile her to a repetition of her crime, he deſtroys that principle entirely, as ſhe has been taught to conſider all other virtues as inferior to that of chaſtity. Hence it is that the hearts of proſtitutes are generally ſteeled againſt the miſeries of their fellow-creatures; that they lend their aid to the ſeducer in his practices upon other girls; that they lie and ſwear and ſteal without compunction; and that too many of them heſitate not to commit murder if it can ſerve any ſelfiſh purpoſe of their own.

The loſs of virtue, though the greateſt that man or woman can ſuſtain, is not the only injury which the ſeducer brings on the girl whom he deceives. She cannot at once reconcile herſelf to proſtitution, or even to the loſs of character; and while a ſenſe of ſhame remains in her mind, the miſery which ſhe ſuffers muſt be exquiſite. She knows that ſhe has forfeited what in the female character is moſt valued by both ſexes; and ſhe muſt be under the perpetual dread of a diſcovery. She cannot even confide in the honour of her ſeducer, who may reveal her ſecret in a fit of drunkenneſs, and thus rob her of her fame as well as of her virtue; and while ſhe is in this ſtate of anxious uncertainty, the agony of her mind muſt be inſupportable. That it is ſo in fact, the many inſtances of child murder by unmarried women of every rank, leave us no room to doubt. The affection of a mother to her new-born child is one of the moſt unequivocal and ſtrongeſt inſtincts in human nature (ſee Instinct); and nothing ſhort of the extremity of diſtreſs could prompt any one ſo far to oppoſe her nature as to embrue her hands in the blood of her imploring infant.

Even this deed of horror ſeldom prevents a detection of the mother's frailty, which is indeed commonly diſcovered, though no child has been the conſequence of her intrigue. He who can ſeduce is baſe enough to betray; and no woman can part with her honour, and retain any well-grounded hope that her amour ſhall be kept ſecret. The villain to whom ſhe ſurrendered will glory in his victory, if it was with difficulty obtained; and if ſhe ſurrendered at diſcretion, her own behaviour will reveal her ſecret. Her reputation is then irretrievably loſt, and no future circumſpection will be of the ſmalleſt avail to recover it. She will be ſhunned by the virtuous part of her own ſex, and treated as a mere inſtrument of pleaſure by the other. In ſuch circumſtances ſhe cannot expect to be married with advantage. She may perhaps be able to captivate the heart of a heedleſs youth, and prevail upon him to unite his fate to her's before the delirium of his paſſion ſhall give him time for reflection; ſhe may be addreſſed by a man who is a ſtranger to her ſtory, and married while he has no ſuſpicion of her ſecret; or ſhe may be ſolicited by one of a ſtation inferior to her own, who, though acquainted with every thing that has befallen her, can barter the delicacy of wedded love for ſome pecuniary advantage; but from none of theſe marriages can ſhe look for happineſs. The delirium which prompted the firſt will ſoon vaniſh, and leave the huſband to the bitterneſs of his own reflections, which can hardly fail to produce cruelty to the wife. Of the ſecret, to which, in the ſecond caſe, the lover was a ſtranger, the huſband will ſoon make a diſcovery, or at leaſt find room for harbouring ſtrong ſuſpicions; and ſuſpicions of having been deceived in a point ſo delicate have hitherto been uniformly the parents of miſery. In the third caſe, the man married her merely for money, of which having got the poſſeſſion, he has no farther inducement to treat her with reſpect. Such are ſome of the conſequences of ſeduction, even when the perſon ſeduced has the good fortune to get afterwards a huſband; but this is a fortune which few in her circumſtances can reaſonably expect. By far the greater part of thoſe who have been defrauded of their virtue by the arts of the ſeducer ſink deeper and deeper into guilt, till they become at laſt common proſtitutes. The public is then deprived of their ſervice as wives and parents; and inſtead of contributing to the population of the ſtate, and to the ſum of domeſtic felicity, theſe outcaſts of ſociety become ſeducers in their turn, corrupting the morals of every young man whoſe appetites they can inflame, and of every young woman whom they can entice to their own practices.

All this complication of evil is produced at firſt by arts, which, if employed to deprive a man of his property, would ſubject the offender to the execration of his fellow-ſubjects, and to an ignominious death: but while the forger of a bill is purſued with relentleſs rigour by the miniſters of juſtice, and the ſwindler loaded with univerſal reproach, the man who by fraud and forgery has enticed an innocent girl to gratify his deſires at the expence of her virtue, and thus introduced her into a path which muſt infallibly lead to her own ruin, as well as to repeated injuries to the public at large, is not deſpiſed by his own ſex, and is too often careſſed even by the virtuous part of the other. Yet the loſs of property may be eaſily repaired; the loſs of honour is irreparable! It is vain to plead in alleviation of this guilt, that women ſhould be on their guard againſt the arts of the ſeducer. Moſt unqueſtionably they ſhould; but arts have been uſed which hardly any degree of caution would have been ſufficient to counteract. It may as well be ſaid that the trader ſhould be on his guard againſt the arts of the forger, and accept of no bill without previouſly conſulting him in whoſe name it is written. Caſes, indeed, occur in trade, in which this caution would be impoſſible; but he muſt be little acquainted with the workings of the human heart, who does not know that ſituations likewiſe occur in life, in which it is equally impoſſible for a girl of virtue and tenderneſs to reſiſt the arts of the man who has completely gained her affections.

The mentioning of this circumſtance leads us to conſider another ſpecies of ſeduction, which, though not ſo highly criminal as the former, is yet far removed from innocence; we mean the practice which is too prevalent among young men of fortune of employing every art in their power to gain the hearts of heedleſs girls whom they reſolve neither to marry nor to rob of their honour. Should a man adhere to the latter part of this reſolution, which is more than common fortitude can always promiſe for itſelf, the injury which he does to the object of his amuſement is yet very great, as he raiſes hopes of the moſt ſanguine kind merely to diſappoint them, and diverts her affections perhaps for ever from ſuch men as, had they been fixed on one of them, might have rendered her completely happy. Diſappointments of this kind have ſometimes been fatal to the unhappy girl; and even when they have neither deprived her of life, nor diſordered her reaſon, they have often kept her wholly from marriage, which, whatever it be to a man, is that from which every woman expects her chief happineſs. We cannot therefore conclude this article more properly than with warning our female readers not to give up their hearts haſtily to men whoſe ſtation in life is much higher than their own; and we beg leave to aſſure every one of them, that the man who ſolicits the laſt favour under the moſt ſolemn promiſe of a ſubſequent marriage, is a baſe ſeducer, who prefers a momentary gratification of his own to her honour and happineſs through life, and has no intention to fulfil his promiſe. Or, if he ſhould by any means be compelled to fulfil it, ſhe may depend upon much ill treatment in return for her premature compliance with his baſe deſires.

SEDUM, Orpine, a genus of plants belonging to the decandria claſs, and in the natural method ranking under the 13th order, *Succulentæ*. See Botany *Index*.

SEED, in *Phyſiology*, a ſubſtance prepared by nature for the reproduction and conſervation of the ſpecies both in animals and plants. See Botany and Physiology.

SEEDLINGS, among gardeners, denote ſuch roots of gilliflowers, &c. as come from ſeed ſown. Alſo the young tender ſhoots of any plants that are newly ſown.

SEEDS, Preservation of, in a ſtate fit for vegetation, is a matter of great and general importance, becauſe, if it be poſſible to accompliſh it, we ſhall thus be enabled to rear many uſeful plants in one country which are there unknown, being indigenous only in others at a great diſtance from it.

A gentleman informs us, that many years ago he obſerved ſome ſeeds which had got accidentally among raiſins, being ſuch as are raiſed in England with difficulty, after being ſent from abroad in the uſual manner. He ſowed them in pots within a framing; and as every one of them grew, he ſent orders to his ſons, who were at that time abroad, to pack up all kinds of ſeeds they could procure, in abſorbent paper, and ſend ſome of them ſurrounded by raiſins, and others by brown moiſt ſugar; concluding, that the preſervation of the former ſeeds had been owing to a peculiarly favourable ſtate of the moiſture thus afforded them. He likewiſe concluded that, as many of our common ſeeds, ſuch as clover, charlock, &c. would lie dormant for ages within the earth, well preſerved for vegetation whenever they were thrown to its ſurface, and expoſed to the influence of the atmoſphere, ſo likewiſe might theſe foreign ſeeds be equally preſerved, at leaſt for many months, by the kindly covering and genial moiſture afforded them by ſugar or raiſins. This opinion was fully verified, as not one in twenty of them failed to vegetate, while the ſame ſpecies of ſeeds ſent home in common parcels along with them, did not vegetate at all. Having examined them prior to their being committed to the earth, he obſerved that there was a prevailing dryneſs in the latter, while the former looked healthy and freſh, not being in the ſmalleſt degree infeſted by inſects, as was the caſe with the others. It has been repeatedly tried to convey ſeeds cloſed up in bottles, but this method has failed of ſucceſs, a larger proportion of air, as well as a proper ſtate of moiſture, perhaps being neceſſary. It may be requiſite to obſerve, that no difference was made in the package of the ſeeds, reſpecting their being kept in huſks, pods, &c. ſo as to give thoſe preſerved in raiſins or ſugar any advantage over the others, the whole being ſent equally guarded by their natural teguments *.

SEEDY, in the brandy trade, a term uſed by the dealers to denote a fault that is found in ſeveral parcels of French brandy, which renders them unſaleable. The French ſuppoſe that theſe brandies obtain the flavour which they expreſs by this name, from weeds that grow among the vines from whence the wine of which this brandy is preſſed was made.

SEEING, the perceiving of external objects by means of the eye. For an account of the organs of ſight, and the nature of viſion, ſee ANATOMY and OPTICS *Index*.

SEEKS, a religious ſect ſettled at Patna, and ſo called from a word contained in one of the commandments of their founder, which ſignifies *learn thou*. In books giving an account of oriental ſects and oriental cuſtoms, we find mention made both of *Seeks* and *Seiks*; and we are ſtrongly inclined to think that the ſame tribe is meant to be denominated by both words. If ſo, different authors write very differently of their principles and manners. We have already related ſomething of the character of the *Seiks* under the article HINDOOS; but in the Aſiatic Reſearches, Mr Wilkins gives a much more amiable account of the *Seeks*, which we lay before our readers with pleaſure.

The Seeks are a ſect diſtinguiſhed both from the Muſſulmans and the worſhippers of Brahma; and, from our author's account of them, muſt be an amiable people. He aſked leave to enter into their chapel: They ſaid it was a place of worſhip, open to all men, but intimated that he muſt take off his ſhoes. On complying with this ceremony, he was politely conducted into the hall, and ſeated upon a carpet in the midſt of the aſſembly. The whole building forms a ſquare of about 40 feet. The hall is in the centre, divided from four other apartments by wooden arches, upon pillars of the ſame materials. The walls above the arches were hung with European looking-glaſſes in gilt frames, and with pictures. On the left hand, as one enters, is the chancel, which is furniſhed with an altar covered with cloth of gold, raiſed a little above the ground in a declining poſition. About it were ſeveral flower-pots and roſe-water bottles, and three urns to receive the donations of the charitable. On a low deſk, near the altar, ſtood a great book, of folio ſize, from which ſome portions are daily read in the divine ſervice. When notice was given that it was *noon*, the congregation arranged themſelves upon the carpet on each ſide of the hall. The great book and deſk were brought from the altar, and placed at the oppoſite extremity. An old ſilver-haired man kneeled down before the deſk, with his face towards the altar, and by him ſat a man with a drum, and two or three with cymbals. The book was now opened, and the old man began to chant to the time of the inſtruments, and at the concluſion of every verſe moſt of the congregation joined chorus in a reſponſe, with countenances exhibiting great marks of joy. Their tones were not harſh; the time was quick; and Mr Wilkins learned that the ſubject was a hymn in praiſe of the unity, omnipreſence, and omnipotence of the Deity. The hymn concluded, the whole company got up and preſented their faces, with joined hands, towards the altar in the attitude of prayer. The prayer was a ſort of litany pronounced by a young man in a loud and diſtinct voice; the people joining, at certain periods, in a general reſponſe. This prayer was followed by a ſhort bleſſing from the old man, and an invitation to the aſſembly to partake of a friendly feaſt. A ſhare was offered to Mr Wilkins, who was too polite to refuſe it. It was a kind of ſweetmeat compoſed of ſugar and flower mixed up with clarified butter. They were next ſerved with a few ſugar plums; and thus ended the feaſt and ceremony.

In the courſe of converſation Mr Wilkins learned that the founder of this ſect was *Nancek Sah*, who lived about 400 years ago; who left behind him a book, compoſed by himſelf in verſe, containing the doctrines he had eſtabliſhed; that this book teaches, that there is but one God, filling all ſpace, and pervading all matter; and that there will be a day of retribution, when virtue will be rewarded, and vice puniſhed. (Our author forgot to aſk in what manner). It forbids murder, theft, and ſuch other deeds as are by the majority of mankind eſteemed crimes, and inculcates the practice of all the virtues; but, particularly, a univerſal philanthropy and hoſpitality to ſtrangers and travellers. It not only commands univerſal toleration, but forbids diſputes with thoſe of another perſuaſion. If any one ſhow a ſincere inclination to be admitted among them, any five or more Seeks being aſſembled in any place, even on the highway, they ſend to the firſt ſhop where ſweet-

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* *Tranſactions of the Society of Arts*, vol. xvi.

meats are ſold, and procure a very ſmall quantity of a particular kind called *batāſā* (Mr Wilkins does not tell us of what it is compoſed), which having diluted in pure water, they ſprinkle ſome of it on the body and eyes of the proſelyte, whilſt one of the beſt inſtructed repeats to him the chief canons of their faith, and exacts from him a ſolemn promiſe to abide by them the reſt of his life. They offered to admit Mr Wilkins into their ſociety; but he declined the honour, contenting himſelf with their alphabet, which they told him to guard as the apple of his eye, as it was a ſacred character. Mr Wilkins finds it but little different from the Dewanagari. The language itſelf is a mixture of Perſian, Arabic, and Shanſcrit, grafted upon the provincial dialect of Punjah, which is a kind of Hindowee, or, as we commonly call it, *Moors*.

SEGALIEN, a large iſland ſeparated from the coaſt of Chineſe Tartary by a narrow channel. It is called Tchoka by the natives, and Oku-Jeſſu by the Chineſe. It is ſituated between 46° and 54° N. Lat.; but its breadth from eaſt to weſt is unknown. The frigates under the command of Perouſe came to anchor in different bays, to the fineſt of which, in 48° 59′ N. Lat. and 140° 32′ E. Long. from Paris, the French commodore gave the name of Baie d'Eſtaing.

Segalien is well wooded, and mountainous towards the centre, but flat and level along the coaſt, the ſoil of which is peculiarly favourable to agriculture; and vegetation is extremely vigorous. The whole ſurface is almoſt covered with foreſts of pine, birch, oak, and willow trees; and the ſeas, rivers, and brooks, abound with excellent ſalmon and trout. In general, the weather is mild and foggy; and the inhabitants are healthy and ſtrong, and many of them live to an extreme old age. The preſents received by the natives from the French, were only valued in proportion to their utility. They make uſe of looms, which are complete inſtruments, though ſmall. The inhabitants in general do not exceed five feet in height, although ſome of the talleſt meaſure about five feet four inches. Their countenances are animated and agreeable; their cheeks are large, their noſe rounded at the extremity; they have ſtrong voices, and rather thick lips, which are of a dull red.

The women are not ſo tall as the men, but of a more rounded and delicate form, with dreſſes nearly ſimilar; their upper lip is tattoed all over of a blue colour; the hair of their head is black, ſmooth, and of a moderate ſtrength, worn about ſix inches long behind, and they cut it into a bruſh on the top of their head and over the temples. They wear ſurtouts of ſkin or quilted nankeen, which reach to the calf of the leg, and ſometimes lower, by which the uſe of drawers is in a great meaſure rendered unneceſſary. They all wear girdles, like the lower orders among the Chineſe, from which a knife is ſuſpended as a defence againſt the bears, and a number of ſmall pockets for holding their flint and ſteel, pipe and box of tobacco, for they are very great ſmokers. Their huts are ſmall in proportion to the number of inhabitants they contain, but ſufficient to defend them againſt the rain and other inclemencies of the atmoſphere. The roof conſiſts of two inclined planes, from 10 to 12 feet high at their union, and three or four on the ſides; the breadth of the roof is 15, and its length 18 feet. They uſe iron pots in cooking, alſo ſhells, veſſels made of wood and birch bark, of different forms and workmanſhip. They have two meals a-day, the one at noon, and the other in the evening. Each family has its own hunting and fiſhing implements, and their arms are bows, javelins, and a kind of ſpontoon, which laſt is employed in hunting the bear.

The only domeſtic animals are dogs, of a middling ſize, with ſhaggy hair, pricked ears, and a long ſharp muzzle, with a loud but not ſavage cry.

The people of Segalien are of a mild and unſuſpicious diſpoſition, and appear to hold a commercial intercourſe with the Chineſe through the medium of the Mantchou Tartars, with the Ruſſians to the north of their iſland, and the Japaneſe to the ſouth; but the articles of trade conſiſt only of a few furs and whale oil.

SEGEBERG, a town of Germany, in the duchy of Holſtein, and in Wagria; with a caſtle ſtanding on a high mountain, conſiſting of limeſtone, large quantities of which are carried to Hamburg and Lubeck. It belongs to Denmark, and is ſeated on the river Treve, in E. Long. 10. 9. N. Lat. 54. 0.

SEGEDIN, a ſtrong town of Lower Hungary, in the county of Czongrad, with a caſtle. The Imperialiſts took it from the Turks in 1686. It is ſeated at the confluence of the rivers Teſſe and Maſroch, in E. Long. 20. 35. N. Lat. 46. 28.

SEGMENT *of a* CIRCLE, in *Geometry*, is that part of the circle contained between a chord and an arch of the ſame circle.

SEGMENTS, LINE OF, two particular lines on Gunter's ſector. They lie between the lines of ſines and ſuperficies, and are numbered, 5, 6, 7, 8, 9, 10. They repreſent the diameter of a circle, ſo divided into 100 parts, that a right line drawn through theſe parts, and perpendicular to the diameter, ſhall cut the circle into two ſegments, the greater of which ſhall have the ſame proportion to the whole circle, as the parts cut off have to 100.

SEGNA, a city of Croatia, belonging to the houſe of Auſtria, and ſeated on the coaſt of the gulf of Venice. It was formerly a place of ſtrength and great importance; but it has ſuffered many calamities, and its inhabitants at preſent do not amount to 7000. In the beginning of this century it ſent 50 merchant ſhips to ſea; but the inconveniency of its ſituation and badneſs of its harbour, in which the ſea is never calm, diſcouraged navigation, and Segna has now very few ſhips belonging to it. Among the cuſtoms of the Segnans, Mr Fortis mentions one relative to the dead, which for its ſingularity may be worthy of notice.

Fortis's Travels into Dalmatia.

" All the relations and friends of the family go to kiſs the corpſe, by way of taking leave, before burial. Each of them uncovers the face, over which a handkerchief is ſpread, more or leſs rich according to the family; having kiſſed the dead perſon, every one throws another handkerchief over the face; all which remain to the heirs, and ſometimes there are 20, 30, and more at this ceremony. Some throw all theſe handkerchiefs into the grave with the corpſe; and this, in former times, was the general cuſtom; but then they were rich. This ſeems to have been brought into uſe as a ſubſtitute for the ancient *vaſi lachrymatorii*." E. Long. 15. 21. N. Lat. 45. 22.

SEGNI, an ancient town of Italy, in the Campagna of Rome, with a biſhop's ſee, and the title of duchy. It is ſaid that organs were firſt invented here. It is ſeated on a mountain. E. Long. 13. 15. N. Lat. 41. 50.

SEGO, the metropolis of the kingdom of Bambarra in Africa, on the banks of the Niger, in N. Lat. 14. 4. and W. Long. 2. 1. It conſiſts of four diſtinct towns, two on the northern bank of the river, called Sego Korro, and Sego Boo; and two on the ſouthern bank, called Sego Soo Korro, and Sego See Korro, all ſurrounded with lofty mud walls, and the houſes are conſtructed of clay, ſeveral of them two ſtories high, and even white-waſhed. Moſques are to be ſeen in every quarter, and the ſtreets, though narrow, are ſufficiently broad for every uſeful purpoſe, where wheel-carriages are wholly unknown. According to Mr Park, the inhabitants of Sego amount to 30,000; and it is the conſtant reſidence of the king of Bambarra, a conſiderable part of whoſe revenue ariſes from the fare given by paſſengers for croſſing the river. The people, however, are not ſo hoſpitable as in many other African towns, as the Moors are here very numerous, whoſe bigotry renders them the implacable enemies of every white man, if ſuſpected of being a Chriſtian.

Mr Park being therefore prohibited from living in Sego, reſided for three days in an adjacent village, and was diſmiſſed on the fourth, after receiving 5000 kowries from the king, to enable him to buy proviſions in the courſe of his journey; and although it amounted only to 20s. ſterling, ſo very cheap were the neceſſaries of life in Bambarra, that he found it ſufficient to procure proviſions for himſelf, and corn for his horſe, for not fewer than 50 days.

SEGORBE, a town of Spain, in the kingdom of Valencia, with the title of a duchy, and a biſhop's ſee. It is ſeated on the ſide of a hill, between the mountains, in a ſoil very fertile in corn and wine, and where there are quarries of fine marble. It was taken from the Moors in 1245; and the Romans thought it worth their while to carry ſome of the marble to Rome. W. Long. 0. 3. N. Lat. 39. 48.

SEGOVIA, an ancient city of Spain, of great power in the time of the Cæſars, is built upon two hills near the banks of the Arayda in Old Caſtile. W. Long. 3. 48. N. Lat. 41. 0. It is ſtill a biſhop's ſee, and is diſtinguiſhed for ſome venerable remains of antiquity. In the year 1525 the city contained 5000 families, but now they do not ſurpaſs 2000, a ſcanty population for 25 pariſhes; yet, beſide 21 churches and a cathedral, there are 21 convents.

The firſt object in Segovia that attracts the eye is the aqueduct, which the ſingular ſituation of the city renders neceſſary. As it is built upon two hills, and the valley by which they are ſeparated, and extends conſiderably in every direction, it was difficult for a part of the citizens to be ſupplied with water. The difficulty was removed, according to the opinion of the learned, in the reign of Trajan, by this aqueduct, which is one of the moſt aſtoniſhing and the beſt preſerved of the Roman works. In the opinion of Mr Swinburne, who ſurveyed it in 1776, and who ſeems to have given a very accurate account of the curioſities of Segovia, it is ſuperior in elegance of proportion to the Pont du Gard at Niſmes. It is ſo perfectly well preſerved, that it does not ſeem leaky in any part. From the firſt low arches to the reſervoir in the town, its length is 2400 Spaniſh feet; its greateſt height (in the Plaza del Azobejo at the foot of the walls) is 104; it is there compoſed of a double row of arches, built of large ſquare ſtones without mortar, and over them a hollow wall of coarſer materials for the channel of the water, covered with large oblong flags. Of the lower range of arcades, which are 15 feet wide by 65 high, there are 42. The upper arches are 119 in number, their height 27 Spaniſh feet, their breadth ſeventeen, the tranſverſal thickneſs, or depth of the piers, eight feet.

Swinburne's Travels through Spain.

The cathedral is a mixture of the Gothic and Mooriſh architecture. The inſide is very ſpacious, and of majeſtic ſimplicity. The windows are well diſpoſed, and the great altar has been lately decorated with the fineſt Grenadan marble. But it is to be regretted, that in this cathedral, as well as in moſt others of Spain, the choir is placed in the middle of the nave. The church is nearly upon the model of the great church of Salamanca, but it is not ſo highly finiſhed.

Travels in Spain by the Chev. de Bourgoanne.

The alcazar, or ancient palace of the Moors, ſtands in one of the fineſt poſitions poſſible, on a rock riſing above the open country. A fine river waſhes the foot of the precipice, and the city lies admirably well on each ſide on the brow of the hill; the declivity is woody, and the banks charmingly rural; the ſnowy mountains and dark foreſts of Saint Ildefonzo compoſe an awful back-ground to the picture. Towards the town there is a large court before the great outward tower, which, as the priſon of Gil Blas, is ſo well deſcribed by Le Sage, that the ſubject requires no farther explanation. The reſt of the buildings form an antique palace, which has ſeldom been inhabited by any but priſoners ſince the reign of Ferdinand and Iſabella, who were much attached to this ſituation. There are ſome magnificent halls in it, with much gilding in the ceilings, in a ſemi-barbarous taſte. All the kings of Spain are ſeated in ſtate along the cornice of the great ſaloon; but it is doubtful whether they are like the princes whoſe names they bear; if that reſemblance, however, be wanting, they have no other merit to claim. The royal apartments are now occupied by a college of young gentlemen cadets, educated at the king's expence in all the ſciences requiſite for forming an engineer. The grand-maſter of the ordnance reſides at Segovia, which is the head eſtabliſhment of the Spaniſh artillery.

The mint is below the alcazar, a large building, the moſt ancient place of coinage in the kingdom. The machines for melting, ſtamping, and milling the coin, are worked by water: but there is reaſon to believe that Seville has at preſent more buſineſs, as being nearer the ſource of riches, the port of Cadiz, where the ingots of America are landed.

The unevenneſs of the crown of the hill gives a wild look to this city. Moſt of the ſtreets are crooked and dirty, the houſes wooden and very wretched; nor do the inhabitants appear much the richer for their cloth manufactory. Indeed, it is not in a very flouriſhing condition, but what cloth they make is very fine.

The country about Segovia has the reputation of being the beſt for rearing the kind of ſheep that produces the beautiful Spaniſh wool; but as thoſe flocks wander over many other parts of the kingdom, Segovia ſeems to have no excluſive title to this reputation. Segovia (ſays Mr Townſend, whoſe valuable travels will be read with much pleaſure) was once famous for its cloth made on

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the king's account; but other nations have ſince become rivals in this branch, and the manufacture in this city has been gradually declining. When the king gave it up to a private company, he left about 3000l. in trade; but now he is no longer a partner in the buſineſs. In the year 1612 were made here 25,500 pieces of cloth, which conſumed 44,625 quintals of wool, employed 34,189 perſons; but at preſent they make only about 4000 pieces. The principal imperfections of this cloth are, that the thread is not even, and that much greaſe remains in it when it is delivered to the dyer; in conſequence of which the colour is apt to fail. Yet, independently of imperfections, ſo many are the diſadvantages under which the manufacture labours, that foreigners can afford to pay 3l. for the aroba of fine wool, for which the Spaniard gives no more than 20s. and after all his charges can command the market even in the ports of Spain.

Townſend's Journey through Spain.

SEGOVIA, *New*, a town of North America, in New Spain, and in the audience of Guatimala; ſeated on the river Yare, on the confines of the province of Honduras. W. Long. 84. 30. N. Lat. 13. 25.

SEGOVIA, a town of America, in Terra Firma, and in the province of Venezuela, ſeated on a river, near a very high mountain, where there are mines of gold. W. Long. 65. 30. N. Lat. 8. 20.

SEGOVIA, a town of Aſia, in the iſland of Manila, and one of the largeſt of the Philippines, ſeated at the north end of the iſland, 240 miles north of Manila, and ſubject to Spain. E. Long. 120. 59. N. Lat. 18. 36.

SEGREANT, is the herald's word for a griffin when drawn in a leaping poſture, and diſplaying his wings as if ready to fly.

SEGUE, in the Italian muſic, is often found before *aria*, *alleluja*, *amen*, &c. to ſhow that thoſe portions or parts are to be ſung immediately after the laſt note of that part over which it is writ; but if theſe words *ſi placet*, or *ad libitum*, are joined therewith, it ſignifies, that theſe portions may be ſung or not at pleaſure.

SEGUIERIA, a genus of plants belonging to the claſs polyandria. See BOTANY *Index*.

SEJANT, a term uſed in heraldry, when a lion, or other beaſt, is drawn in an eſcutcheon ſitting like a cat with his fore-feet ſtraight.

SEJANUS, ÆLIUS, a native of Vulſinum in Tuſcany, who diſtinguiſhed himſelf in the court of Tiberius. His father's name was Seius Strabo; a Roman knight, commander of the pretorian guards. His mother was deſcended from the Junian family. Sejanus firſt gained the favour of Caius Cæſar, the grandſon of Auguſtus, but afterwards he attached himſelf to the intereſt and the views of Tiberius, who then ſat on the imperial throne. The emperor, who was naturally of a ſuſpicious temper, was free and open with Sejanus, and while he diſtruſted others, he communicated his greateſt ſecrets to this fawning favourite. Sejanus improved this confidence; and when he had found that he poſſeſſed the eſteem of Tiberius, he next endeavoured to become the favourite of the ſoldiers, and the darling of the ſenate. As commander of the pretorian guards he was the ſecond man in Rome, and in that important office he made uſe of inſinuations and every mean artifice to make himſelf beloved and revered. His affability and condeſcenſion gained him the hearts of the common ſoldiers, and, by appointing his own favourites and adherents to places of truſt and honour, all the officers and centurions of the army became devoted to his intereſt. The views of Sejanus in this were well known; yet, to advance with more ſucceſs, he attempted to gain the affection of the ſenators. In this he met with no oppoſition. A man who has the diſpoſal of places of honour and dignity, and who has the command of the public money, cannot but be the favourite of thoſe who are in need of his aſſiſtance. It is even ſaid, that Sejanus gained to his views all the wives of the ſenators, by a private and moſt ſacred promiſe of marriage to each of them, whenever he had made himſelf independent and ſovereign of Rome. Yet, however ſucceſsful with the beſt and nobleſt families in the empire, Sejanus had to combat numbers in the houſe of the emperor; but theſe ſeeming obſtacles were ſoon removed. All the children and grandchildren of Tiberius were ſacrificed to the ambition of the favourite under various pretences; and Druſus the ſon of the emperor, by ſtriking Sejanus, made his deſtruction ſure and inevitable. Livia, the wife of Druſus, was gained by Sejanus; and, though the mother of many children, ſhe was prevailed upon to aſſiſt her adulterer in the murder of her huſband, and ſhe conſented to marry him when Druſus was dead. No ſooner was Druſus poiſoned, than Sejanus openly declared his wiſh to marry Livia. This was ſtrongly oppoſed by Tiberius; and the emperor, by recommending Germanicus to the ſenators for his ſucceſſor, rendered Sejanus bold and determined. He was more urgent in his demands; and, when he could not gain the conſent of the emperor, he perſuaded him to retire to ſolitude from the noiſe of Rome and the troubles of the government. Tiberius, naturally fond of eaſe and luxury, yielded to his repreſentations, and retired to Campania, leaving Sejanus at the head of the empire. This was highly gratifying to the favourite, but he was not without a maſter. Prudence and moderation might have made him what he wiſhed to be; but having offended the emperor beyond forgiveneſs, he reſolved to retrieve his loſs, and by one vigorous effort to decide the fate of the empire. He called together his friends and followers; he paid court to ſuch as ſeemed diſaffected; he held forth rewards and promiſes; and, having increaſed the number of his partiſans, formed a bold conſpiracy, reſolved by any means to ſeize the ſovereign power.

Lempriere's Dictionary.

A powerful league was formed with aſtoniſhing rapidity, and great numbers of all deſcriptions, ſenators as well as military men, entered into the plot. Among theſe, Satrius Secundus was the confidential friend and prime agent of the miniſter. Whatever was this man's motive, whether fear, or views of intereſt, or ingratitude (for no principle of honour can be imputed to him), he reſolved to betray the ſecret to Tiberius. For this purpoſe he addreſſed himſelf to Antonia, the daughter of Anthony the triumvir, the widow of Druſus, and the mother of Germanicus. When this illuſtrious woman, who was honoured by the court and revered by the people, heard the particulars, ſhe ſent diſpatches to the emperor by one of her ſlaves. Tiberius was aſtoniſhed, but not diſmayed. The danger preſſed; his habitual ſlowneſs was out of ſeaſon; the time called for vigour and deciſive meaſures. He ſent Macro to Rome, with a ſpecial commiſſion to take upon him the command of the prætorian guards. He added full inſtructions for

Murphy's Tacitus, Book v.

Sejanus.

his conduct in all emergencies. Early in the morning on the 15th, before the kalends of November, a report was ſpread, that letters had arrived at Rome, in which the emperor ſignified his intention to aſſociate Sejanus with himſelf in the tribunitian power. The ſenate was ſummoned to meet in the temple of Apollo, near the imperial palace. Sejanus attended without delay. A party of the prætorians followed him. Macro met him in the veſtibule of the temple. He approached the miniſter with all demonſtrations of profound reſpect, and taking him aſide, "Be not ſurpriſed (he ſaid) that you have no letter from the prince: it is his pleaſure to declare you his colleague in the tribunitian power; but he thinks that a matter of ſo much importance ſhould be communicated to the fathers by the voice of the conſuls. I am going to deliver the emperor's orders." Sejanus, elated with joy, and fluſhed with his new dignity, entered the ſenate-houſe; Macro followed him. As ſoon as the conſuls arrived, he delivered the letter from Tiberius, and immediately went forth to the prætorian guards. He informed them, that by order of the prince, a large donative was to be diſtributed among the ſoldiers. He added, that, by a new commiſſion, he himſelf was appointed their commanding officer; and, if they followed him to the camp, they would there receive the promiſed bounty. The lure was not thrown out in vain: the prætorian guards quitted their ſtation. Laco, who ſtood near at hand, immediately ſurrounded the ſenate-houſe with a body of the city cohorts.

The letter to the conſuls was confuſed, obſcure, and tedious, only glancing at Sejanus, till at laſt the language of invective left no room for doubt. Sejanus kept his ſeat like a man benumbed, ſenſeleſs and ſtupid with aſtoniſhment. His friends, who a little before congratulated him on his new dignity, deſerted him on every ſide. He was commanded by the conſul to riſe and follow him, and being loaded with irons, was conducted to priſon. His downfal filled the city with exultation. The populace, who worſhipped him in the hour of proſperity, rejoiced to ſee the ſad cataſtrophe to which he was now reduced. They followed in crowds, rending the air with ſhouts, and pouring forth a torrent of abuſe and ſcurrilous language. The priſoner endeavoured to hide his face; but the mob delighted to ſee remorſe and ſhame and guilt and horror in every feature of his diſtracted countenance. They reviled him for his acts of cruelty; they laughed at his wild ambition; they tore down his images, and daſhed his ſtatues to pieces. He was doomed by Tiberius to ſuffer death on that very day; but, as he had a powerful faction in the ſenate, it was not thought adviſeable, for the mere formality of a regular condemnation, to hazard a debate. Private orders were given to Macro to diſpatch him without delay; but the conſul, ſeeing the diſpoſitions of the people, and the calm neutrality of the prætorian guards, judged it beſt to re-aſſemble the fathers. They met in the temple of Concord. With one voice Sejanus was condemned to die, and the ſentence was executed without delay. He was ſtrangled in the priſon. His body was dragged to the Gemoniæ, and, after every ſpecies of inſult from the populace, at the end of three days was thrown into the Tiber. Such was the tragic end of that ambitious favourite. He fell a terrible example to all, who, in any age or country, may hereafter endeavour by their vices to riſe above their fellow-citizens.

Sejanus.
||
Seiſin.

SEIGNIOR, is, in its general ſignification, the ſame with *lord*, but is particularly uſed for the lord of the fee or of a manor, as *ſeigneur* among the feudiſts is he who grants a fee or benefit out of the land to another; and the reaſon is, becauſe having granted away the uſe and profit of the land, the property or dominion he ſtill retains in himſelf.

SEIGNIORAGE, is a royalty or prerogative of the king, whereby he claims an allowance of gold and ſilver brought in the maſs to be exchanged for coin. As ſeigniorage, out of every pound weight of gold, the king had for his coin 5s. of which he paid to the maſter of the mint ſometimes 1s. and ſometimes 1s. 6d. Upon every pound weight of ſilver, the ſeigniorage allowed to the king in the time of Edward III. was 18 pennyweights, which then amounted to about 1s. out of which he ſometimes paid 8d. at others 9d. to the maſter. In the reign of King Henry V. the king's ſeigniorage of every pound of ſilver was 15d. &c.

SEIGNIORY, is borrowed from the French *ſeigneurie*, i. e. *dominatus*, *imperium*, *principatus*; and ſignifies with us a manor or lordſhip, *ſeigniory de ſokemans*. *Seigniory in groſs*, ſeems to be the title of him who is not lord by means of any manor, but immediately in his own perſon; as *tenure in capite*, whereby one holds of the king, as of his crown, is *ſeigniory in groſs*.

SEIKS. See HINDOSTAN.

SEISIN, in *Law*, ſignifies poſſeſſion. In this ſenſe we ſay, *premier ſeiſin*, for the firſt poſſeſſion, &c.

Seiſin is divided into that *in deed* or *in fact*, and that *in law*. A ſeiſin in *deed* is where a poſſeſſion is actually taken: but a ſeiſin in *law* is, where lands deſcend, and the party has not entered thereon; or, in other words, it is where a perſon has a right to lands, &c. and is by wrong diſſeiſed of them. A ſeiſin in law is held to be ſufficient to avow on; though to the bringing of an aſſize, actual ſeiſin is required; and where ſeiſin is alleged, the perſon pleading it muſt ſhow of what eſtate he is ſeiſed, &c.

Seiſin of a ſuperior ſervice is deemed to be a ſeiſin of all ſuperior and caſual ſervices that are incident thereto; and ſeiſin of a leſſee for years, is ſufficient for him in reverſion.

Livery of SEISIN, in *Law*, an eſſential ceremony in the conveyance of landed property; being no other than the pure feodal inveſtiture, or delivery of corporal poſſeſſion of the land or tenement. This was held abſolutely neceſſary to complete the donation; *Nam feudam ſine inveſtitura nullo modo conſtitui potuit*: and an eſtate was then only perfect when, as Fleta expreſſes it in our law, *fit juris et ſeiſinæ conjunctio*. See FEOFMENT.

Inveſtitures, in their original riſe, were probably intended to demonſtrate in conquered countries the actual poſſeſſion of the lord; and that he did not grant a bare litigious right, which the ſoldier was ill qualified to proſecute, but a peaceable and firm poſſeſſion. And, at a time when writing was ſeldom practiſed, a mere oral gift, at a diſtance from the ſpot that was given, was not likely to be either long or accurately retained in the memory of byſtanders, who were very little intereſted in the grant. Afterwards they were retained as a public and notorious act, that the country might take notice of and teſtify the transfer of the eſtate; and that ſuch as claimed title by other means might know againſt whom to bring their actions.

In all well-governed nations, ſome notoriety of this kind has been ever held requiſite, in order to acquire and aſcertain the property of lands. In the Roman law, *plenum dominium* was not ſaid to ſubſiſt unleſs where a man had both the *right* and the *corporal poſſeſſion*; which poſſeſſion could not be acquired without both an actual intention to poſſeſs, and an actual ſeiſin or entry into the premiſſes, or part of them in the name of the whole. And even in eccleſiaſtical promotions, where the freehold paſſes to the perſon promoted, corporal poſſeſſion is required at this day to veſt the property completely in the new proprietor; who, according to the diſtinction of the canoniſt, acquires the *jus ad rem*, or inchoate and imperfect right, by nomination and inſtitution; but not the *jus in re*, or complete and full right, unleſs by corporal poſſeſſion. Therefore in dignities poſſeſſion is given by inſtalment; in rectories and vicarages by induction; without which no temporal rights accrue to the miniſter, though every eccleſiaſtical power is veſted in him by inſtitution. So alſo even in deſcents of lands, by our law, which are caſt on the heir by act of the law itſelf, the heir has not *plenum dominium*, or full and complete ownerſhip, till he has made an actual corporal entry into the lands: for if he dies before *entry* made, *his* heir ſhall not be entitled to take the poſſeſſion, but the heir of the perſon who was laſt actually ſeiſed. It is not therefore only a mere right to enter, but the actual entry, that makes a man complete owner; ſo as to tranſmit the inheritance to his own heirs: *non jus, ſed ſeiſina, facit ſtipitem.*

Yet the corporal tradition of lands being ſometimes inconvenient, a ſymbolical delivery of poſſeſſion was in many caſes anciently allowed; by transferring ſomething near at hand, in the preſence of credible witneſſes, which by agreement ſhould ſerve to repreſent the very thing deſigned to be conveyed; and an occupancy of this ſign or ſymbol was permitted as equivalent to occupancy of the land itſelf. Among the Jews we find the evidence of a purchaſe thus defined in the book of Ruth: "Now this was the manner in former time in Iſrael, concerning redeeming and concerning changing, for to confirm all things: a man plucked off his ſhoe, and gave it to his neighbour; and this was a teſtimony in Iſrael." Among the ancient Goths and Swedes, contracts for the ſale of lands were made in the preſence of witneſſes, who extended the cloak of the buyer, while the ſeller caſt a clod of the land into it, in order to give poſſeſſion; and a ſtaff or wand was alſo delivered from the vender to the vendee, which paſſed through the hands of the witneſſes. With our Saxon anceſtors the delivery of a turf was a neceſſary ſolemnity to eſtabliſh the conveyance of lands. And, to this day, the conveyance of our copyhold eſtates is uſually made from the ſeller to the lord or his ſteward by delivery of a rod or verge, and then from the lord to the purchaſer by re-delivery of the ſame in the preſence of a jury of tenants.

Conveyances in writing were the laſt and moſt refined improvement. The mere delivery of poſſeſſion, either actual or ſymbolical, depending on the ocular teſtimony and remembrance of the witneſſes, was liable to be forgotten or miſrepreſented, and became frequently incapable of proof. Beſides, the new occaſions and neceſſities introduced by the advancement of commerce, required means to be deviſed of charging and incumbering eſtates, and of making them liable to a multitude of conditions and minute deſignations, for the purpoſes of raiſing money, without an abſolute ſale of the land; and ſometimes the like proceedings were found uſeful in order to make a decent and competent proviſion for the numerous branches of a family, and for other domeſtic views. None of which could be effected by a mere, ſimple, corporal transfer of the ſoil from one man to another, which was principally calculated for conveying an abſolute unlimited dominion. Written deeds were therefore introduced, in order to ſpecify and perpetuate the peculiar purpoſes of the party who conveyed: yet ſtill, for a very long ſeries of years, they were never made uſe of, but in company with the more ancient and notorious method of transfer by delivery of corporal poſſeſſion.

Livery of ſeiſin, by the common law, is neceſſary to be made upon every grant of an eſtate of freehold in hereditaments corporeal, whether of inheritance or for life only. In hereditaments incorporeal it is impoſſible to be made; for they are not the object of the ſenſes: and in leaſes for years, or other chattel intereſts, it is not neceſſary. In leaſes for years indeed an actual *entry* is neceſſary, to veſt the eſtate in the leſſee: for a bare leaſe gives him only a right to enter, which is called his intereſt in the term, or *intereſſe termini*: and when he enters in purſuance of that right, he is then, and not before, in poſſeſſion of his term, and complete tenant for years. This entry by the tenant himſelf ſerves the purpoſe of notoriety, as well as livery of ſeiſin from the granter could have done; which, it would have been improper to have given in this caſe, becauſe that ſolemnity is appropriated to the conveyance of a freehold. And this is one reaſon why freeholds cannot be made to commence *in futuro*, becauſe they cannot (at the common law) be made but by livery of ſeiſin; which livery, being an actual manual tradition of the land, muſt take effect *in præſenti*, or not at all.

Livery of ſeiſin is either in *deed* or in *law*.

Livery in *deed* is thus performed. The feoffor, leſſor, or his attorney, together with the feoffee, leſſee, or his attorney, (for this may as effectually be done by deputy or attorney as by the principals themſelves in perſon), come to the land or to the houſe; and there, in the preſence of witneſſes, declare the contents of the feoffment or leaſe on which livery is to be made. And then the feoffor, if it be of land, doth deliver to the feoffee, all other perſons being out of the ground, a clod or turf, or a twig or bough there growing, with words to this effect: "I deliver theſe to you in the name of ſeiſin of all the lands and tenements contained in this deed." But, if it be of a houſe, the feoffor muſt take the ring or latch of the door, the houſe being quite empty, and deliver it to the feoffee in the ſame form; and then the feoffee muſt enter alone, and ſhut the door, and then open it, and let in the others. If the conveyance or feoffment be of divers lands, lying ſcattered in one and the ſame county, then in the feoffor's poſſeſſion, livery of ſeiſin of any parcel, in the name of the reſt, ſufficeth for all; but if they be in ſeveral counties, there muſt be as many liveries as there are counties. For, if the title to theſe lands comes to be diſputed, there muſt

muſt be as many trials as there are counties, and the jury of one county are no judges of the notoriety of a fact in another. Beſides, anciently, this ſeiſin was obliged to be delivered *coram paribus de vicineto*, before the peers or freeholders of the neighbourhood, who atteſted ſuch delivery in the body or on the back of the deed; according to the rule of the feodal law, *Pares debent intereſſe inveſtituræ feudi, et non alii:* for which this reaſon is expreſsly given; becauſe the peers or vaſſals of the lord, being bound by their oath of fealty, will take care that no fraud be committed to his prejudice, which ſtrangers might be apt to connive at. And though afterwards the ocular atteſtation of the *pares* was held unneceſſary, and livery might be made before any credible witneſſes, yet the trial, in caſe it was diſputed, (like that of all other atteſtations), was ſtill reſerved to the *pares* or jury of the county. Alſo, if the lands be out on leaſe, though all lie in the ſame county, there muſt be as many liveries as there are tenants: becauſe no livery can be made in this caſe, but by the conſent of the particular tenant; and the conſent of one will not bind the reſt. And in all theſe caſes it is prudent, and uſual, to endorſe the livery of ſeiſin on the back of the deed, ſpecifying the manner, place, and time of making it; together with the names of the witneſſes. And thus much for livery in deed.

Livery in *law* is where the ſame is not made *on* the land, but *in ſight of it* only; the feoffor ſaying to the feoffee, "I give you yonder land, enter and take poſſeſſion." Here, if the feoffee enters during the life of the feoffor, it is a good livery, but not otherwiſe; unleſs he dares not enter through fear of his life or bodily harm; and then his continual claim, made yearly in due form of law, as near as poſſible to the lands, will ſuffice without an entry. This livery in law cannot, however, be given or received by attorney, but only by the parties themſelves.

SEIZE, in the ſea-language, is to make faſt or bind, particularly to faſten two ropes together with rope-yarn. The ſeizing of a boat is a rope tied to a ring or little chain in the fore-ſhip of the boat, by which means it is faſtened to the ſide of the ſhip.

SEIZURE, in commerce, an arreſt of ſome merchandiſe, moveable, or other matter, either in conſequence of ſome law or of ſome expreſs order of the ſovereign. Contraband goods, thoſe fraudulently entered, or landed without entering at all, or at wrong places, are ſubject to ſeizure. In ſeizures among us, one half goes to the informer, and the other half to the king.

SELAGO, a genus of plants belonging to the didynamia claſs; and in the natural method ranking under the 48th order, *Aggregatæ*. See BOTANY *Index*.

SELDEN, JOHN, called by Grotius *the glory of England*, was born at Salvington in Suſſex in 1584. He was educated at the free ſchool at Chicheſter; whence he was ſent to Hart Hall in the univerſity of Oxford, where he ſtaid four years. In 1612, he entered himſelf in Clifford's Inn, in order to ſtudy the law; and about two years after removed to the Inner Temple, where he ſoon acquired great reputation by his learning. He had already publiſhed ſeveral of his works; and this year wrote verſes in Latin, Greek, and Engliſh, upon Mr William Browne's Britannia's Paſtorals. In 1614, he publiſhed his Titles of Honour; and in 1616, his Notes on Sir John Forteſcue's book *De Laudibus Legum Angliæ*. In 1618, he publiſhed his Hiſtory of Tythes; which gave great offence to the clergy, and was animadverted upon by ſeveral writers; and for that book he was called before the high commiſſion court, and obliged to make a public acknowledgement of his ſorrow for having publiſhed it. In 1621, being ſent for by the parliament, though he was not then a member of that houſe, and giving his opinion very ſtrongly in favour of their privileges in oppoſition to the court, he was committed to the cuſtody of the ſheriff of London, but was ſet at liberty after five weeks confinement. In 1623, he was choſen burgeſs for Lancaſter; but, amidſt all the diviſions of the nation, kept himſelf neuter, proſecuting his ſtudies with ſuch application, that though he was the next year choſen reader of Lyon's Inn, he refuſed to perform that office. In 1625, he was choſen burgeſs for Great Bedwin in Wiltſhire, to ſerve in the firſt parliament of King Charles I. in which he declared himſelf warmly againſt the duke of Buckingham; and on his Grace's being impeached by the Houſe of Commons, was appointed one of the managers of the articles againſt him. In 1627 and 1628, he oppoſed the court party with great vigour. The parliament being prorogued to January 20. 1629, Mr Selden retired to the earl of Kent's houſe at Wreſt, in Bedfordſhire, where he finiſhed his *Marmora Arundeliana*. The parliament being met, he, among others, again diſtinguiſhed himſelf by his zeal againſt the court; when the king diſſolving the parliament, ordered ſeveral of the members to be brought before the King's Bench bar, and committed to the Tower. Among theſe was Mr Selden, who inſiſting on the benefit of the laws, and refuſing to make his ſubmiſſion, was removed to the King's Bench priſon. Being here in danger of his life on account of the plague then raging in Southwark, he petitioned the lord high treaſurer, at the end of Trinity term, to intercede with his Majeſty that he might be removed to the Gate-houſe, Weſtminſter, which was granted: but in Michaelmas term following, the judges objecting to the lord treaſurer's warrant, by which he had been removed to the Gate-houſe, an order was made for conveying him back to the King's Bench, whence he was releaſed in the latter end of the ſame year; but fifteen years after, the parliament ordered him 5000l. for the loſſes he had ſuſtained on this occaſion. He was afterwards committed with ſeveral other gentlemen, for diſperſing a libel; but the author, who was abroad, being diſcovered, they were at length ſet at liberty. In 1634, a diſpute ariſing between the Engliſh and Dutch concerning the herring-fiſhery on the Britiſh coaſt, he was prevailed upon by Archbiſhop Laud to draw up his *Mare Clauſum*, in anſwer to Grotius's *Mare Liberum:* which greatly recommended him to the favour of the court. In 1640, he was choſen member for the univerſity of Oxford; when he again oppoſed the court, though he might, by complying, have raiſed himſelf to very conſiderable poſts. In 1643, he was appointed one of the lay-members to ſit in the aſſembly of divines at Weſtminſter, and was the ſame year appointed keeper of the records in the Tower. Whilſt he attended his duty in the aſſembly, a warm debate aroſe reſpecting the diſtance of Jericho from Jeruſalem. The party which contended for the ſhorteſt diſtance, urged, as a proof of their opinion being well founded, that fiſhes were carried from the one city to the other, and ſold in the market. Their adverſaries were ready to yield to the force of this concluſive argument, when Selden, who deſpiſed both parties, as well as the frivolouſneſs of their diſpute, exclaimed, "Perhaps the fiſhes were ſalted!" This unexpected remark left the victory doubtful, and renewed the debate; and our author, who was ſick of ſuch trifling, ſoon found employment more ſuited to his genius; for, in 1645, he was made one of the commiſſioners of the admiralty. The ſame year he was unanimouſly elected maſter of Trinity college, Cambridge; but declined accepting. He died in 1654; and was interred in the Temple-church, where a monument is erected to his memory. Dr Wilkes obſerves, that he was a man of uncommon gravity and greatneſs of ſoul, averſe to flattery, liberal to ſcholars, charitable to the poor; and though he had great latitude in his principles with regard to eccleſiaſtical power, yet he had a ſincere regard for the church of England. He wrote many learned works beſides thoſe already mentioned; the principal of which are. 1. *De Jure Naturali et Gentium juxta Diſciplinam Hebræorum.* 2. *De Nuptiis et Divorciis.* 3. *De Anno Civili veterum Hebræorum.* 4. *De Nummis.* 5. *De Diis Syris.* 6. *Uxor Hebraica.* 7. *Jani Anglorum Facies altera*, &c. All his works were printed together in 1726, in 3 vols folio.

SELENITE, in *Mineralogy*, the cryſtallized ſulphate of lime or gypſum. See Lime, in Mineralogy *Index*. Selenite literally ſignifies *moon-ſtone*, and is expreſſive of the colour and ſoft luſtre of the mineral.

SELENOGRAPHY, a branch of coſmography, which deſcribes the moon and all the parts and appearances thereof, as geography does thoſe of the earth. See Moon, and Astronomy *Index*.

SELEUCIA, in *Ancient Geography*, ſurnamed *Babylonia*, becauſe ſituated on its confines, at the confluence of the Euphrates and Tigris. Ptolemy places it in Meſopotamia. It is called alſo *Seleucia ad Tigrim*, (Polybius, Strabo, Iſidorus Characenus); waſhed on the ſouth by the Euphrates, on the eaſt by the Tigris, (Theophylactus); generally agreed to have been built or enlarged by Seleucus Nicanor, maſter of the eaſt after Alexander; by means of which Babylon came to be deſerted. It is ſaid to have been originally called *Coche*, (Ammian, Eutropius); though others, as Arrian, diſtinguiſh it, as a village, from *Seleucia*: and, according to Zoſimus, the ancient name of Seleucia was *Zochaſia*. Now called *Bagdad*. E. Long. 44. 21. N. Lat. 33. 10. There were many other cities of the ſame name, all built by Seleucus Nicanor.

SELEUCIDÆ, in *Chronology*. Era of the Seleucidæ, or the Syro-Macedonian era, is a computation of time, commencing from the eſtabliſhment of the Seleucidæ, a race of Greek kings, who reigned as ſucceſſors of Alexander the Great in Syria, as the Ptolemies did in Egypt. This era we find expreſſed in the books of the Maccabees, and on a great number of Greek medals ſtruck by the cities of Syria, &c. The Rabbins call it the *era of contracts*, and the Arabs *therik dilkarnain*, that is, the "era of the two horns." According to the beſt accounts, the firſt year of this era falls in the year 311 B. C. being 12 years after Alexander's death.

SELEUCUS, Nicanor, one of the chief generals under Alexander the Great, and, after his death, founder of the race of princes called *Seleucidæ*. He is equally celebrated as a renowned warrior, and as the father of his people; yet his virtues could not protect him from the fatal ambition of Ceraunus, one of his courtiers, by whom he was aſſaſſinated 280 B. C.

SELF-Heal, the Prunella Vulgaris, Lin. This herb was recommended by the older phyſicians as a mild reſtringent and vulnerary; but its virtues appear to be very feeble, and therefore it is now rarely uſed.

SELF-Command, is that ſteady equanimity which enables a man in every ſituation to exert his reaſoning faculty with coolneſs, and to do what the preſent circumſtances require. It depends much upon the natural temperament of the body, and much upon the moral cultivation of the mind. He who enjoys good health, and has braced his frame by exerciſe, has always a greater command of himſelf than a man of equal mental powers, who has ſuffered his conſtitution to become relaxed by indolence; and he who has from his early youth been accuſtomed to make his paſſions ſubmit to his reaſon, muſt, in any ſudden emergency, be more capable of acting properly than he who has tamely yielded to his paſſion. Hence it is that recluſe and literary men, when forced into the buſtle of public life, are incapable of acting where promptneſs is requiſite; and that men who have once or twice yielded to a ſenſe of impending danger ſeldom acquire afterwards that command of themſelves which may be neceſſary to extricate them from ſubſequent dangers. In one of the earlieſt battles fought by the late king of Pruſſia, the ſovereign was among the firſt men who quitted the field: had he behaved in the ſame manner a ſecond and a third time, he would never have become that hero whoſe actions aſtoniſhed Europe. A celebrated engineer among ourſelves, who was well known to the writer of this ſhort article, had little ſcience, and was a ſtranger to the principles of his own art; but being poſſeſſed of a firm and vigorous frame, and having been accuſtomed to ſtruggle with dangers and difficulties, he had ſuch a conſtant command of himſelf, as enabled him to employ with great coolneſs every neceſſary reſource in the day of battle.

But it is not only in battle, and in the face of immediate danger, that ſelf-command is neceſſary to enable a man to act with propriety. There is no ſituation in life where difficulties, greater or leſs, are not to be encountered; and he who would paſs through life with comfort to himſelf, and with utility to the public, muſt endeavour to keep his paſſions in conſtant ſubjection to his reaſon. No man can enjoy without inquietude what he cannot loſe without pain; and no man who is overwhelmed with deſpondency under any ſudden misfortune can exert the talents neceſſary to retrieve his circumſtances. We ought, therefore, by every means to endeavour to obtain a conſtant command of ourſelves; and nowhere ſhall we find better leſſons for this purpoſe than in ancient Lacedemon. There certain occupations were appointed for each ſex, for every hour, and for every ſeaſon of life. In a life always active, the paſſions have no opportunity to deceive, ſeduce, or corrupt; and the nervous ſyſtem acquires a firmneſs which makes it a fit inſtrument to a vigorous mind.

SELF-Defence implies not only the preſervation of one's life, but alſo the protection of his property, be-

cauſe

cauſe without property life cannot be preſerved in a civilized nation. The extent of property eſſential to life is indeed ſmall, and this conſideration may enable us to decide a queſtion which ſome moraliſts have made intricate. By what means, it has been aſked, may a man protect his property? May he kill the perſon who attacks it, if he cannot otherwiſe repel the attack?

That a man, in the ſtate of nature, may kill the perſon who makes an attack on his life, if he cannot otherwiſe repel the attack, is a truth which has never been controverted; and he may do the ſame in civil ſociety, if his danger be ſo imminent that it cannot be averted by the interpoſition of the protection provided for individuals by the ſtate. In all poſſible ſituations, except the three following, whatever is abſolutely neceſſary to the preſervation of life may be lawfully performed, for the law of ſelf-preſervation is the firſt and moſt ſacred of thoſe laws which are impreſſed on every mind by the author of nature.

The three excepted ſituations are thoſe of a ſoldier in the day of battle, of a criminal about to ſuffer by the laws of his country, and of a man called upon to renounce his religion. The ſoldier hazards his life in the moſt honourable of all cauſes, and cannot betray his truſt, or play the coward, without incurring a high degree of moral turpitude. He knows that the very profeſſion in which he is engaged neceſſarily ſubjects him to danger; and he voluntarily incurred that danger for the good of his country, which, with great propriety, annexes to his profeſſion peculiar privileges and much glory. The criminal under ſentence of death cannot, without adding to his guilt, reſiſt the execution of that ſentence; for the power of inflicting puniſhment is eſſential to ſociety, and ſociety is the ordinance of God, (ſee SOCIETY). The man who is called upon to renounce his religion ought to ſubmit to the cruelleſt death rather than comply with that requeſt, ſince religion is his only ſecurity for future and permanent happineſs. But in every other ſituation, that which is abſolutely neceſſary to the preſervation of life is undoubtedly lawful. Hence it is that a perſon ſinking in water is never thought to be guilty of any crime, though he drag his neighbour after him by his endeavours to ſave himſelf; and hence, too, a man in danger of periſhing by ſhipwreck may drive another from a plank which cannot carry them both, for ſince one of two lives muſt be loſt, no law, human or divine, calls upon either of them to prefer his neighbour's life to his own.

But though the rights of ſelf-defence authoriſe us to repel every attack made upon our life, and in caſes of extremity to ſave ourſelves at the expence of the life of our innocent neighbour, it is not ſo evident that, rather than give to an unjuſt demand a few ſhillings or pounds, we may lawfully deprive a fellow creature of life, and the public of a citizen. A few pounds loſt may be eaſily regained; but life when loſt can never be recovered. If theſe pounds, indeed, be the whole of a man's property; if they include his clothes, his food, and the houſe where he ſhelters his head—there cannot be a doubt but that, rather than part with them, he may lawfully kill the aggreſſor, for no man can exiſt without ſhelter, food, and raiment. But it is ſeldom that an attempt is made, or is indeed practicable, to rob a man at once of all that he poſſeſſes. The queſtion then of any importance is, May a man put a robber to death rather than part with a ſmall part of his property? Mr Paley doubts whether he could innocently do ſo in a ſtate of nature, "becauſe it cannot be contended to be for the augmentation of human happineſs, that one man ſhould loſe his life or limb, rather than another a pennyworth of his property." He allows, that in civil ſociety the life of the aggreſſor may be always taken away by the perſon aggrieved, or meant to be aggrieved, when the crime attempted is ſuch as would ſubject its perpetrator to death by the laws of his country.

It is not often that we feel ourſelves diſpoſed to differ in opinion from this moſt valuable and intelligent writer; but on the preſent occaſion we cannot help thinking that he does not reaſon with his uſual preciſion. To us he even ſeems to loſe ſight of his own principles. No legiſlature can have a right to take away life in civil ſociety, but in ſuch caſes as individuals have the ſame right in a ſtate of nature. If therefore a man in the ſtate of nature, have not a right to protect his property by killing the aggreſſor, when it cannot be otherwiſe protected, it appears to us ſelf-evident that no legiſlature can have a right to inflict the puniſhment of death upon ſuch offences; but if the laws inflicting death upon the crime of robbery be morally evil, it is certain that an individual cannot be innocent when he prevents robbery by the death of the robber, merely becauſe he knows that the laws of his country have decreed that puniſhment againſt thoſe convicted of that crime. But we think that the protection of property by the death of the aggreſſor may be completely vindicated upon more general principles. It is neceſſary, in every ſtate, that property be protected, or mankind could not ſubſiſt; but in a ſtate of nature every man muſt be the defender of his own property, which in that ſtate muſt neceſſarily be ſmall: and if he be not allowed to defend it by every mean in his power, he will not long be able to protect it at all. By giving him ſuch liberty, a few individuals may, indeed, occaſionally loſe their lives and limbs for the preſervation of a very ſmall portion of private property; but we believe that the ſum of human happineſs will be more augmented by cutting off ſuch worthleſs wretches than by expoſing property to perpetual depredation; and therefore, if general utility be the criterion of moral good, we muſt be of opinion that a man may in every caſe lawfully kill a robber rather than comply with his unjuſt demand.

But if a man may without guilt preſerve his property by the death of the aggreſſor, when it cannot be preſerved by any other means, much more may a woman have recourſe to the laſt extremity to protect her chaſtity from forcible violation. This, indeed, is admitted by Mr Paley himſelf, and will be controverted by no man who reflects on the importance of the female character, and the probable conſequences of the ſmalleſt deviation from the eſtabliſhed laws of female honour. See SEDUCTION.

SELF-Knowledge, the knowledge of one's own character, abilities, opinions, virtues, and vices. This has always been conſidered as a difficult though important acquiſition. It is difficult, becauſe it is diſagreeable to inveſtigate our errors, our faults, and vices; becauſe we are apt to be partial to ourſelves, even when we have done wrong; and becauſe time and habitual attention are requiſite to enable us to diſcover our real character. But theſe difficulties are more than counterbalanced by the advantages of ſelf-knowledge.

By knowing the extent of our abilities, we ſhall never raſhly engage in enterpriſes where our ineffectual exertions may be productive of harm: by inveſtigating our opinions, we may diſcover thoſe which have no foundation, and thoſe alſo which lead us inſenſibly into vice. By examining our virtues and vices, we ſhall learn what principles ought to be ſtrengthened, and what habits ought to be removed.

Man is a rational and intelligent being, capable of great improvement, and liable to great vices. If he act without examining his principles, he may be hurried by blind paſſion into crimes. If he aſpire at noble and valuable acquiſitions, he muſt act upon a plan, with deliberation and fore-thought; for he is not like a vegetable, which attains perfection by the influence of external cauſes: he has powers within himſelf which muſt be exerted, and exerted with judgment, in order to attain the perfection of his nature. To enable him to employ theſe powers aright, he muſt know, firſt, what is his duty; and, ſecondly, he muſt often review his principles and conduct, that he may diſcover whether he is performing his duty, or in what circumſtances he has failed. When he finds that he has fallen into error and vice, he will naturally inquire what cauſes have produced this effect, that he may avoid the ſame for the time to come. This is the method by which every reformation in religion and ſcience has been produced, and the method by which the arts have been improved. Before Lord Bacon introduced the new way of philoſophizing, he muſt firſt have conſidered wherein true philoſophy conſiſted; ſecondly, he muſt have inquired in what reſpects the ancient method of philoſophizing was falſe or uſeleſs: and after determining theſe two points, he was qualified to deſcribe the way by which the ſtudy of philoſophy could be ſucceſsfully purſued without deviating into hypotheſis and error. Luther found out the errors of the church of Rome by comparing their doctrines with the Scriptures. But had this compariſon never been made, the reformation could never have taken place. Without ſelf-knowledge, or without that knowledge of our character which is derived from a compariſon of our principles and conduct with a perfect ſtandard of morality, we can never form plans and reſolutions, or make any exertion to abandon the vicious habits which we have contracted, and ſtrengthen thoſe virtuous principles in which we are deficient.

As much may be learned from the errors of thoſe who have been in ſimilar ſituations with ourſelves; ſo many uſeful cautions may be obtained from our own errors; and he that will remember theſe, will ſeldom be twice guilty of the ſame vice.

It was evidently the intention of Providence that man ſhould be guided chiefly by experience. It is by the obſervations which we make on what we ſee paſſing around us, or from what we ſuffer in our own perſon, that we form maxims for the conduct of life. The more minutely therefore we attend to our principles, and the more maxims we form, we ſhall be the better fitted to attain moral perfection.

With reſpect to our underſtanding, to mark the errors which we have fallen into, either by its natural defects or by negligence, is alſo of great importance; for the greateſt genius and moſt profound ſcholar are liable to theſe errors, and often commit them as well as the weak and illiterate. But by obſerving them, and tracing them to their cauſes, they at length acquire an habitual accuracy. It is true, that men of feeble minds can never by knowing their own defects exalt themſelves to the rank of genius; but ſuch knowledge will enable them to improve their underſtandings, and ſo to appreciate their own powers, as ſeldom to attempt what is beyond their ſtrength. They may thus become uſeful members of ſociety; and though they will not probably be admired for their abilities, they will yet eſcape the ridicule which is poured upon vanity.

It is difficult to lay down preciſe rules for the acquiſition of this ſelf-knowledge, becauſe almoſt every man is blinded by a fallacy peculiar to himſelf. But when one has got rid of that partiality which ariſes from ſelf-love, he may eaſily form a juſt eſtimate of his moral improvements, by comparing the general courſe of his conduct with the ſtandard of his duty; and if he has any doubt of the extent of his intellectual attainments, he will moſt readily diſcover the truth by comparing them with the attainments of others who have been moſt ſucceſsful in the ſame purſuits. Should vanity ariſe in his mind from ſuch a compariſon, let him then compare the extent of his knowledge with what is yet to be known, and he will then be in little danger of thinking of himſelf more highly than he ought to think. See PREJUDICE and *SELF-Partiality*.

SELF-Love, is that inſtinctive principle which impels every animal, rational and irrational, to preſerve its life and promote its own happineſs. It is very generally confounded with ſelfiſhneſs; but we think that the one propenſity is diſtinct from the other. Every man loves himſelf; but every man is not ſelfiſh. The ſelfiſh man graſps at all *immediate* advantages, regardleſs of the conſequences which his conduct may have upon his neighbour. Self-love only prompts him who is actuated by it to procure to himſelf the greateſt poſſible ſum of happineſs during the whole of his exiſtence. In this purſuit the rational ſelf-lover will often forego a preſent enjoyment to obtain a greater and more permanent one in reverſion; and he will as often ſubmit to a preſent pain to avoid a greater hereafter. Self-love, as diſtinguiſhed from ſelfiſhneſs, always comprehends the whole of a man's exiſtence, and in that extended ſenſe of the phraſe, we heſitate not to ſay that every man is a ſelf-lover; for, with eternity in his view, it is ſurely not poſſible for the moſt diſintereſted of the human race not to prefer himſelf to all other men, if their future and everlaſting intereſts could come into competition. This indeed they never can do; for though the introduction of evil into the world, and the different ranks which it makes neceſſary in ſociety, put it in the power of a man to raiſe himſelf, in the preſent ſtate, by the depreſſion of his neighbour, or by the practice of injuſtice, yet in the purſuit of a prize which is to be gained only by ſoberneſs, righteouſneſs, and piety, there can be no rivalſhip among the different competitors. The ſucceſs of one is no injury to another; and therefore, in this ſenſe of the phraſe, ſelf-love is not only lawful, but abſolutely unavoidable. It has been a queſtion in morals, whether it be not likewiſe the incentive to every action, however, virtuous or apparently diſintereſted?

Thoſe who maintain the affirmative ſide of this queſtion ſay, that the proſpect of immediate pleaſure, or the dread of immediate pain, is the only apparent motive to action in the minds of infants, and indeed of all who look not before them, and infer the future from the paſt. They own, that when a boy has had ſome experience, and is capable of making compariſons, he will often decline an immediate enjoyment which he has formerly found productive of future evil more than equivalent to all its good; but in doing ſo they think, and they think juſtly, that he is ſtill actuated by the principle of ſelf-love, purſuing the greateſt good of which he knows himſelf to be capable. After experiencing that truth, equity, and benevolence in all his dealings is the readieſt, and indeed the only certain method of ſecuring to himſelf the kindneſs and good offices of his fellow creatures, and much more when he has learned that they will recommend him to the Supreme Being, upon whom depends his exiſtence and all his enjoyments, they admit that he will practice truth, equity, and benevolence; but ſtill, from the ſame principle, purſuing his own ultimate happineſs as the object which he has always in view. The proſpect of this great object will make him feel an exquiſite pleaſure in the performance of the actions which he conceives as neceſſary to its attainment, till at laſt, without attending in each inſtance to their conſequences, he will, by the great aſſociating principle which has been explained elſewhere (ſee METAPHYSICS, Part I. chap. i.) feel a refined enjoyment in the actions themſelves, and perform them, as occaſions offer, without deliberation or reflection. Such, they think, is the origin of benevolence itſelf, and indeed of every virtue.

Thoſe who take the other ſide of the queſtion, can hardly deny that ſelf-love thus modified may prompt to virtuous and apparently diſintereſted conduct; but they think it degrading the dignity of a man to ſuppoſe him actuated ſolely by motives which can be traced back to a deſire of his own happineſs. They obſerve, that the Author of our nature has not left the preſervation of the individual, or the continuance of the ſpecies, to the deductions of our reaſon, computing the ſum of happineſs which the actions neceſſary to theſe ends produce to ourſelves: on the contrary, He has taken care of both, by the ſurer impulſe of inſtinct planted in us for theſe very purpoſes. And is it conceivable, ſay they, that He would leave the care of our fellow-creatures a matter of indifference, till each man ſhould be able to diſcover or be taught that by loving his neighbour, and doing him all the good in his power, he would be moſt effectually promoting his own happineſs? It is diſhonouring virtue, they continue, to make it proceed in any inſtance from a proſpect of happineſs, or a dread of miſery; and they appeal from theory to fact, as exhibited in the conduct of ſavage tribes, who deliberate little on the conſequences of their actions.

Their antagoniſts reply, that the conduct of ſavage tribes is to be conſidered as that of children in civilized nations, regulated entirely by the examples which they have before them; that their actions cannot be the offspring of innate inſtincts, otherwiſe ſavage virtues would, under ſimilar circumſtances, everywhere be the ſame, which is contrary to fact; that virtue proceeds from an intereſted motive on either ſuppoſition; and that the motive which the inſtinctive ſcheme holds up is the moſt ſelfiſh of the two. The other theory ſuppoſes, that the governing motive is the hope of *future* happineſs and the dread of *future* miſery; the inſtinctive ſcheme ſupplies a *preſent* motive in the ſelf-complacency ariſing in the heart from a conſciouſneſs of right conduct. The former is a rational motive, the latter has nothing more to do with reaſon than the enjoyment ariſing from eating or drinking, or from the intercourſe between the ſexes. But we mean not to purſue the ſubject farther, as we have ſaid enough on it in the articles BENEVOLENCE, INSTINCT, PASSION, and PHILANTHROPY. We ſhall therefore conclude with obſerving, that there is certainly a virtuous as well as a vicious ſelf-love, and that "true ſelf-love and ſocial are the ſame."

SELF-Murder. See SUICIDE.

SELF-Partiality, is a phraſe employed by ſome philoſophers * to expreſs that weakneſs of human nature through which men overvalue themſelves when compared with others. It is diſtinguiſhed from general partiality, by thoſe who make uſe of the expreſſion, becauſe it is thought that a man is led to overrate his own accompliſhments, either by a particular inſtinct, or by a proceſs of intellect different from that by which he overrates the accompliſhments of his friends or children. The former kind of partiality is wholly ſelfiſh; the latter partakes much of benevolence.

This diſtinction may perhaps be deemed plauſible by thoſe who conſider the human mind as little more than a bundle of inſtincts; but it muſt appear perfectly ridiculous to ſuch as reſolve the greater part of apparent inſtincts into early and deep-rooted aſſociations of ideas. If the partialities which moſt men have to their friends, their families, and themſelves, be inſtinctive, they are certainly inſtincts of different kinds; but an inſtinctive partiality is a contradiction in terms. Partiality is founded on a compariſon between two or more objects; but genuine inſtincts form no compariſons. See INSTINCT. No man can be ſaid to be partial to the late Dr Johnſon, merely for thinking highly of his intellectual powers; nor was the doctor partial to himſelf, though he thought in this reſpect with the generality of his countrymen; but if, upon a compariſon with Milton, he was deemed the greater poet of the two, ſuch a judgment will be allowed to be partial, whether formed by himſelf or by any of his admirers. We apprehend, however, that the proceſs of its formation was the ſame in every mind by which it was held.

The origin of ſelf-partiality is not difficult to be found; and our partialities to our friends may be traced to a ſimilar ſource. By the conſtitution of our nature, we are impelled to ſhun pain and to purſue pleaſure; but remorſe, the ſevereſt of all pains, is the never-failing conſequence of vicious conduct. Remorſe ariſes from the dread of that puniſhment which we believe will in a future ſtate be inflicted on vice unrepented of in this; and therefore every vicious perſon endeavours by all poſſible means to baniſh that dread from his own mind. One way of effecting this is to compare his own life with the lives of others; for he fancies that if numbers be as wicked as himſelf, the benevolent Lord of all things will not involve them in one common ruin. Hence, by magnifying to himſelf the temptations which led him aſtray, and diminiſhing the injuries which his conduct has done in the world, and by adopting a courſe diametrically the reverſe, when eſtimating the

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* See Lord *Kaimes's Art of Thinking.*

the morality or immorality of the conduct of his neighbours, he ſoon comes to believe that he is at leaſt not more wicked than they. Thus is ſelf-partiality formed in the mind, and quickly blinds him who is under its influence ſo completely, as to hide from him the very faults which he ſees and blames in others. Hence the coward thinks himſelf only cautious, the miſer frugal. Partiality is formed in the very ſame manner to natural or acquired accompliſhments, whether mental or corporeal. Theſe always procure reſpect to him who is poſſeſſed of them; and as reſpect is accompanied with many advantages, every man wiſhes to obtain it for himſelf. If he fails in his attempts, he conſoles himſelf with the perſuaſion that it is at leaſt due to his merits, and that it is only withheld by the envy of the public. He compares the particular branch of ſcience or bodily accompliſhment in which he himſelf moſt excels, with thoſe which have conferred ſplendour on his rival; and eaſily finds that his own excellencies are of the higheſt order, and entitled to the greateſt ſhare of public eſteem. Hence the polite ſcholar deſpiſes the mathematician; the reader of Ariſtotle and Plato all the modern diſcoveries in phyſical and moral ſcience; and the mere experimentaliſt holds in the moſt ſovereign contempt a critical knowledge of the ancient languages. The pupil of the ancients denies the merits of the moderns, whilſt the mere modern allows nothing to the ancients; and thus each becomes partial to his own acquiſitions, and of courſe to himſelf, for having been at the trouble to make them.

Partiality to our friends and families is generated in the very ſame way. Whenever we acquire ſuch an affection for them as to conſider their happineſs as adding to our own (ſee PASSION), we magnify their excellencies and diminiſh their defects, for the ſame reaſon, and by the ſame proceſs, that we magnify and diminiſh our own. All partialities, however, are prejudices, and prejudices of the worſt kind. They ought therefore to be guarded againſt with the utmoſt care, by the ſame means which we have elſewhere recommended (ſee PREJUDICE, and METAPHYSICS, N°98.); and he who is partial to his own virtue or his own knowledge, will do well to compare the former, not with the conduct of his neighbours, but with the expreſs rule of his duty; and to conſider the latter as no farther valuable than as it contributes to the ſum of human happineſs.

SELIM I. emperor of the Turks, was the ſecond ſon of Bajazet II. He made war upon his father, and though defeated in 1511, he at laſt dethroned him and took him priſoner, and immediately diſpatched him by poiſon, together with his elder brother Achmet, and his younger Korkud, an amiable and enlightened prince. Having eſtabliſhed his throne by theſe crimes, he marched againſt Campſon-Guary ſovereign of Egypt, gained a great victory at Aleppo, and ſlew their general. But though the ſultan periſhed in that battle, the Mameluks determined to oppoſe the emperor. Selim entering their country at the head of his army, defeated the Egyptians in two battles, and ordered Toumonbai, the new elected ſultan, who had fallen into his hands, to be hung on a gibbet. He then took Cairo and Alexandria, and in a ſhort time reduced all Egypt to ſubjection. Thus ended the dominion of the Mameluks in Egypt, which had continued for more than 260 years. He confirmed the ancient privileges of the Venetians in Egypt and Syria, by which they carried on their commerce with India, and formed a league with them to deſtroy the power of the Portugueſe in that country. (See INDIA, N° 37.). Selim had before this gained a great victory over the Perſians, and ſtripped them of Tauris and Keman. He was preparing to attack Chriſtendom when he was ſeized with an ulcerous ſore in the back. Thinking that the air of Adrianople would reſtore his health, he ordered himſelf to be conducted thither; but he died at Clari in Thrace on his road to that city, in the year 1520, in the very ſpot where he had poiſoned his father. He reigned eight years, and lived 54. He was a prince of great courage, ſobriety, and liberality: he was fond of hiſtory, and wrote ſome verſes. But theſe good qualities were obſcured by the moſt abominable crimes that ever diſgraced human nature; he made his way to the throne by ſhedding the blood of his father, and ſecured it by murdering his brothers and eight nephews, and every baſhaw who had been faithful to his duty.

SELINUM, a genus of plants belonging to the pentandria claſs; and in the natural method ranking under the 45th order, *Umbellatæ*. See BOTANY *Index*.

SELKIRK, ALEXANDER, whoſe adventures gave riſe to a well-known hiſtorical romance, was born at Largo, in Fifeſhire in Scotland, about the year 1676, and was bred a ſeaman. He went from England, in 1703, in the capacity of ſailing-maſter of a ſmall veſſel called the *Cinque-Ports Galley*, Charles Pickering captain, burthen about 90 tons, with 16 guns and 63 men; and in September the ſame year ſailed from Cork, in company with another ſhip of 26 guns and 120 men, called the St George, commanded by that famous navigator William Dampier, intended to cruiſe againſt the Spaniards in the South ſea. On the coaſt of Brazil, Pickering died, and was ſucceeded in his command by his lieutenant Thomas Stradling. They proceeded on their voyage round Cape Horn to the iſland of Juan Fernandes, whence they were driven by the appearance of two French ſhips of 36 guns each, and left five of Stradling's men there on ſhore, who were taken off by the French. Hence they ſailed to the coaſt of America, where Dampier and Stradling quarrelled, and ſeparated by agreement, on the 19th of May 1704. In September following, Stradling came again to the iſland of Juan Fernandes, where Selkirk and his captain had a difference, which, with the circumſtance of the ſhip's being very leaky, and in bad condition, induced him to determine on ſtaying there alone; but when his companions were about to depart, his reſolution was ſhaken, and he deſired to be taken on board again. The captain, however, refuſed to admit him, and he was obliged to remain, having nothing but his clothes, bedding, a gun, and a ſmall quantity of powder and ball; a hatchet, knife, and kettle; his books, and mathematical and nautical inſtruments. He kept up his ſpirits tolerably till he ſaw the veſſel put off, when (as he afterwards related) his heart yearned within him, and melted at parting with his comrades and all human ſociety at once.

" ——Yet believe me, Arcas,
Such is the rooted love we bear mankind,

Selkirk.

All ruffians as they were, I never heard
A ſound ſo diſmal as their parting oars."
Thomſon's Agamemnon.

Thus left ſole monarch of the iſland, with plenty of the neceſſaries of life, he found himſelf in a ſituation hardly ſupportable. He had fiſh, goat's fleſh, turnips and other vegetables; yet he grew dejected, languid, and melancholy, to ſuch a degree, as to be ſcarce able to refrain from doing violence to himſelf. Eighteen months paſſed before he could, by reaſoning, reading his bible, and ſtudy, be thoroughly reconciled to his condition. At length he grew happy, employing himſelf in decorating his huts, chaſing the goats, whom he equalled in ſpeed, and ſcarcely ever failed of catching. He alſo tamed young kids, laming them to prevent their becoming wild; and he kept a guard of tame cats about him, to defend him when aſleep from the rats, who were very troubleſome. When his clothes were worn out, he made others of goats ſkins, but could not ſucceed in making ſhoes, with the uſe of which, however, habit, in time, enabled him to diſpenſe. His only liquor was water. He computed that he had caught 1000 goats during his abode in the iſland; of which he had let go 500, after marking them by ſlitting their ears. Commodore Anſon's people, who were there about 30 years after, found the firſt goat which they ſhot upon landing, was thus marked, and as it appeared to be very old, concluded that it had been under the power of Selkirk. But it appears by Captain Carteret's account of his voyage in the Swallow ſloop, that other perſons practiſed this mode of marking, as he found a goat with his ears thus ſlit on the neighbouring iſland of Mas-a-fuera, where Selkirk never was. He made companions of his tame goats and cats, often dancing and ſinging with them. Though he conſtantly performed his devotions at ſtated hours, and read aloud; yet, when he was taken off the iſland, his language, from diſuſe of converſation, had become ſcarcely intelligible. In this ſolitude he continued four years and four months; during which time only two incidents happened which he thought worth relating, the occurrences of every day being in his circumſtances nearly ſimilar. The one was, that, purſuing a goat eagerly, he caught it juſt on the edge of a precipice, which was covered with buſhes, ſo that he did not perceive it, and he fell over to the bottom, where he lay (according to Captain Roger's account) 24 hours ſenſeleſs; but, as he related to Sir R. Steele, he computed, by the alteration of the moon, that he had lain three days. When he came to himſelf, he found the goat lying under him dead. It was with great difficulty that he could crawl to his habitation, whence he was unable to ſtir for ten days, and did not recover of his bruiſes for a long time. The other event was the arrival of a ſhip, which he at firſt ſuppoſed to be French: and ſuch is the natural love of ſociety in the human mind, that he was eager to abandon his ſolitary felicity, and ſurrender himſelf to them, although enemies; but upon their landing, approaching them, he found them to be Spaniards, of whom he had too great a dread to truſt himſelf in their hands. They were by this time ſo near that it required all his agility to eſcape, which he effected by climbing into a thick tree, being ſhot at ſeveral times as he ran off. Fortunately the Spaniards did not diſcover him, though they ſtayed ſome time under the tree where he was hid, and killed ſome goats juſt by. In this ſolitude Selkirk remained until the 2d of February 1709, when he ſaw two ſhips come into the bay, and knew them to be Engliſh. He immediately lighted a fire as a ſignal; and on their coming on ſhore, found they were the Duke Captain Rogers, and the Ducheſs Captain Courtney, two privateers from Briſtol. He gave them the beſt entertainment he could afford; and, as they had been a long time at ſea without freſh proviſions, the goats which he caught were highly acceptable. His habitation conſiſting of two huts, one to ſleep in, the other to dreſs his food in, was ſo obſcurely ſituated, and ſo difficult of acceſs, that only one of the ſhip's officers would accompany him to it. Dampier, who was pilot on board the Duke, and knew Selkirk very well, told Captain Rogers, that, when on board the Cinque-Ports, he was the beſt ſeaman in the veſſel; upon which Captain Rogers appointed him maſter's mate of the Duke. After a fortnight's ſtay at Juan Fernandes, the ſhips proceeded on their cruize againſt the Spaniards; plundered a town on the coaſt of Peru; took a Manilla ſhip off California; and returned by way of the Eaſt Indies to England, where they arrived the 1ſt of October 1711; Selkirk having been abſent eight years, more than half of which time he had ſpent alone in the iſland. The public curioſity being excited reſpecting him, he was induced to put his papers into the hands of Defoe, to arrange and form them into a regular narrative. Theſe papers muſt have been drawn up after he left Juan Fernandes, as he had no means of recording his tranſactions there. Captain Cooke remarks, as an extraordinary circumſtance, that he had contrived to keep an account of the days of the week and month; but this might be done, as Defoe makes Robinſon Cruſoe do, by cutting notches in a poſt, or many other methods. From this account of Selkirk, Defoe took the idea of writing a more extenſive work, the romance of Robinſon Cruſoe, and very diſhoneſtly defrauded the original proprietor of his ſhare of the profits. Of the time or place or manner of this extraordinary man's death we have received no account; but in 1798 the cheſt and muſket which Selkirk had with him on the iſland were in the poſſeſſion of his grand-nephew, John Selkirk weaver in Largo.

The circumſtances of Selkirk's ſecluſion from human ſociety during his ſtay on Juan Fernandes, and the ſentiments which that ſituation naturally inſpired, have been ſo finely and characteriſtically depicted by Mr Cowper, that many of our readers, we doubt not, will be gratified if we give the verſes alluded to a place here.

I am monarch of all I ſurvey,
  My right there is none to diſpute:
From the centre all round to the ſea,
  I am lord of the fowl and the brute.
Oh, ſolitude! where are the charms
  That ſages have ſeen in thy face?
Better dwell in the midſt of alarms,
  Than reign in this horrible place.
I am out of humanity's reach,
  I muſt finiſh my journey alone,
Never hear the ſweet muſic of ſpeech;
  I ſtart at the ſound of my own.

The beaſts that roam over the plain,
My form with indifference ſee;
They are ſo unacquainted with man,
Their tameneſs is ſhocking to me.
Society, friendſhip, and love,
Divinely beſtow'd upon man,
Oh, had I the wings of a dove,
How ſoon would I taſte you again!
My ſorrows I then might aſſuage
In the ways of religion and truth,
Might learn from the wiſdom of age,
And be cheer'd by the ſallies of youth.
Religion! what treaſure untold
Reſides in that heavenly word!
More precious than ſilver and gold,
Or all that this earth can afford.
But the ſound of the church-going bell
Theſe valleys and rocks never heard,
Ne'er ſigh'd at the ſound of a knell,
Or ſmil'd when a Sabbath appear'd.
Ye winds that have made me your ſport,
Convey to this deſolate ſhore
Some cordial endearing report
Of a land I ſhall viſit no more.
My friends, do they now and then ſend
A wiſh or a thought after me?
O tell me I yet have a friend,
Though a friend I am never to ſee.
How fleet is a glance of the mind!
Compar'd with the ſpeed of its flight,
The tempeſt itſelf lags behind,
And the ſwift-winged arrows of light.
When I think of my own native land,
In a moment I ſeem to be there;
But alas! recollection at hand
Soon hurries me back to deſpair.
But the ſea-fowl is gone to her neſt,
The beaſt is laid down in his lair,
Ev'n here is a ſeaſon of reſt,
And I to my cabin repair.
There's mercy in every place;
And mercy, encouraging thought!
Gives even affliction a grace,
And reconciles man to his lot.

SELKIRK, the capital of the county of the ſame name, is a ſmall town pleaſantly ſituated on a riſing ground, and enjoys an extenſive proſpect in all directions, eſpecially in the courſe of the river Ettrick. It is remarkable for thoſe plaintive airs produced in its neighbourhood, the natural ſimplicity of which are the pride of Scotland and the admiration of ſtrangers.

The citizens of this burgh, like the other inhabitants of the ſheriffdom of Ettrick foreſt, rendered themſelves famous by adhering to the fortune of their ſovereign James IV. Of 100 citizens who followed that monarch to the plains of Flodden, a few returned loaded with ſpoils taken from the Engliſh. Of the trophies of that day, there yet remains in the poſſeſſion of the corporation of weavers, a ſtandard taken by a member of that body. It may alſo be mentioned, that the ſword of William Brydone, the town-clerk, who led the citizens to the battle, and was knighted for his valour, ſtill remains, it is ſaid, in the poſſeſſion of a citizen of Selkirk, his lineal deſcendent. The deſperate valour of the citizens, however, ſo exaſperated the Engliſh, that they reduced their defenceleſs town to aſhes; but their grateful ſovereign, James V. ſhewed his ſenſe of their ſervices by a grant of an extenſive track of Ettrick foreſt, the trees for building their houſes, and the property as a reward for their heroiſm. Selkirk is a royal burgh, uniting with Lanark, Linlithgow, and Peebles, in ſending a member to parliament. W. Long. 2. 46. N. Lat. 55. 26.

SELKIRKSHIRE, called alſo the *Sheriffdom of Ettrick Foreſt*, a county of Scotland, extending about 20 miles in length from eaſt to weſt, and about 12 in breadth from ſouth to north. It borders on the north with part of Tweeddale and Mid-Lothian; on the ſouth and eaſt with Tiviotdale; and on the weſt with Annandale. This county was formerly reſerved by the Scottiſh princes for the pleaſure of the chaſe, and where they had houſes for the reception of their train. At that time the face of the country was covered with woods, in which there were great numbers of red and fallow deer, whence it had the name of *Ettrick Foreſt*. The woods, however, are now almoſt entirely cut down, and the county is chiefly ſupported by the breed of ſheep. They are generally ſold into the ſouth, but ſometimes into the Highlands, about the month of March, where they are kept during ſummer; and after being improved by the mountain-graſs, are returned into the Lowlands in the beginning of winter.

This county, though not very populous at preſent, was once the nurſe of heroes, who were juſtly accounted the bulwark of their native ſoil, being ever ready to brave danger and death in its defence. Of this we have a memorable proof in the pathetic lamentations of their wives and daughters for the diſaſter of the field of Flodden, "where the brave foreſters were a' wed away." The rivers Ettrick and Yarrow unite a little above the town of Selkirk, and terminate in the Tweed. For five miles above its junction with the Ettrick, the Tweed is ſtill adorned with woods, and leads the pleaſed imagination to contemplate what this country muſt have been in former times. The Yarrow, for about five miles above its junction with Ettrick, exhibits nature in a bold and ſtriking aſpect. Its native woods ſtill remain, through which the ſtream has cut its turbid courſe, deeply ingulphed amidſt rugged rocks. Here, certainly in a flood, ſtood the deſcriptive Thomſon when he ſaw it

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"Work and boil, and foam and thunder through."

On a peninſula, cut out by the ſurrounding ſtream, in the middle of this fantaſtically wild ſcene of grandeur and beauty, ſtands the caſtle of Newark, which has been ſuppoſed by many to be the birthplace of Mary Scot the flower of Yarrow.

The population of this county in 1801 amounted to 5070, but the following is the population of the different pariſhes at two different periods, according to the Statiſtical Hiſtory.

Pariſhes.	Population in 1755.	Population in 1790—1798.
Ettrick,	397	470
Galaſhiels,	998	914
Carry forward,	1395	1384

Pariſhes.	Population in 1755.	Population in 1790—1798.
Brought over,	1395	1384
Selkirk,	1793	1700
Yarrow,	1180	1230
	4368	4314
	4314	
Decreaſe,	54	

SELL, or SILL, in building, is of two kinds, viz. *Ground Sell*, denoting the loweſt piece of timber in a wooden building, and that on which the whole ſuperſtructure is raiſed; and *ſell of a window* or *of a door*, which is the bottom piece in the frame of them on which they reſt.

SELLA TURCICA, is a deep impreſſion between the clinoid proceſs of the ſphenoid bone. See ANATOMY *Index*.

SELTZER WATER, is a mineral water which ſprings up at Lower Seltzer, a village in the electorate of Triers, about 10 miles from Frankfort on the Mayne, and 36 from Coblentz.

Seltzer water is brought to this country in ſtone bottles, which are cloſely corked and ſealed, and contain about 3 pints each; and when they are well ſecured, it keeps unchanged for a conſiderable time.

Seltzer water, according to the analyſis of Bergman, contains in an Engliſh wine pint,

	grs.
Carbonate of lime,	3
——— of magneſia,	5
——— of ſoda,	4
Muriate of ſoda,	17.5
	29.5

The ſame quantity of water alſo yields 17 cubic inches of a gaſeous ſubſtance, which is found to be almoſt entirely pure carbonic acid gas.

This water has been long in high repute, on account of its medical virtues, and we have no doubt that it may be uſed with conſiderable benefit in many of thoſe complaints which ariſe from a deranged ſtate of the ſtomach and bowels. The uſual doſe of this water is from half a pint to a pint; but in moſt caſes it may be drunk freely. From its agreeable taſte, and its exhilarating effects on the ſpirits, it is extenſively employed at table as a common drink in Germany and Holland. In this country alſo, both the real and artificial Seltzer water is largely uſed for the ſame purpoſe. Seltzer water may be artificially imitated, by adding the ingredients diluted by analyſis, and in the ſame proportion.

SEM, or SHEM, the ſon of Noah, memorable for his filial piety in concealing the folly and diſgrace of his father, for which he received a remarkable benediction, about 2476 B. C. He lived to the age of 600 years.

Ras SEM. See *RAS Sem* and *PETRIFIED City*.

SEMECARPUS, a genus of plants belonging to the pentandria claſs. See BOTANY *Index*.

SEMEN, SEED. See BOTANY *Index*.

With reſpect to number, plants are either furniſhed with one ſeed, as ſea-pink and biſtort; two, as woodroof and the umbelliferous plants; three, as ſpurge; four, as the lip-flowers of Tournefort and rough-leafed plants of Ray; or many, as ranunculus, anemone, and poppy.

The form of ſeeds is likewiſe extremely various, being either large or ſmall, round, oval, heart-ſhaped, kidney-ſhaped, angular, prickly, rough, hairy, wrinkled, ſleek or ſhining, black, white, or brown. Moſt ſeeds have only one cell or internal cavity; thoſe of leſſer burdock, valerian, lamb's lettuce, cornelian, cherry, and ſebeſten, have two.

With reſpect to ſubſtance, ſeeds are either ſoft, membranaceous, or of a hard bony ſubſtance; as in gromwell, tamarind, and all the nuciferous plants.

In point of magnitude, ſeeds are either very large, as in the cocoa-nut; or very ſmall, as in campanula, *ammannia*, rampions, and throat-wort.

With reſpect to ſituation, they are either diſperſed promiſcuouſly through the pulp (*ſemina nidulantia*), as in water-lily; affixed to a ſuture or joining of the valves of the ſeed-veſſel, as in the croſs-ſhaped and pea-bloom flowers; or placed upon a *placenta* or receptacle within the ſeed-veſſel, as in tobacco and thorn-apple.

Seeds are ſaid to be naked (*ſemina nuda*) which are not contained in a cover or veſſel: ſuch are thoſe of the lip and compound flowers, the umbelliferous and rough-leaved plants. Covered ſeeds (*ſemina tecta*) are contained in ſome veſſel, whether of the capſule, pod, berry, apple, or cherry kind.

A ſimple ſeed is ſuch as bears neither crown, wing, nor downy *pappus*; the varieties in ſeeds, ariſing from theſe circumſtances, are particularly enumerated under their reſpective heads.

In aſſimilating the animal and vegetable kingdoms, Linnæus denominates ſeeds the eggs of plants. The fecundity of plants is frequently marvellous; from a ſingle plant or ſtalk of Indian Turkey wheat, are produced, in one ſummer, 2000 ſeeds; of elecampane, 3000; of ſun-flower, 4000; of poppy, 32,000; of a ſpike of cat's tail, 10,000 and upwards: a ſingle fruit, or ſeed-veſſel, of tobacco, contains 1000 ſeeds; that of white poppy, 8000. Mr Ray relates, from experiments made by himſelf, that 1012 tobacco ſeeds are equal in weight to one grain; and that the weight of the whole quantum of ſeeds in a ſingle tobacco plant, is ſuch as muſt, according to the above proportion, determine their number to be 360,000. The ſame author eſtimates the annual produce of a ſingle ſtalk of ſpleenwort to be upwards of one million of ſeeds.

The diſſemination of plants reſpects the different methods or vehicles by which nature has contrived to diſperſe their ſeeds for the purpoſe of increaſe. Theſe by naturaliſts are generally reckoned four.

1. Rivers and running waters. 2. The wind. 3. Animals. 4. An elaſtic ſpring, peculiar to the ſeeds themſelves.

1. The ſeeds which are carried along by rivers and torrents are frequently conveyed many hundreds of leagues from their native ſoil, and caſt upon a very different climate, to which, however, by degrees they render themſelves familiar.

2. Thoſe which are carried by the wind, are either *winged*, as in fir-tree, trumpet-flower, tulip-tree, birch, arbor-vitæ, meadow rue, and jeſſamine, and ſome umbelliferous plants; furniſhed with a *pappus*, or downy crown, as in valerian, poplar, reed, ſucculent-ſwallow-wort, cotton-tree, and many of the compound flowers; placed

placed within a winged *calyx* or ſeed-veſſel, as in ſcabious, ſea-pink, dock, dioſcorea, aſh, maple, and elm-trees, logwood and woad; or, laſtly, contained within a ſwelled *calyx* or ſeed-veſſel, as in winter cherry, cucubalus, melilot, bladder-nut, fumatory, bladder-ſena, heart-ſeed, and chick-peaſe.

3. Many birds ſwallow the ſeeds of vanelloe, juniper, miſletoe, oats, millet, and other graſſes, and void them entire. Squirrels, rats, parrots, and other animals, ſuffer many of the ſeeds which they devour to eſcape, and thus in effect diſſeminate them. Moles, ants, earth-worms, and other inſects, by ploughing up the earth, admit a free paſſage to thoſe ſeeds which have been ſcattered upon its ſurface. Again, ſome ſeeds attach themſelves to animals, by means of crotchets, hooks, or hairs, which are either affixed to the ſeeds themſelves, as in hound's tongue, mouſe-ear, vervain, carrot, baſtard parſley, ſanicle, water hemp-agrimony, *arctopus*, and *verbeſina;* to their calyx, as in burdock, agrimony, *rhexia*, ſmall wild bugloſs, dock, nettle, pellitory, and ſeed-wort; or to their fruit or ſeed-veſſel, as in liquorice, enchanter's nightſhade, croſswort, cleavers, French honeyſuckle, and arrow-headed graſs.

4. The ſeeds which diſperſe themſelves by an elaſtic force, have that force reſident either in their *calyx*, as in oats, and the greater number of ferns; in their *pappus*, as in centaurea crupina; or in their *capſule*, as in gerannium, herb-bennet, African ſpiræa, fraxinella, horſe-tail, balſam, Malabar nut, cucumber, elaterium, and male balſam apple.

SEMEN, in the animal economy. See PHYSIOLOGY and ANATOMY *Index*.

SEMEN Sanctum, or *Santonicum*. See ARTEMISIA.

SEMENDRIAH, a town of Turkey in Europe, in the province of Servia, with a good citadel. It is the capital of a ſangiacate, was taken by the Turks in 1690, and is ſeated on the Danube, in E. Long. 21. 45. N. Lat. 45. 0.

SEMENTINÆ FERIÆ, in antiquity, feaſts held annually among the Romans, to obtain of the gods a plentiful harveſt. They were celebrated in the temple of Tellus, where ſolemn ſacrifices were offered to Tellus and Ceres. Theſe feaſts were held about ſeed-time, uſually in the month of January; for, as Macrobius obſerves, they were moveable feaſts.

SEMI, a word borrowed from the Latin, ſignifying *half;* but only uſed in compoſition with other words, as in the following articles.

SEMI-Arians, in eccleſiaſtical hiſtory, a branch of the ancient Arians, conſiſting, according to Epiphanius, of ſuch as, in appearance, condemned the errors of that hereſiarch, but yet acquieſced in ſome of the principles thereof, only palliating and hiding them under ſofter and more moderate terms. Though they ſeparated from the Arian faction (ſee ARIANS), they could never be brought to acknowledge that the Son was homoouſios, that is, conſubſtantial, or of the ſame ſubſtance with the Father; they would only allow him to be homoouſios, that is, of a like ſubſtance with the Father, or ſimilar to the Father in his eſſence, not by nature, but by a peculiar privilege.

The ſemi-arianiſm of the moderns conſiſts in their maintaining that the Son was from all eternity begotten by the *will* of the Father, contrary to the doctrine of the orthodox, who ſeem to teach that the eternal generation is *neceſſary*. Such at leaſt are the reſpective opinions of Dr Clarke and Biſhop Bull. See THEOLOGY.

SEMICIRCLE, in *Geometry*, half a circle, or that figure comprehended between the diameter of the circle and half its circumference.

SEMICOLON, in *Grammar*, one of the points or ſtops uſed to diſtinguiſh the ſeveral members of a ſentence from each other.

The mark or character of the ſemicolon is (;), and has its name as being of ſomewhat leſs effect than a colon; or as demanding a ſhorter pauſe.

The proper uſe of the ſemicolon is to diſtinguiſh the conjunct members of a ſentence. Now, by a conjunct member of a ſentence is meant ſuch a one as contains at leaſt two ſimple members.—Whenever, then, a ſentence can be divided into ſeveral members of the ſame degree, which are again diviſible into other ſimple members, the former are to be ſeparated by a ſemicolon. For inſtance: "If fortune bear a great ſway over him, who has nicely ſtated and concerted every circumſtance of an affair; we muſt not commit every thing, without reſerve, to fortune, leſt ſhe have too great a hold of us." Again: *Si quantum in agro lociſque deſertis audacia poteſt, tantum in foro atque judiciis impudentia valeret; non minus in cauſa cederet Aulus Cæcinna Sexta Æbutii impudentiæ, quam tum in vi facienda ceſſit audaciæ.* An inſtance in a more complex ſentence we have in Cicero: *Res familiaris primum bene parta ſit, nulloque turpi quæſtu: tum quam plurimis, modo dignis, ſe utilem præbeat; deinde augeatur ratione, diligentia, parſimonia; nec libidini potius luxuriæque, quam liberalitati et beneficentiæ pareat.*

But though the proper uſe of the ſemicolon be to diſtinguiſh conjunct members, it is not neceſſary that all the members thus divided be conjunct. For upon dividing a ſentence into great and equal parts, if one of them be conjunct, all thoſe other parts of the ſame degree are to be diſtinguiſhed by a ſemicolon.—Sometimes alſo it happens, that members that are oppoſite to each other, but relate to the ſame verb, are ſeparated by a ſemicolon. Thus Cicero: *Ex hac parte pudor, illinc petulantia; hinc fides, illinc fraudatio; hinc pietas, illinc ſcelus*, &c. To this likewiſe may be referred ſuch ſentences, where the whole going before, the parts follow: as "The parts of oratory are four; invention, diſpoſition, elocution, and pronunciation.

SEMICUBIUM, in *Medicine*, an half-bath, wherein the patient is only placed up to the navel.

SEMIDIAMETER, half the diameter, or a right line drawn from the centre of a circle or ſphere to its circumference: being the ſame with what is otherwiſe called the *radius*.

SEMIFLOSCULUS, in *Botany*, a term uſed to expreſs the flowers of the ſyngeneſia claſs. Theſe ſemifloſculi are petals, hollow in their lower part, but in their upper flat, and continued in the ſhape of a tongue.

SEMITONE, in *Muſic*. See INTERVAL.

SEMINAL, ſomething belonging to the ſemen or ſeed.

SEMINARY, in its primary ſenſe, the ground where any thing is ſown, to be afterwards tranſplanted.

SEMINARY, in a figurative ſenſe, is frequently applied to places of education, whence ſcholars are tranſplanted

planted into life.—In Catholic countries it is particularly uſed for a kind of college or ſchool, where youth are inſtructed in the ceremonies, &c. of the ſacred miniſtry. Of theſe there are great numbers; it being ordained by the council of Trent, that there be a ſeminary belonging to each cathedral, under the direction of the biſhop.

SEMINATION, denotes the manner or act of ſhedding and diſperſing the ſeeds of plants. See SEMEN.

SEMIPELAGIANS, in *Eccleſiaſtical Hiſtory*, a name given to ſuch as retain ſome tincture of Pelagianiſm. See PELAGIANS.

The doctrines of this ſect, as well as thoſe of their predeceſſors the Pelagians, have their common ſource in Pelagius, a native of Britain, of whom we have already taken notice. He is ſaid to have been but a ſimple monk, and not in orders. Having gone to Rome about the end of the fourth century, he lived there for ſome years with reputation, and was conſidered both pious and virtuous. Rufinus a prieſt of Aquileia, having come to Rome in the year 397, is affirmed by ſome to have been the perſon who ſuggeſted to Pelagius his peculiar doctrines.

In the year 400 Pelagius began to teach his opinions at Rome, both by ſpeech and writing. He was not the only perſon who taught theſe doctrines, of which we have elſewhere enumerated the heads. His friend and companion Celeſtius, an abler man than himſelf, maintained them likewiſe, and with much more addreſs and ſubtlety. After having promulgated them in Rome, they went into Sicily, where they lived for ſome time. Thence, in the year 411, they paſſed over into Africa. Pelagius ſoon after went into Paleſtine, whilſt Celeſtius remained at Carthage, and was preparing himſelf to take the order of prieſthood; but it being ſoon diſcovered that he taught a new doctrine[*], he was accuſed by the deacon Paulinus in a ſynod held at Carthage in 412, at which Aurelius the biſhop preſided. Celeſtius, on being charged by Paulinus with denying original ſin, made anſwer, "That in truth he doubted whether the ſin of Adam was tranſmitted to his poſterity." He did not however own that children had no need of baptiſm, although this was one of the Pelagian tenets: on the contrary, he wrote a little diſcourſe, in which he acknowledged, that children had need of redemption, and that they could not obtain it without baptiſm. The biſhops at the council of Carthage condemned the doctrines of Celeſtius, and excommunicated him. From this ſentence he appealed to the biſhop of Rome; but he neglected to purſue his appeal, and went to Epheſus, where he endeavoured to get himſelf ordained prieſt. In the mean time, Pelagius having retired into Paleſtine, was kindly received by St Jerome's enemy, John of Jeruſalem. With him he entered into an engagement to attack the reputation of that author. St Jerome defended himſelf from their aſſault, and attacked the doctrines of Pelagius[†], and in this undertaking he was ſoon aſſiſted by St Auſtine. About this time, Oroſius having gone from Spain into Africa and thence into Paleſtine, publiſhed there the proceedings againſt Celeſtius at Carthage, and was prevailed upon by the biſhop of Jeruſalem to enter into a conference with Pelagius in his preſence; but the biſhop having ſhown too much partiality for Pelagius, Oroſius would not acknowledge him for judge, but demanded that the deciſion of that affair, which was among the Latins, might be referred to judges who underſtood the language. This happened in the year 415, at which time there were in Paleſtine two French prelates, who, being driven from their dioceſes, fled into that country, and having been apprized of the opinions of Pelagius and Celeſtius, drew up an abridgement from their own books of the errors imputed to them[‡]. To this they joined the articles condemned in the ſynod of Carthage, and ſome others, which were ſent from Sicily by Hilarius to St Auguſtine, and then preſented the abridgement to the biſhop of Cæſarea. The matter was referred to a council of 14 biſhops, at which, when the memoir was read, Pelagius explained himſelf upon ſome articles, and denied that he was the author of others. He alſo diſowned the propoſitions condemned at Carthage, and ſome others aſcribed to Celeſtius. He did not even heſitate to condemn them; upon which the biſhops decided, that, ſince Pelagius approved the doctrine of the church, and rejected and condemned what was contrary to its belief, they acknowledged him to be of the eccleſiaſtical and catholic communion.

Oroſius returning to Africa, took with him the memoir againſt Pelagius, and preſented it to a meeting of biſhops[*] held at Carthage in 416. Having read over what had been done at a former meeting againſt Celeſtius, they declared that both he and Pelagius ought to be anathematized if they did not publicly renounce and condemn the errors imputed to them. The biſhops of this meeting, and thoſe of Numidia aſſembled the ſame year at Milivetum, wrote upon the ſubject to Pope Innocent, who approved of the judgment of the African prelates, and declared Pelagius, Celeſtius, and their followers excommunicated[†]. Innocent gave an account of this judgment to the biſhops of the Eaſt, and the matter ſeemed altogether at an end, when he died; but Celeſtius having been made prieſt at Epheſus, and having gone to Conſtantinople, whence he was driven by Atticus biſhop of that city, who alſo wrote againſt him to Aſia and to Africa, he came to Rome in the beginning of the pontificate of Zozimus, and undertook to purſue the appeal, which he had formerly made from the judgment of the ſynod of Carthage. Having cited his accuſer Paulinus, and offered to juſtify himſelf, he preſented a Confeſſion of Faith, in which he acknowledged that children ought to be baptized, in order to inherit the kingdom of heaven; but he denied that the ſin of Adam was tranſmitted to his children. He appeared before the biſhops and clergymen aſſembled by the pope, and declared, that he condemned all the errors with which he had been charged. The pope delayed his judgment for two months, and in the mean time received a letter and a confeſſion of faith from Pelagius, very artfully drawn up. When the time for judgment arrived, Zozimus held a ſynod, and ſaid, that he thought the declarations of Pelagius and Celeſtius ſufficient for their juſtification. He was diſpleaſed at the two French biſhops for not appearing againſt them, and wrote two letters on that head, one to the biſhops of Africa, and another in particular to Aurelius, biſhop of Carthage. The African biſhops, to the number of 214, without regarding the judgment paſſed at Rome, aſſembled at Carthage, and, having confirmed their former deciſions, condemned the doctrines of the Pelagians. They wrote

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[*] *Auguſtini*, lib. ii. *De Gratia.*

[†] *St Jerome's Works and the Apology of Oroſius.*

[‡] *St Auſtine on Original Sin, and againſt the Pelagians.*

[*] *The Epiſtles of St Auguſtine.*

[†] *Marius Mercator's Commentary.*

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to the biſhop of Rome to acquaint him, that he had been deceived by Celeſtius, and diſcovered to him the equivocations of his letter and of the Confeſſion of Faith of Pelagius, ſending him a memoir of the errors of which he ſhould require a diſtinct and preciſe revocation from the two heretics. The pope made anſwer, that, although his authority was ſo great, that none durſt diſſent from his judgment, ſtill that he was willing to communicate the matter to them, and would let it remain in the ſame ſtate, until a new deliberation could take place. This letter was preſented to a council held at Carthage in 418, at which eight canons were drawn up againſt the Pelagian hereſy. The biſhop of Rome, in the mean time, was inclined to examine again the affair of Celeſtius, and to endeavour to draw from him diſtinct and preciſe anſwers according to the plan ſuggeſted by the African biſhops in their memoir; but Celeſtius would not come forward, and accordingly withdrew from Rome. From his flight the pope concluded, that he impoſed upon him formerly, and that he held the new doctrines; and, accordingly, changing his opinion with reſpect to him, he approved of the decrees of the African prelates, and renewed the condemnations of his predeceſſor, Pope Innocent, againſt him and Pelagius*. This judgment he publiſhed in a letter which was ſent to all the biſhops. About the ſame time an edict was publiſhed by the emperor Honorius againſt Pelagius and Celeſtius, ordering, that they ſhould be baniſhed from Rome, and that all their followers ſhould be ſent into exile.

In the following year Honorius publiſhed another edict, by which it was ordered, that the biſhops who would not ſign the pope's letter, ſhould be deprived of their churches. Accordingly, Julian the biſhop of Eclana, who was afterwards head of the party, and ſeventeen other biſhops, were caſhiered; upon which they wrote a letter to Rufus, biſhop of Theſſalonica, and demanded a univerſal council from the emperor, which he refuſed. Celeſtius returned again to Rome, but was again expelled the city; whilſt his followers, being expelled from Italy, retired to different countries. Some of them came over into Britain, and others went into the Eaſt. Atticus baniſhed them from Conſtantinople, and they were alſo baniſhed from Epheſus. Theodotus, biſhop of Antioch, condemned them in a ſynod held at Dioſpolis, and baniſhed Pelagius and his followers out of Paleſtine, whither they had returned. Julian the biſhop was condemned in a provincial ſynod of Cilicia, whither he had retired to Theodorus biſhop of Mopſueſta, who was obliged to anathematize him. What became of Pelagius is unknown, as hiſtory gives no farther account of him; but Celeſtius having returned to Rome, and being driven thence by Pope Celeſtin, went with Julian and ſome other biſhops of their party to Conſtantinople, where they endeavoured to prevail upon the emperor Theodoſius to aſſemble a council, inſtead of which he ordered them to leave the city. After this they joined with the Neſtorians†, and were condemned together with them in a general council held at Epheſus in 431; and there now remained but a ſmall number of Pelagians diſperſed in the Weſt. Julian after having endeavoured ſeveral times to get himſelf reinſtated in his biſhopric, was at laſt obliged to retire into Sicily, where he died.

To the Pelagians ſucceeded the Semipelagians, who rejected the doctrines of the former with reſpect to original ſin and the power of free will to do good‡. They owned, that man had need of the grace of God to perſevere in well-doing; but they believed, that the beginning of good will and faith did not neceſſarily depend upon grace; for that man, by the mere force of nature, might deſire to do good, and that God ſeconded that good will by his aſſiſtance, which depended upon liberty, and was given to all men. Beſides theſe, they maintained ſome other peculiar tenets. The origin of ſome of their opinions is founded in this, that ſome of the books which were written by St Auguſtine in his laſt years, with reſpect to the controverſies which aroſe in the monaſtery of Adrumetum, relative to correction, grace, and predeſtination, having been carried into Gaul, happened to give offence to ſeveral perſons, and particularly to the monks of Lerins, who conſidered his doctrines hoſtile to that of free will. This led them to think and to maintain, that, in order to be ſaved, it was neceſſary to leave to man the power of knowing and deſiring good by the force of nature, ſo that the beginning might come from man. Several conſiderable perſons in Gaul, and even ſome biſhops, but particularly the prieſts, were of this opinion. Caſſian, deacon of Conſtantinople, and afterwards prieſt at Marſeilles, authorized it in his conferences, and Fauſtus, biſhop of Riez, ſupported it very ſtrenuouſly. St Auguſtine ſtood up to oppoſe this doctrine from its very firſt appearance, and was ſupported by Proſper and Hilarius. Pope Celeſtin complained to the biſhops of Gaul, that they ſuffered their prieſts to ſpeak ill of the doctrines of St Auguſtine; and Popes Gelaſius and Hormiſdas condemned the books of Fauſtus; and laſt of all, the council of Orange, held in 529, condemned particularly the principal tenets of the Semipelagians, and put an end at that time to the controverſy, about 100 years after the death of St Auguſtine.—See the hiſtories of Moſheim, Dupin, and Fleury, &c. &c.

The Semipelagians were very numerous; and their doctrines, though variouſly explained, were received in many of the monaſtic ſchools in Gaul, whence they ſpread themſelves far and wide through Europe. With reſpect to the Greeks and other Chriſtians of the Eaſt, we may remark, that they had adopted the Semipelagian tenets, even before they were promulgated in Gaul by Caſſian and Fauſtus.

After the period, however, at which the Semipelagian doctrines were condemned in the council of Orange, we find but little notice taken of this ſect by hiſtorians. Although its tenets were maintained by a few in the ſucceeding centuries, the ſect could boaſt of no eminent leaders, and ſunk into obſcurity. In the beginning, indeed, of the reformation, ſome of the Pelagian tenets were again brought into circulation. Every one is acquainted with the hoſtility of Luther to the doctrine of free will, who went ſo far into the oppoſite extreme as to entitle one of his works againſt the celebrated Eraſmus on this ſubject, "*De Servo Arbitrio.*" But notwithſtanding that Luther was their leader, this doctrine of his was not adopted by ſome of the moſt eminent of the reformers. His learned friend, the mild and worthy Melancthon, although he at firſt (either from not having ſufficiently conſidered the ſubject, or becauſe this doctrine was ſo unpalatable to the great body of the reformers on account of the authority of Luther), joined

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* See the *Letters of St Auguſtine.*

† *Proſper in his Chronicle.*

‡ *Hilary's Letters to Auguſtine.*

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with Luther in his hoſtility to the doctrine of free will, ſo far as to ſay, that free will could have no effect, under the influence of grace, ſhortly after changed his opinion ſo as to run into the oppoſite extreme. For although Luther at his outſet had affirmed, that the preſcience of God annihilated free will in all his creatures, he was ſo ſoftened down into moderation at the time of the drawing up of the famous Confeſſion of Augſburg, as to allow Melancthon, who compoſed it, to inſert theſe words, "that it was neceſſary to allow free will to all who poſſeſſed the uſe of reaſon, not however in ſuch things as regarded God, which they could not commence, *or at leaſt which they could not complete*, without his aſſiſtance and grace, but in the affairs, or works, of the preſent life ſolely, and in order to perform their duty towards ſociety *." In this paſſage two truths are clearly admitted: 1. That there is free will in man; and, 2. That of itſelf it has no efficacy in ſuch works as are purely Chriſtian or religious. But although this be evident, and although it would ſeem as if he attributed the efficacy of religious works ſolely to the grace of God, yet the reſtricting words "*at leaſt*," ſhow, that he was of opinion, that free will, by its own natural force and efficacy, though it could not complete, *could at leaſt commence*, Chriſtian or religious works, without the aſſiſtance of grace. To ſuch of our readers as are acquainted with eccleſiaſtical hiſtory, it is unneceſſary to remark, that this was one of the leading tenets of the Semipelagians. But Melancthon did not ſtop here. It is true, that, in order to keep well with the reformers, he was obliged, in thoſe public inſtruments which he drew up, to inſinuate rather than avow his partiality for the doctrine of free will, the exerciſe of which, we ſee, he confined in the Confeſſion of Augſburg to ſuch actions merely as regarded civil life and our duties to ſociety. In the Saxon Confeſſion of Faith, however, he proceeds a ſtep farther, and ſays "that the will is free; that God neither wiſhes for, nor approves, nor co-operates in the production of ſin; but that the free will of man and of the devils is the true cauſe of their ſin and of their fall." Many no doubt will be of opinion, that Melancthon merits praiſe for having thus corrected Luther, and for having more clearly expreſſed his own opinion, than he had done in the Confeſſion of Augſburg. He even proceeds farther, and extends the exerciſe of free will to religious or Chriſtian works. For after having explained in the Saxon Confeſſion of Faith the nature of free will, and the manner in which it makes a choice, and having alſo ſhown, that it is not of itſelf ſufficient in thoſe works, or actions, which regard a future life, he affirms twice "that the will, even after having received the influence of the Holy Spirit, does not remain idle," that is to ſay, it is not merely paſſive under the influence of grace, but can reject it, or co-operate with it, at pleaſure. Neceſſity, it is true, obliged him to expreſs his opinion rather obſcurely. But what he inſinuates only in theſe laſt quoted words, is clearly and fully expreſſed in one of his letters to Calvin. "I had, ſays he, a friend who, in reaſoning upon predeſtination, believed equally the two following things; namely, that every thing happens amongſt men as it is ordained by Providence, but that there is, nevertheleſs, a contingency in actions or in events. He confeſſed, however, that he was unable to reconcile theſe two things. For my part, (continues Melancthon), who am of opinion, that God neither wiſhes for, nor is the cauſe of ſin, I acknowledge this contingency in the feebleneſs of our judgment, in order that the ignorant may confeſs, that David fell of himſelf, and voluntarily into ſin; that he had it in his power to preſerve the grace of the Holy Spirit which he had within him, and that in this combat or trial, it is neceſſary to acknowledge ſome exerciſe or action of the will *." This opinion he confirms and illuſtrates by a paſſage from St Baſil, where he ſays, "Have but the will, or the inclination, and God is with you." By which words Melancthon ſeems to inſinuate, that the will is not only active in the works of religion, but even begins them without grace. This, however, was not the meaning of St Baſil, as is evident from ſeveral other parts of his writings; but that it was the opinion of Melancthon appears fully from this paſſage, as well as from that which we have cited from the Confeſſion of Augſburg, in which he inſinuates, that the error is not in ſaying, that the will can of itſelf commence, but in thinking, that it can without grace finiſh or complete, religious or Chriſtian works. Thus it appears, that he conſidered the will capable of rejecting the influence of grace, ſince he declares, that David could preſerve the Holy Spirit when he loſt it, as well as he could loſe it when he kept it within him. But although this was his decided opinion, he durſt not avow it fully in the Saxon Confeſſion of Faith, but was obliged to content himſelf with inſinuating it gently in theſe words, "The will, even after receiving the grace of the Holy Spirit, is not idle or without action." All this precaution, however, was inſufficient to ſave Melancthon from cenſure. Francowitz, better known by the name of Illyricus, being jealous of him and his enemy, by his influence with his party procured the condemnation of theſe words of the Saxon Confeſſion, and of the paſſage from St Baſil, at two ſynods held by the Reformers; at the ſame time, that one party of the Lutherans were unwilling to adopt Melancthon's opinion, "that the will is not paſſive, when under the influence of grace," we are at a loſs to think how they could deny it, ſince they almoſt unanimouſly confeſs, that a perſon under the influence of grace may reject and loſe it. This opinion is avowed in the Confeſſion of Augſburg and in Melancthon's Apology. It was even, long after that, decided upon anew, inculcated ſtrongly in their book of Concord, and was brought frequently againſt them by their opponents as a proof of inconſiſtency and contradiction.

Theſe are not the only inſtances in which the Lutherans were charged with Semipelagian principles. One of the ableſt and the moſt learned of their opponents, we cannot help thinking, had in more than one inſtance made good the charge againſt them. To prove this we need only refer to the remarks that have been made on the eight celebrated propoſitions in the third book of Concord, relative to the co-operation of the will with grace. According to the firſt ſeven of theſe propoſitions, an attentive liſtening to the preaching of the word of God produceth grace; and according to the fifth, any man, even a libertine or an infidel, is free, or has it in his power to liſten attentively to the preaching of the word of God. He has it then in his power to give to himſelf that which to him is productive of grace, and may thus be the ſole author of his own converſion or-

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* See *the 18th article, and Melancthon's Apology.*

* See *Calvin's Letters.*

or regeneration. In the eighth propoſition it is affirmed, that we are not permitted to doubt, but that the grace of the Holy Spirit, even though it may not be felt, does accompany an attentive hearing of the word of God; and to do away every doubt about the ſpecies of attention which they mean, we muſt obſerve, that they ſpeak of attention in as much as it precedes the grace of the Holy Spirit, and of that attention which, in conſequence of its dependence on free-will, we have it in our power to beſtow upon the word or not, juſt as we pleaſe. It is the exerciſe of this free attention which they ſay operates grace. But here it would ſeem, that they were in extremes; for, as they ſaid upon one hand, that, when the Holy Spirit begins to move us, we act not at all; ſo they maintained on the other, that this operation of the Holy Spirit, which converts us without any co-operation on our part, is neceſſarily attendant upon an act of our wills, in which the Holy Spirit has no ſhare, and in which our liberty acts purely by its natural force or power. Such of our readers as are anxious to examine the progreſs of the Pelagian and Semipelagian principles after the dawn of the Reformation, we muſt refer to the works of the principal reformers and to thoſe of their adverſaries, as well as to the different writers upon eccleſiaſtical hiſtory.

SEMIRAMIS, in fabulous hiſtory, a celebrated queen of Aſſyria, daughter of the goddeſs Derceto, by a young Aſſyrian. She was expoſed in a deſert; but her life was preſerved by doves for one whole year, till Simmas, one of the ſhepherds of Ninus, found her and brought her up as his own child. Semiramis, when grown up, married Menones, the governor of Nineveh, and accompanied him to the ſiege of Bactria; where, by her advice and prudent directions, ſhe haſtened the king's operations, and took the city. Theſe eminent ſervices, together with her uncommon beauty, endeared her to Ninus. The monarch aſked her of her huſband, and offered him his daughter Soſana in her ſtead; but Menones, who tenderly loved Semiramis, refuſed; and when Ninus had added threats to entreaties, he hanged himſelf. No ſooner was Menones dead, than Semiramis, who was of an aſpiring ſoul, married Ninus, by whom ſhe had a ſon called *Ninyas*. Ninus was ſo fond of Semiramis, that at her requeſt he reſigned the crown, and commanded her to be proclaimed queen and ſole empreſs of Aſſyria. Of this, however, he had cauſe to repent: Semiramis put him to death, the better to eſtabliſh herſelf on the throne; and when ſhe had no enemies to fear at home, ſhe began to repair the capital of her empire, and by her means Babylon became the moſt ſuperb and magnificent city in the world. She viſited every part of her dominions, and left every where immortal monuments of her greatneſs and benevolence. To render the roads paſſable and communication eaſy, ſhe hollowed mountains and filled up valleys, and water was conveyed at a great expence by large and convenient aqueducts to barren deſerts and unfruitful plains. She was not leſs diſtinguiſhed as a warrior: Many of the neighbouring nations were conquered; and when Semiramis was once told as ſhe was dreſſing her hair, that Babylon had revolted, ſhe left her toilette with precipitation, and though only half dreſſed, ſhe refuſed to have the reſt of her head adorned before the ſedition was quelled and tranquillity re-eſtabliſhed. Semiramis has been accuſed of licentiouſneſs; and ſome authors have obſerved that ſhe regularly called the ſtrongeſt and ſtouteſt men in her army to her arms, and afterwards put them to death, that they might not be living witneſſes of her incontinence. Her paſſion for her ſon was alſo unnatural; and it was this criminal propenſity which induced Ninyas to deſtroy his mother with his own hands. Some ſay that Semiramis was changed into a dove after death, and received immortal honours in Aſſyria. It is ſuppoſed that ſhe lived about 11 centuries before the Chriſtian era, and that ſhe died in the 62d year of her age and the 25th of her reign. Many fabulous reports have been propagated about Semiramis, and ſome have declared that for ſome time ſhe diſguiſed herſelf and paſſed for her ſon Ninyas. *Lempriere's Bibliotheca Claſſica.*

SEMPERVIVUM, HOUSE LEEK, a genus of plants belonging to the claſs dodecandria; and in the natural method ranking under the 13th order, *Succulentæ*. See BOTANY *Index*.

SENAAR, or SENNAAR. See SENNAAR.

SENATE, in general, is an aſſembly or council of ſenators; that is, of the principal inhabitants of a ſtate, who have a ſhare in the government.

The ſenate of ancient Rome is of all others the moſt celebrated. It exerciſed no contentious juriſdiction; but appointed judges, either from among the ſenators or knights, to determine proceſſes: it alſo appointed governors of provinces, and diſpoſed of the revenues of the commonwealth, &c. Yet did not the whole ſovereign power reſide in the ſenate, ſince it could not elect magiſtrates, make laws, or decide of war and peace; in all which caſes the ſenate was obliged to conſult the people.

The ſenate, when firſt inſtituted by Romulus, conſiſted of 100 members; to whom he afterwards added the ſame number when the Sabines had migrated to Rome. Tarquin the ancient made the ſenate conſiſt of 300, and this number remained fixed for a long time; but afterwards it fluctuated greatly, and was increaſed firſt to 700, and afterwards to 900 by Julius Cæſar, who filled the ſenate with men of every rank and order. Under Auguſtus the ſenators amounted to 1000, but this number was reduced, and fixed to 600. The place of a ſenator was always beſtowed upon merit: the monarchs had the privilege of chooſing the members; and after the expulſion of the Tarquins, it was one of the rights of the conſuls, till the election of the cenſors, who from their office ſeemed moſt capable of making choice of men whoſe character was irreproachable, whoſe morals were pure, and relations honourable. Only particular families were admitted into the ſenate; and when the plebeians were permitted to ſhare the honours of the ſtate, it was then required that they ſhould be born of free citizens. It was alſo required that the candidates ſhould be knights before their admiſſion into the ſenate. They were to be above the age of 25, and to have previouſly paſſed through the inferior offices of quæſtor, tribune of the people, edile, prætor, and conſul.

The ſenate always met of courſe on the 1ſt of January, for the inauguration of the new conſuls; and in all months, univerſally, there were three days, viz. the kalends, nones, and ides, on which it regularly met: but it always met on extraordinary occaſions, when called together by conſul, tribune, or dictator.

To render their decrees valid and authentic, a certain number of members was requiſite, and ſuch as were abſent without ſome proper cauſe were always fined. In the reign of Auguſtus, 400 ſenators were requiſite to make a ſenate. Nothing was tranſacted before ſunriſe or after ſunſet. In their office the ſenators were the guardians of religion; they diſpoſed of the provinces as they pleaſed; they prorogued the aſſemblies of the people; they appointed thankſgivings; nominated their ambaſſadors; diſtributed the public money, and in ſhort had the management of every thing political or civil in the republic, except the creating of magiſtrates, the enacting of laws, and the declaration of war or peace, which were confined to the aſſemblies of the people.

SENATOR, in general, denotes a member of ſome ſenate.

The dignity of a Roman ſenator could not be ſupported without the poſſeſſion of 80,000 ſeſterces, or about 7000l. Engliſh money; and therefore ſuch as ſquandered away their money, and whoſe fortune was reduced below this ſum, were generally ſtruck out of the liſt of ſenators. This regulation was not made in the firſt ages of the republic, when the Romans boaſted of their poverty. The ſenators were not permitted to be of any trade or profeſſion. They were diſtinguiſhed from the reſt of the people by their dreſs; they wore the laticlave, half-boots of a black colour, with a creſcent or ſilver buckle in the form of a C; but this laſt honour was confined only to the deſcendants of thoſe hundred ſenators who had been elected by Romulus, as the letter C ſeems to imply. See the preceding article.

Among us, ſenator is a member of parliament. In the laws of King Edward the Confeſſor, we are told that the Britons called thoſe *ſenators* whom the Saxons called afterwards *aldermen* and *borough-maſters*; though not for their age, but their wiſdom; for ſome of them were young men, but very well ſkilled in the laws. Kenulph king of the Mercians granted a charter, which ran thus, viz. *Conſilio et conſenſu* epiſcoporum *et* ſenatorum *gentis ſuæ largitus fuit dicto monaſterio*, &c.

In Scotland, the lords of ſeſſion are called *ſenators* of the college of juſtice.

SENATUS AUCTORITAS. See the next article.

SENATUS-Conſultum, which made part of the Roman law. When any public matter was introduced into the ſenate, which was always called *referre ad ſenatum*, any ſenator whoſe opinion was aſked, was permitted to ſpeak upon it as long as he pleaſed, and on that account it was often uſual for the ſenators to protract their ſpeeches till it was too late to determine. When the queſtion was put, they paſſed to the ſide of that ſpeaker whoſe opinion they approved, and a majority of votes was eaſily collected, without the trouble of counting the numbers. When the majority was known, the matter was determined, and a *ſenatus conſultum* was immediately written by the clerks of the houſe, at the feet of the chief magiſtrates, and it was ſigned by all the principal members of the houſe. When there was not a ſufficient number of members to make a ſenate, the deciſion was called *ſenatus auctoritas*, but it was of no force if it did not afterwards paſs into a *ſenatus conſultum*.

The *ſenatus conſulta* were at firſt left in the cuſtody of the kings, and afterward of the conſuls, who could ſuppreſs or preſerve them; but about the year of Rome 304, they were always depoſited in the temple of Ceres, and afterwards in the treaſury, by the ediles of the people.

SENECA, LUCIUS ANNÆUS, a Stoic philoſopher, was born at Corduba in Spain, about the beginning of the Chriſtian era, of an equeſtrian family, which had probably been tranſplanted thither in a colony from Rome. He was the ſecond ſon of Marcus Annæus Seneca, commonly called the *rhetorician*, whoſe remains are printed under the title of *Suaſoriæ et Controverſiæ, cum Declamationum Excerptis*; and his youngeſt brother Annæus Mela (for there were three of them) had the honour of being father to the poet Lucan. He was removed to Rome, together with his father and the reſt of his family, while he was yet in his infancy. There he was educated in the moſt liberal manner, and under the beſt maſters. He learned eloquence from his father; but his genius rather leading him to philoſophy, he put himſelf under the ſtoics Attalus, Sotion, and Papirius Fabianus; men famous in their way, and of whom he has made honourable mention in his writings. It is probable, too, that he travelled when he was young, ſince we find him, in ſeveral parts of his works, particularly in his *Quæſtiones Naturales*, making very exact and curious obſervations upon Egypt and the Nile.—But this, though entirely agreeable to his own humour, did not at all correſpond with that ſcheme or plan of life which his father had drawn out for him; who, therefore, forced him to the bar, and put him upon ſoliciting for public employments; ſo that he afterwards became quæſtor, prætor, and, as Lipſius will have it, even conſul.

In the firſt year of the reign of Claudius, when Julia the daughter of Germanicus was accuſed of adultery by Meſſalina, and baniſhed, Seneca was baniſhed too, being charged as one of the adulterers. Corſica was the ſeat of his exile, where he lived eight years; "happy in the midſt of thoſe things which uſually make other people miſerable;" *inter eas res beatus, quæ ſolent miſeros facere*: and here he wrote his books of conſolation, addreſſed to his mother Helvia, and to his friend Polybius, and perhaps ſome of thoſe tragedies which go under his name; for he ſays, *modo ſe levioribus ſtudiis ibi oblectaſſe*. Agrippina being married to Claudius, upon the death of Meſſalina, ſhe prevailed with the emperor to recal Seneca from baniſhment; and afterwards procured him to be tutor to her ſon Nero, whom ſhe deſigned for the empire. Africanus Burrhus, a prætorian præfect, was joined with him in this important charge: and theſe two preceptors, who were entruſted with equal authority, had each his reſpective department. By the bounty and generoſity of his royal pupil, Seneca acquired that prodigious wealth which rendered him in a manner equal to kings. His houſes and walks were the moſt magnificent in Rome. His villas were innumerable: and he had immenſe ſums of money placed out at intereſt in almoſt every part of the world. The hiſtorian Dio reports him to have had 250,000l. ſterling at intereſt in Britain alone; and reckons his calling it in all at a ſum, as one of the cauſes of a war with that nation.

All this wealth, however, together with the luxury and effeminacy of a court, does not appear to have had any ill effect upon the temper and diſpoſition of Seneca. He continued abſtemious, exact in his manners, and

and, above all, free from the vices ſo commonly prevalent in ſuch places, flattery and ambition. "I had rather (ſaid he to Nero) offend you by ſpeaking the truth, than pleaſe you by lying and flattery: *maluerim veris offendere, quam placere adulando.*" How well he acquitted himſelf in quality of preceptor to his prince, may be known from the five firſt years of Nero's reign, which have always been conſidered as a perfect pattern of good government; and if that emperor had but been as obſervant of his maſter through the whole courſe of it, as he was at the beginning, he would have been the delight, and not, as he afterwards proved, the curſe and deteſtation of mankind. But when Poppæa and Tigellinus had got the command of his humour, and hurried him into the moſt extravagant and abominable vices, he ſoon grew weary of his maſter, whoſe life muſt indeed have been a conſtant rebuke to him. Seneca, perceiving that his favour declined at court, and that he had many accuſers about the prince, who were perpetually whiſpering in his ear the great riches of Seneca, his magnificent houſes and fine gardens, and what a favourite through means of theſe he was grown with the people, made an offer of them all to Nero. Nero refuſed to accept them: which, however, did not hinder Seneca from changing his way of life; for, as Tacitus relates, he "kept no more levees, declined the uſual civilities which had been paid to him, and, under a pretence of indiſpoſition, or ſome engagement or other, avoided as much as poſſible appearing in public."

Nero, in the mean time, who, as it is ſuppoſed, had diſpatched Burrhus by poiſon, could not be eaſy till he had rid himſelf of Seneca alſo: For Burrhus was the manager of his military concerns, and Seneca conducted his civil affairs. Accordingly, he attempted, by means of Cleonicus, a freedman of Seneca, to take him off by poiſon; but this not ſucceeding, he ordered him to be put to death, upon an information that he was privy to Piſo's conſpiracy againſt his perſon. Not that he had any real proof of Seneca's being concerned in this plot, but only that he was glad to lay hold of any pretence for deſtroying him.—He left Seneca, however, at liberty to chooſe his manner of dying; who cauſed his veins to be opened immediately. His wife Paulina, who was very young in compariſon of himſelf, had yet the reſolution and affection to bear him company, and thereupon ordered her veins to be opened at the ſame time; but as Nero was not willing to make his cruelty more odious and inſupportable than there ſeemed occaſion for, he gave orders to have her death prevented: upon which her wounds were bound up, and the blood ſtopped, in juſt time enough to ſave her; though, as Tacitus ſays, ſhe looked ſo miſerably pale and wan all her life after, that it was eaſy to read the loſs of her blood and ſpirits in her countenance. In the mean time, Seneca, finding his death ſlow and lingering, deſired Statius Annæus his phyſician to give him a doſe of poiſon, which had been prepared ſome time before in caſe it ſhould be wanted; but this not having its uſual effect, he was carried to a hot bath, where he was at length ſtifled with the ſteams. He died, as Lipſius conjectures, in the 63d or 64th year of his age, and in about the 10th or 11th of Nero's reign. Tacitus, on mentioning his death, obſerves, that, as he entered the bath, he took of the water, and with it ſprinkled ſome of his neareſt domeſtics, ſaying, "That he offered thoſe libations to Jupiter the Deliverer." Theſe words are an evident proof that Seneca was not a Chriſtian, as ſome have imagined him to have been; and that the 13 epiſtles from Seneca to St Paul, and from St Paul to Seneca, are ſuppoſititious pieces. His philoſophical works are well known.—They conſiſt of 124 *epiſtles* and diſtinct treatiſes; and, except his books of phyſical queſtions, are chiefly of the moral kind, treating of anger, conſolation, providence, tranquillity of mind, conſtancy, clemency, the ſhortneſs of life, a happy life, retirement, benefits. He has been juſtly cenſured by Quintilian and other critics, as one of the firſt corrupters of the Roman ſtyle; but his works are highly valuable, on account of the vaſt erudition which they diſcover, and the beautiful moral ſentiments which they contain.

SENECIO, GROUNDSEL; a genus of plants belonging to the claſs ſyngeneſia, and to the order of polygamia ſuperflua; and in the natural method ranking under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SENEGAL, a part of Negroland in Africa, the boundaries of which are not known. See GUINEA.

Iſle of SENEGAL, ſometimes called *Saint Louis*, is a ſmall iſland in the mouth of the river Senegal, and according to Maſkelyne's tables is ſituated in N. Lat. 15. 53. W. Long. 16. 31. The Dutch were the firſt Europeans who ſettled at Senegal; but their colony was expelled by the French in 1687. It was taken by the Engliſh in 1692; and retaken by the French the year following. It was a ſecond time taken poſſeſſion of by the Engliſh in 1758; but in 1779 the French recovered it, and it was ceded to the Britiſh crown by the treaty of 1783.

The beſt account of this iſland which we have ſeen, is given in the intereſting voyage of M. Saugnier to the coaſt of Africa. This adventurer viſited Senegal in June 1785.

"The iſland (ſays he), properly ſpeaking, is only a bank of ſand in the middle of the river. It is 1000 geometrical paces long, and about 60 in its greateſt width; is almoſt on a level with the river and with the ſea, being defended from the latter by Barbary point, which is of greater elevation than the colony. The eaſtern branch of the river is the more conſiderable of the two, being about 400 toiſes acroſs; the weſtern branch is only from 50 to 200 toiſes wide. The iſle conſiſts entirely of burning ſands, on the barren ſurface of which you ſometimes meet with ſcattered flints, thrown out among their ballaſt by veſſels coming from Goree, or with the ruins of buildings formerly erected by Europeans. There is ſcarcely ſuch a thing as a garden upon the iſland; European ſeeds in general not thriving here. It is not ſurpriſing that the ſoil is ſo unproductive; for the air is ſtrongly impregnated with ſea ſalt, which pervades every thing, and conſumes even iron in a very ſhort ſpace of time. The heats are exceſſive, and rendered ſtill more inſupportable by the reflection of the ſand; ſo that from ten in the morning until four in the afternoon it is almoſt impoſſible to do any work. During the months of January, February, March, and April, the heats are moderated; but in Auguſt and the following months they become ſo oppreſſive as even to affect the natives themſelves. What effect then muſt they have upon the Europeans, ſuddenly tranſported into this burning climate? The nights are a little leſs ſultry; not always, however, but only when the ſea-breeze ſets in. It is then that the inhabitants of the colony breathe a freſher air, for which they have been

been longing the whole of the day; but this air in our climate would ſeem a burning vapour. The nights are nevertheleſs troubleſome, notwithſtanding the comforts of the ſea-breeze. The inſtant the ſun is ſet, we are aſſailed by an infinity of gnats, which are called *muſquitos*; their ſtings are very painful, and their multitudes incredible. The inhabitants find but a poor defence in their gauze-curtains. For my own part, accuſtomed as I had been to live among the Moors, I was but little annoyed by theſe inſects. Being half a ſavage, I felt no deſire to recommend myſelf to the favourable regard of the fair ſex, and I was therefore under no neceſſity of taking care of my perſon. In imitation of my former maſters, I ſmeared myſelf with butter, and this expedient preſerved me at all times from theſe impertinent ſtingers, theſe ſpiteful enemies to the repoſe of the human kind.

"If the proſpect of Senegal is not agreeable to the eye, much leſs are its environs, which are covered over only with ſand, and overrun with mangoes. It may be ſaid, without exaggeration, that there is not a more forlorn ſituation to be found on the face of the inhabited globe, or a place in which the common neceſſaries of life are procured with greater difficulties. Water, that indiſpenſable aliment of man, is here not potable. Wells are dug in the ſand to the depth of five or ſix feet, and water is obtained by theſe means; but whatever pains are taken to freſhen it, it ever retains a brackiſh taſte. I have diſtilled this water myſelf, and obſerved that it always had a diſagreeable ſavour, which cannot fail to be hurtful to the health: it is true, that when the river is high, its ſtreams are freſh, but the water is only the more dangerous. It proves the cauſe of moſt of thoſe maladies which carry off the Europeans ſo rapidly, that at the end of every three years the colony has a freſh ſet of inhabitants. The blacks themſelves, although accuſtomed to the climate, are not in this ſeaſon free from diſeaſe."

The fort of St Louis is a quadrangle, and has two baſtions of conſiderable ſtrength; but the greateſt ſecurity of the fort is its natural ſituation. The cannon of the fort are numerous, and the arſenal well ſupplied with ſmall arms and ſtores. Beſides this fort the French had no other upon the river, except Fort St Joſeph, which ſtands about four leagues below the cataract at Govina, though they had a few factories in different parts.

The principal commodity of this country is that of gum-Senegal (ſee *GUM-Senegal*), which is a valuable branch of commerce, as it is uſed in many arts and manufactures, particularly by the painters in water-colours, the ſilk-weavers, and dyers.

The French import from the river Senegal not only gum-arabic, but elephants teeth, hides, bees-wax, gold-duſt, cotton, oſtrich feathers, ambergris, indigo, and civet.

Notwithſtanding the barrenneſs of the ſpot, Senegal contains more than 6000 negroes, including the captives of the Tapades, or negroes born of the black inhabitants of the country. They are never put up to ſale, unleſs convicted of ſome crime. Their huts, conſtructed in the form of bee-hives, and ſupported upon four ſtakes, ſurround the habitations of the negro inhabitants. The entire height of thoſe huts may riſe to about 12 feet, the width in every direction is commonly from 10 to 12. The beds are compoſed of hurdles laid upon croſs-bars, ſupported by forked ſtakes at the height of about a foot from the ground. Here the ſlaves ſleep promiſcuouſly, men, women, girls, and boys. A fire is made in the middle of the hut, which is filled with ſmoke, ſufficient to ſtifle any man but a negro.

The men are tall, and the women are accounted the handſomeſt negreſſes of all Africa. The Senegalians may be conſidered as the moſt courageous people of that part of the world, without even excepting the Moors. Their courage, however, is more nearly allied to temerity than to bravery. In the courſe of the voyage to Galam, they meet the greateſt dangers with gaiety and ſong; they dread neither muſket nor cannon, and are equally fearleſs of the cayman or crocodile. Should one of their companions be killed, and devoured by theſe animals before their face, they are not deterred from plunging into the water, if the working of the ſhip require it. Theſe excellent qualifications which diſtinguiſh them, and on which they value themſelves ſo much, do not, however, preſerve them from the common contagion of the country, which inclines them all to rapine. They are emulous to ſurpaſs one another in all the arts of over-reaching and fraud. The conduct of the Europeans has, no doubt, encouraged theſe vices as much as the leſſons of the marabous, who inculcate the duty of plundering the Chriſtians to the utmoſt of their power.

The Yolof negroes of Senegal are either Chriſtians or Mahometans, or rather one and the other, or with more truth neither; religion being a matter of indifference to them. Thoſe on the continent are of the ſame way of thinking, and their religious practices are kept up only for the ſake of form. A bar of iron, a few beads, will make them change their opinion at will. By ſuch means are they acted upon; a ſufficient proof of their want of all religious principle. The marabous, or prieſts, and the men of their law, are no better than the reſt. "I have examined the character of ſeveral of this order of men (ſays M. Saugnier), and even among the nation of the Poules, who are conſidered as great fanatics, I diſcovered that they were only publicly attached to their opinions. 'This white man (ſay they) does ſo; he is better informed than I, and why ſhould not I imitate his example?'' This way of reaſoning is common to all that tract of country.

The colony of Senegal is ſurrounded with iſlands, which, on account of the proximity of the ſea, are all more unhealthy than that on which the town is built. They are full of ſtanding pools, that, when dried up by the ſun, exhale a putrid vapour that carries mortality with it, and deſolates theſe iſlands. It is doubtleſs the ſame cauſe that takes off ſo many of the French at Senegal during the dangerous ſeaſon of the year. This alſo may be in part occaſioned by the bad quality of the water, which flows from the ponds in the neighbourhood of the colony, and though incorporated with that of the river, comes down little agitated by the current, and is eaſily diſtinguiſhed by a vapidneſs of taſte. This particular is, in my opinion, eſſentially worthy of notice, and if properly attended to by our medical men, might become the means of preſerving many lives.

SENEGAL-River, ſee NIGER. As ſo little is known reſpecting this river, which is one of the greateſt in Africa, any additional information muſt be intereſting.

We ſhall therefore preſent our readers with the account contained in the communications preſented to the Aſſociation for promoting the diſcovery of the Interior Parts of Africa, which, as far as we know, is the lateſt and moſt authentic.

The river known to Europeans by the name of *Niger* or *Senegal* runs on the ſouth of the kingdom of Caſhna, in its courſe towards Tombuctou; and if the report which Ben Alli heard in that town may be credited, it is afterwards loſt in the ſands on the ſouth of the country of Tombuctou. In the map (A), only the known part of its courſe is marked by a line; and the ſuppoſititious part by dots. It may be proper to obſerve, that the Africans have two names for this river; that is, *Neel il Abeed*, or river of the Negroes; and *Neel il Kibeer*, or the great river. They alſo term the Nile (that is the Egyptian river) *Neel Shem;* ſo that the term *Neel*, from whence our Nile, is nothing more than the appellative of river; like Ganges, or Sinde.

Of this river the riſe and termination are unknown, but the courſe is from eaſt to weſt. So great is its rapidity, that no veſſel can aſcend its ſtream; and ſuch is the want of ſkill, or ſuch the abſence of commercial inducements among the nations who inhabit its borders, that even with the current, neither veſſels nor boats are ſeen to navigate. In one place, indeed, the traveller finds accommodations for the paſſage of himſelf and of his goods; but even there, though the ferrymen, by the indulgence of the ſultan of Caſhna, are exempted from all taxes, the boat which conveys the merchandiſe is nothing more than an ill-conſtructed raft; for the planks are faſtened to the timbers with ropes, and the ſeams are cloſed both within and without by a plaſter of tough clay, of which a large proviſion is always carried on the raft, for the purpoſe of excluding the ſtream wherever its entrance is obſerved.

The depth of the river at the place of paſſage, which is more than a hundred miles to the ſouth of the city of Caſhna, the capital of the empire of that name, is eſtimated at 23 or 24 feet Engliſh. Its depth is from 10 to 12 peeks, each of which is 27 inches.

Its width is ſuch, that even at the iſland of Gongoo, where the ferrymen reſide, the ſound of the loudeſt voice from the northern ſhore is ſcarcely heard; and at Tombuctou, where the name of *Gnewa*, or black, is given to the ſtream, the width is deſcribed as being that of the Thames at Weſtminſter. In the rainy ſeaſon it ſwells above its banks, and not only floods the adjacent lands, but often ſweeps before it the cattle and cottages of the ſhort-ſighted or too confident inhabitants.

That the people who live in the neighbourhood of the Niger ſhould refuſe to profit by its navigation, may juſtly ſurpriſe the traveller: but much greater is his aſtoniſhment, when he finds that even the food which the bounty of the ſtream would give, is uſeleſsly offered to their acceptance; for ſuch is the want of ſkill, or ſuch the ſettled diſlike of the people to this ſort of proviſion, that the fiſh with which the river abounds are left in undiſturbed poſſeſſion of its waters.

SENEKA, or SENEGA, *Rattleſnake-root, Milk-wort.* See POLYGALA, BOTANY and MATERIA MEDICA *Index.*

SENESCHAL, (*Seneſchallus*), derived from the German *ſein*, "a houſe or place," and *ſcale*, "an officer," is a ſteward, and ſignifies one who has the diſpenſing of juſtice in ſome particular caſes: As the high ſeneſchal or ſteward of England; *ſeneſchal de la hotel de roi*, "ſteward of the king's houſehold, ſeneſchal, or ſteward of courts, &c." *Co. Lit.* 61. *Croke's Juriſd.* 102. *Kitch.* 83. See STEWARD.

SENN, a ſort of itinerant cow-keeper in Switzerland, particularly in the canton of Appenzell. Theſe men do not raiſe as much hay as is requiſite for their cattle during the winter, and ſome of them have no graſs lands. To ſupply this defect, they employ agents throughout the canton, whoſe province it is to inform them where good hay may be obtained, when the ſenn, who is in want of fodder, agrees with the more opulent farmers for the winter, to whom he ſucceſſively drives his cattle when they return from the graſs, in conſequence of which he often viſits five different places during the winter. The perſon who ſells the hay provides the ſenn with ſtabling for his beaſts, and with board and lodgings for himſelf and family. The ſenn pays the ſtipulated price for the hay, and allows his hoſt as much milk, whey, and a kind of lean cheeſe, as may be made uſe of in the family, and alſo leaves him the manure of his cows. In the middle of April, the ſenn again iſſues forth with his herd to the fertile Alps, which he rents during the ſummer.

Fine cattle are the pride of the cow-keeper who inhabits the Alps. He adorns his beſt cows with large bells ſuſpended from broad thongs, which are manufactured and ſold by the inhabitants of the Tyrol. Theſe are faſtened round the cow's neck by means of a large buckle. The largeſt of theſe bells meaſure a foot in diameter, ſwell out in the middle, and tapering towards the end. The whole peal of bells, including the thongs, is worth 150 guilders, while the apparel of the ſenn himſelf, even in his beſt attire, is not worth more than 20 guilders. Theſe bells are chiefly worn in the ſpring, when driven to the Alps, and in the autumn or winter. It is ſurpriſing to ſee how proud and pleaſed the cows ſtalk forth when ornamented with their bells. One would ſcarcely imagine how ſenſible theſe animals are of their rank, and even touched with vanity and jealouſy! Should the leading cow be deprived of her honours, ſhe is grieved at the diſgrace, which is manifeſted by her conſtant lowing, abſtaining from food, and growing lean. The rival, on whom the badge of diſtinction has devolved, feels her marked vengeance, being wounded and perſecuted by her in the moſt furious manner, until the former either recovers her bell, or is removed from the herd. However ſingular this may appear, it is rendered indiſputable by the concurring teſtimony of centuries.

The voice of the ſenn brings the cows together, when diſperſed on the Alps, who is then ſaid to allure them. That the cattle can well diſtinguiſh the note of their keeper,

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(A) The map alluded to is that which accompanies the volume which contains the proceedings of the Aſſociation. This work was printed in 1791.

keeper, appears from their haſtening to him, though at a great diſtance. He furniſhes that cow which is in the habit of ſtraying fartheſt with a ſmall bell, and by her arrival he knows that all the reſt are aſſembled.

SENNA, the leaf of the caſſia ſenna of Linnæus. See CASSIA, BOTANY and MATERIA MEDICA *Index*.

Woodville's Medical Botany.

Senna appears to have been cultivated in England in the time of Parkinſon (1640); and Miller tells us, that by keeping theſe plants in a hotbed all the ſummer, he frequently had them in flower; but adds, it is very rarely that they perfect their ſeeds in England. There can be little doubt, however, but that ſome of the Britiſh poſſeſſions may be found well enough adapted to the growth of this vegetable, and that the patriotic views of the Society for encouraging Arts, &c. which has offered a reward to thoſe who ſucceed in the attempt, will be ultimately accompliſhed.

Senna, which is in common uſe as a purgative, was firſt known to the Arabian phyſicians Serapion and Meſue: the firſt among the Greeks who takes any notice of it is Actuarius, but he only ſpeaks of the fruit, and not of the leaves. To remove the diſagreeable taſte of this medicine, Dr Cullen recommends coriander ſeeds; and, for preventing the gripings with which it is ſometimes attended, he thinks the warmer aromatics, as cardamoms or ginger, would be more effectual.

The *Senna Italica*, or blunt-leaved ſenna, is a variety of the Alexandrian ſpecies; which, by its cultivation in the ſouth of France (Provence), has been found to aſſume this change. It is leſs purgative than the pointed-leaved ſenna, and is therefore to be given in larger doſes. It was employed as a cathartic by Dr Wright at Jamaica, where it grows on the ſand banks near the ſea.

Lond. Med. Jour. vol. viii.

SENNAAR, a country of Africa, bordering upon Abyſſinia, with the title of a kingdom; the preſent government of which was eſtabliſhed in the 16th century by a race of negroes named, in their own language, *Shillook*. This country, together with all the northern parts of Africa, had been overrun by the Saracens during the rapid conqueſts of the caliphs; but inſtead of erecting any diſtinct principalities here, as in other parts, they had incorporated themſelves with the old inhabitants called *Shepherds*, whom they found at their arrival; had converted them to their religion, and become one people with them. In 1504 the Shillook, a people before unknown, came from the weſtern banks of the river Bahiar el Abiad, which empties itſelf into the Nile, and conquered the country; allowing the Arabs, however, to retain their poſſeſſions on condition of paying them a certain tribute. Theſe founded the city of Sennaar, and have ever ſince continued to carry on an intercourſe with Egypt in the way of merchandiſe. At the eſtabliſhment of their monarchy the whole nation were Pagans, but ſoon after became converts to Mohammedaniſm, and took the name of *Funge*, an appellation ſignifying "lords or conquerors," and likewiſe free citizens. Mr Bruce, who paſſed through this country in his return from Abyſſinia, gives a liſt of 20 kings who have reigned in it ſince the conqueſt of the Shillook.

This country is inhabited by a people ſo barbarous and brutiſh, that no hiſtory of them can be expected. One of the moſt remarkable of their cuſtoms is, that the king aſcends the throne with the expectation of being murdered whenever the general council of the nation thinks proper. The dreadful office of executioner belongs to one ſingle officer, ſtyled in the language of the country, *Sid el Coom;* and who is always a relation of the monarch himſelf. It was from his regiſters that Mr Bruce took the liſt of the kings already mentioned, with the number of years they reigned, and which may therefore be received as authentic. The Sid el Coom in office at the time that Mr Bruce viſited this country was named Achmet, and was one of his beſt friends. He had murdered the late king, with three of his ſons, one of whom was an infant at its mother's breaſt; he was alſo in daily expectation of performing the ſame office to the reigning ſovereign. He was by no means reſerved concerning the nature of his office, but anſwered freely every queſtion that was put to him. When aſked by Mr Bruce why he murdered the king's young ſon in his father's preſence? he anſwered, that he did it from a principle of duty to the king himſelf, who had a right to ſee his ſon killed in a lawful and regular manner, which was by cutting his throat with a ſword, and not in a more painful or ignominious way, which the malice of his enemies might poſſibly have inflicted.

Bruce's Travels, vol. iv.

The king, he ſaid, was very little concerned at the ſight of his ſon's death, but he was ſo very unwilling to die himſelf, that he often preſſed the executioner to let him eſcape; but finding his intreaties ineffectual, he ſubmitted at laſt without reſiſtance. On being aſked whether he was not afraid of coming into the preſence of the king, conſidering the office he might poſſibly have to perform? he replied, that he was not in the leaſt afraid on this account; that it was his duty to be with the king every morning, and very late in the evening; that the king knew he would have no hand in promoting his death; but that, when the matter was abſolutely determined, the reſt was only an affair of decency; and it would undoubtedly be his own choice, rather to fall by the hand of his own relation in private than by a hired aſſaſſin, an Arab, or a Chriſtian ſlave, in the ſight of the populace. Baady the king's father, having the misfortune to be taken priſoner, was ſent to Atbara to Welled Haſſan the governor of that province to be put to death there. But the king, who was a ſtrong man, and always armed, kept ſo much upon his guard, that Welled could find no opportunity of killing him but by running him through the back with a lance as he was waſhing his hands. For this Welled himſelf was afterwards put to death; not on account of the murder itſelf, but becauſe, in the firſt place, he, who was not the proper executioner, had preſumed to put the king to death; and, in the next, becauſe he had done it with a lance, whereas the only lawful inſtrument was a ſword.

On the death of any of the ſovereigns of this country, his eldeſt ſon ſucceeds to the throne of courſe; on which as many of his brothers as can be found are apprehended, and put to death by the Sid el Coom in the manner already related. Women are excluded from the ſovereignty here as well as in Abyſſinia. The princeſſes of Sennaar, however, are worſe off than thoſe of Abyſſinia, having no ſettled income, nor being treated in any degree better than the daughters of private perſons. The king is obliged, once in his lifetime, to plough and ſow a piece of ground; whence he is named *Baady*, the "countryman or peaſant;" a

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title as common among the monarchs of Sennaar as Cæſar was among the Romans. The royal family were originally negroes; but as the kings frequently marry Arab women, the white colour of the mother is communicated to the child. This, we are told by Mr Bruce, is invariably the caſe, when a negro man of Sennaar marries an Arab woman; and it holds equally good, when an Arab man marries a negro woman; and he likewiſe informs us, that he never ſaw one black Arab all the time he was at Sennaar.

The ſoil and climate of this country are extremely unfavourable both to man and beaſt. The men are ſtrong and remarkable for their ſize, but ſhort-lived; and there is ſuch a mortality among the children, that were it not for a conſtant importation of ſlaves, the metropolis would be depopulated. The ſhortneſs of their lives, however, may perhaps be accounted for, from their indulging themſelves from their infancy in every kind of exceſs. No horſe, mule, or aſs, will live at Sennaar or for many miles round it. The caſe is the ſame with bullocks, ſheep, dogs, cats, and poultry; all of them muſt go to the ſands every half-year. It is difficult to account for this mortality; though Mr Bruce aſſures us it is the caſe everywhere about the metropolis of this country, where the ſoil is a fat earth, during the firſt ſeaſon of the rains. Two greyhounds which he brought along with him from Atbara, and the mules he brought from Abyſſinia, lived only a few weeks after their arrival at Sennaar. Several of the kings of Sennaar have tried to keep lions, but it was always found impoſſible to preſerve them alive after the rains. They will live, however, as well as other quadrupeds, in the ſands, at no great diſtance from the capital. No ſpecies of tree except the lemon flowers near this city; the cultivation of the roſe has often been attempted, but always without ſucceſs. In other reſpects, however, the ſoil of Sennaar is exceedingly fertile, being ſaid to yield 300 fold; but this is thought by Mr Bruce to be a great exaggeration. It is all ſown with dora or millet, which is the principal food of the people; wheat and rice are alſo produced here, which are ſold by the pound, even in years of plenty. The ſoil all round is ſtrongly impregnated with ſalt, ſo that a ſufficient quantity to ſerve the inhabitants is extracted from it.

Sennaar, a city of Africa, the capital of the kingdom of that name. It ſtands according to Mr Bruce's obſervations, in N. Lat. 13° 34′ 36″, E. Long. 33° 30′ 30″, on the weſt ſide of the Nile, and cloſe upon the banks of it; the ground on which it ſtands being juſt high enough to prevent the inundation. The town is very populous, and contains a great many houſes. In Poncet's time they were all of one ſtory; but now moſt of the officers have houſes of two ſtories high. They are built of clay mixed with a very little ſtraw, and have all flat roofs; which ſhows that the rains here muſt be much leſs in quantity than to the ſouthward. During the time of Mr Bruce's reſidence here, however, there was one week of continual rain, and the Nile, after loud thunder and great darkneſs to the ſouth, increaſed violently; the whole ſtream being covered with the wrecks of houſes and their furniture; ſo that he ſuppoſed it had deſtroyed many villages to the ſouthward. About 12 miles to the north-weſt of Sennaar is a collection of villages named *Shaddly*, from a great ſaint of that name, who conſtructed ſeveral granaries here. Theſe are no other than large pits dug in the ground, and well plaſtered in the inſide with clay, then filled with grain when it is at its loweſt price, and afterwards covered up and plaſtered again at top: theſe pits they call *matamores*. On any proſpect of dearth they are opened, and the corn ſold to the people. About 24 miles north of Shaddly there is another ſet of granaries named *Wed-Aboud*, ſtill greater than Shaddly; and upon theſe two the ſubſiſtence of the Arabs principally depends: for as theſe people are at continual war with each other, and direct their fury rather againſt the crops than the perſons of their enemies, the whole of them would be unavoidably ſtarved, were it not for this extraordinary reſource. Small villages of ſoldiers are ſcattered up and down this country to guard the grain after it is ſown, which is only that ſpecies of millet named *dora;* the ſoil, it is ſaid, being incapable of producing any other. There are great hollows made in the earth at proper diſtances throughout the country, which fill with water in the rainy ſeaſon, and are afterwards of great uſe to the Arabs as they paſs from the cultivated parts to the ſands. The fly, which is ſuch a dreadful enemy to the cattle, is never ſeen to the northward of Shaddly.

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To the weſtward of theſe granaries the country is quite full of trees as far as the river Abiad, or El-aice. In this extenſive plain there ariſe two ridges of mountains, one called *Jibbel Moira*, or the *Mountain of water;* the other *Jibbel Segud*, or the *Cold Mountain*. Both of them enjoy a fine climate, and ſerve for a protection to the farms about Shaddly and Aboud already mentioned. Here alſo are fortreſſes placed in the way of the Arabs, which ſerve to oblige them to pay tribute in their flight from the cultivated country, during the rains, to the dry lands of Atbara. Each of theſe diſtricts is governed by a deſcendant of their ancient and native princes, who long reſiſted all the power of the Arabs. Sacrifices of a horrid nature are ſaid to have been offered up on theſe mountains till about the year 1554, when one of the kings of Sennaar beſieged firſt one and then the other of the princes in their mountains; and having forced them to ſurrender, he faſtened a chain of gold to each of their ears, expoſed them in the market-place at Sennaar, and ſold them for ſlaves at leſs than a farthing each. Soon after this they were circumciſed, converted to the Mahometan religion, and reſtored to their kingdoms.

Vol. iv. p. 475.

"Nothing (ſays Mr Bruce) is more pleaſant than the country around Sennaar in the end of Auguſt and beginning of September. The grain, being now ſprung up, makes the whole of this immenſe plain appear a level green land, interſperſed with great lakes of water, and ornamented at certain intervals with groups of villages; the conical tops of the houſes preſenting at a diſtance the appearance of ſmall encampments. Through this very extenſive plain winds the Nile, a delightful river there, above a mile broad, full to the very brim, but never overflowing. Everywhere on theſe banks are ſeen herds of the moſt beautiful cattle of various kinds. The banks of the Nile about Sennaar reſemble the pleaſanteſt part of Holland in the ſummer ſeaſon; but ſoon after, when the rains ceaſe, and the ſun exerts its utmoſt influence, the dora begins to ripen, the leaves to turn yellow and to rot, the lakes to putrefy, ſmell, become full of vermin, and all its beauty ſuddenly diſappears: bare ſcorched Nubia returns, and all its terrors of poiſonous

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ſonous winds and moving ſands, glowing and ventilated with ſultry blaſts, which are followed by a troop of terrible attendants; epilepſies, apoplexies, violent fevers, obſtinate agues, and lingering painful dyſenteries, ſtill more obſtinate and mortal.

"War and treaſon ſeem to be the only employment of this horrid people, whom Heaven has ſeparated by almoſt impaſſable deſerts from the reſt of mankind; confining them to an accurſed ſpot, ſeemingly to give them an earneſt in time of the only other curſe which he has reſerved to them for an eternal hereafter."

With regard to the climate of the country round Sennaar, Mr Bruce has ſeveral very curious obſervations. The thermometer riſes in the ſhade to 119 degrees; but the degree indicated by this inſtrument does not at all correſpond with the ſenſations occaſioned by it; nor with the colour of the people who live under it. "Nations of blacks (ſays he) live within latitude 13 and 14 degrees; about 10 degrees ſouth of them, nearly under the line, all the people are white, as we had an opportunity of obſerving daily in the Galla. Sennaar, which is in latitude 13 degrees, is hotter by the thermometer 50 degrees, when the ſun is moſt diſtant from it, than Gondar, which is a degree farther ſouth, when the ſun is vertical.—Cold and hot (ſays our author) are terms merely relative, not determined by the latitude, but elevation of the place. When, therefore, we ſay *hot*, ſome other explanation is neceſſary concerning the place where we are, in order to give an adequate idea of the ſenſations of that heat upon the body, and the effects of it upon the lungs. The degree of the thermometer conveys this but very imperfectly; 90 degrees is exceſſively hot at Loheia in Arabia Felix; and yet the latitude of Loheia is but 15 degrees; whereas 90 degrees at Sennaar is only warm as to ſenſe; though Sennaar, as we have already ſaid, is in latitude 13 degrees.

"At Sennaar, then, I call it *cold*, when one fully clothed and at reſt feels himſelf in want of fire. I call it *cool*, when one fully clothed and at reſt feels he could bear more covering all over, or in part, than he has at that time. I call it *temperate*, when a man ſo clothed, and at reſt, feels no ſuch want, and can take moderate exerciſe, ſuch as walking about a room without ſweating. I call it *warm*, when a man, ſo clothed, does not ſweat when at reſt; but, on taking moderate exerciſe, ſweats, and again cools. I call it *hot*, when a man at reſt, or with moderate exerciſe, ſweats exceſſively. I call it *very hot*, when a man with thin, or little clothing, ſweats much, though at reſt. I call it *exceſſive hot*, when a man, in his ſhirt and at reſt, ſweats exceſſively, when all motion is painful, and the knees feel feeble, as if after a fever. I call it *extreme hot*, when the ſtrength fails, a diſpoſition to faint comes on, a ſtraitneſs is found in the temples, as if a ſmall cord was drawn tight about the head, the voice impaired, the ſkin dry, and the head ſeems more than ordinarily large and light. This, I apprehend, denotes death at hand; but this is rarely if ever effected by the ſun alone, without the addition of that poiſonous wind which purſued us through Atbara, where it has, no doubt, contributed to the total extinction of every thing that hath the breath of life. A thermometer, graduated upon this ſcale, would exhibit a figure very different from the common one; for I am convinced by experiment, that a web of the fineſt muſlin, wrapt round the body at Sennaar, will occaſion at mid-day a greater ſenſation of heat in the body, than a riſe of 5 degrees in the thermometer of Fahrenheit.

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"At Sennaar, from 70 to 78 degrees of Fahrenheit's thermometer is cool; from 79 to 92 temperate; at 92 degrees begins warmth. Although the degree of the thermometer marks a greater heat than is felt by the body of us ſtrangers, it ſeems to me that the ſenſations of the natives bear ſtill a leſs proportion to that degree than ours. On the 2d of Auguſt, while I was lying perfectly enervated on a carpet in a room deluged with water at 12 o'clock, the thermometer at 116, I ſaw ſeveral black labourers pulling down a houſe, working with great vigour, without any ſymptoms of being incommoded."

The dreſs of the people of Sennaar conſiſts only of a long ſhirt of blue cloth, which wraps them up from the under part of the neck to the feet. It does not, however, conceal the neck in the men, though it does in the women. The men ſometimes have a ſaſh tied about their middle; and both men and women go barefooted in the houſes, whatever their rank may be. The floors of their apartments, eſpecially thoſe of the women, are covered with Perſian carpets. Both men and women anoint themſelves, at leaſt once a-day, with camel's greaſe mixed with civet, which, they imagine, ſoftens their ſkins, and preſerves them from cutaneous eruptions; of which they are ſo fearful, that they confine themſelves to the houſe if they obſerve the ſmalleſt pimple on their ſkins. With the ſame view of preſerving their ſkins, though they have a clean ſhirt every day, they ſleep with a greaſed one at night, having no other covering but this. Their bed is a tanned bull's hide, which this conſtant greaſing ſoftens very much; it is alſo very cool, though it gives a ſmell to their bodies from which they cannot be freed by any waſhing.

Our author gives a very curious deſcription of the queens and ladies of the court at Sennaar. He had acceſs to them as a phyſician, and was permitted to pay his viſit alone. He was firſt ſhown into a large ſquare apartment, where there were about 50 black women, all quite naked excepting a very narrow piece of cotton rag about their waiſts. As he was muſing whether theſe were all queens, one of them took him by the hand, and led him into another apartment much better lighted than the former. Here he ſaw three women ſitting upon a bench or ſofa covered with blue Surat cloth; they themſelves being clothed from the neck to the feet with cotton ſhirts of the ſame colour. Theſe were three of the king's wives; his favourite, who was one of the number, appeared to be about ſix feet high, and ſo corpulent that our traveller imagined her to be the largeſt creature he had ſeen next to the elephant and rhinoceros. Her features perfectly reſembled thoſe of a negro; a ring of gold paſſed through her under lip, and weighed it down, till, like a flap, it covered her chin, leaving her teeth bare, which were ſmall and very fine. The inſide of her lip was made black with antimony. Her ears reached down to her ſhoulders, and had the appearance of wings: there was a gold ring in each of them about five inches in diameter, and ſomewhat ſmaller than a man's little finger; the weight of which had drawn down the hole where her ear was pierced

pierced ſo much that three fingers might eaſily paſs above the ring. She had a gold necklace like that called *Eſclavage*, of ſeveral rows, one below another; to which were hung rows of ſequins pierced. She had two manacles of gold upon her ancles larger than thoſe uſed for chaining felons. Our author could not imagine how it was poſſible for her to walk with them, till he was informed that they were hollow. The others were dreſſed much in the ſame manner; only there was one who had chains coming from her ears to the outſide of each noſtril, where they were faſtened. A ring was alſo put through the griſtle of her noſe, and which hung down to the opening of her mouth; having all together ſomething of the appearance of a horſe's bridle; and Mr Bruce thinks that ſhe muſt have breathed with difficulty.

The poorer ſort of the people of Sennaar live on the flour or bread of millet; the rich make puddings of this, toaſting the flour before the fire, and putting milk and butter into it; beſides which they uſe beef partly roaſted and partly raw. They have very fine and fat horned cattle, but the meat commonly ſold in the market is camel's fleſh. The liver and ſpare rib of this animal are always eaten raw; nor did our author ſee one inſtance to the contrary all the time he was in the country. Hog's fleſh is not ſold in the market; but all the common people of Sennaar eat it openly; thoſe in office, who pretend to be Mahometans, doing the ſame in ſecret.

There are no manufactures in this country, and the principal article of trade is blue Surat cloth. In former times, when caravans could paſs with ſafety, Indian goods were brought in quantities from Jidda to Sennaar, and then diſperſed over the country of the blacks. The returns were made in gold, a powder called *tibbar*, civet, rhinoceroſes horns, ivory, oſtrich feathers, and above all ſlaves or glaſs, more of theſe being exported from Sennaar than from all the eaſt of Africa. This trade, however, as well as that of the gold and ivory, is almoſt deſtroyed; though the gold is ſtill reputed to be the beſt and pureſt in Africa, and is therefore bought at Mocha to be carried to India, where it all centres at laſt.

SENNERTUS, DANIEL, an eminent phyſician, was born in 1572 at Breſlaw; and in 1593 he was ſent to Wittemberg, where he made great progreſs in philoſophy and phyſic. He viſited the univerſities of Leipſic, Jena, Francfort on the Oder, and Berlin; but ſoon returned to Wittemberg, where he was promoted to the degree of doctor of phyſic, and ſoon after to a profeſſorſhip in the ſame faculty. He was the firſt who introduced the ſtudy of chemiſtry into that univerſity; he gained a great reputation by his works and practice, and was very generous to the poor. He died of the plague at Wittemberg in 1637. He raiſed himſelf enemies by contradicting the ancients. He thought the ſeed of all living creatures animated, and that the ſoul of this ſeed produces organization. He was accuſed of impiety for aſſerting that the ſouls of beaſts are not material; for this was affirmed to be the ſame thing with aſſerting that they are immortal; but he rejected this conſequence, as he well might do. See METAPHYSICS, Part III. chap. vi.

SENONES, in *Ancient Geography*, a people of Gallia Celtica, ſituated on the Sequana to the ſouth of the Pariſii, near the confluence of the Jeauna or Yonne with the above mentioned river. Their moſt conſiderable exploit was their invaſion of Italy, and taking and burning ROME, as related under that article. This was done by a colony of them long before tranſported into Italy, and ſettled on the Adriatic. Their capital Agendicum in Gaul, was in the lower age called *Senones*, now *Sens*. In Italy the Senones extended themſelves as far as the river Aeſis; but were afterwards driven beyond the Rubicon, which became the boundary of Gallia Ciſalpina, (Polybius, Strabo).

SENSATION, in *Philoſophy*, the perception of external objects by means of the ſenſes. See METAPHYSICS, Part I. chap. i.

SENSE, a faculty of the ſoul whereby it perceives external objects by means of the impreſſions they make on certain organs of the body. See METAPHYSICS, Part I. and ANATOMY, N° 137, &c.

Common SENSE, is a term that has been variouſly uſed both by ancient and modern writers. With ſome it has been ſynonymous with public ſenſe; with others it has denoted prudence; in certain inſtances, it has been confounded with ſome of the powers of taſte; and, accordingly, thoſe who commit egregious blunders with regard to decorum, ſaying and doing what is offenſive to their company, and inconſiſtent with their own character, have been charged with a defect in common ſenſe. Some men are diſtinguiſhed by an uncommon acuteneſs in diſcovering the characters of others; and this talent has been ſometimes called *common ſenſe;* ſimilar to which is that uſe of the term, which makes it to ſignify that experience and knowledge of life which is acquired by living in ſociety. To this meaning Quintilian refers, ſpeaking of the advantages of a public education: *Senſum ipſum qui communis dicitur, ubi diſcet, cum ſe à congreſſu, qui non hominibus ſolum, ſed mutis quoque animalibus naturalis eſt, ſegregarit?* Lib. i. cap. 2.

But the term *common ſenſe* hath in modern times been uſed to ſignify that power of the mind which perceives truth, or commands belief, not by progreſſive argumentation, but by an inſtantaneous, inſtinctive, and irreſiſtible impulſe; derived neither from education nor from habit, but from nature; acting independently of our will, whenever its object is preſented, according to an eſtabliſhed law, and therefore called *ſenſe;* and acting in a ſimilar manner upon all, or at leaſt upon a great majority of mankind, and therefore called *common ſenſe.* See METAPHYSICS, N° 127.

Moral SENSE, is a determination of the mind to be pleaſed with the contemplation of thoſe affections, actions, or characters, of rational agents, which we call *good* or *virtuous*.

This moral ſenſe of beauty in actions and affections may appear ſtrange at firſt view; ſome of our moraliſts themſelves are offended at it in Lord Shafteſbury, as being accuſtomed to deduce every approbation or averſion from rational views of intereſt. It is certain that his lordſhip has carried the influence of the moral ſenſe very far, and ſome of his followers have carried it farther. The advocates for the ſelfiſh ſyſtem ſeem to drive their opinions to the oppoſite extreme, and we have elſewhere endeavoured to ſhow that the truth lies between the contending parties. See MORAL PHILOSOPHY, N° 27—32.

Public SENSE is defined by the noble author of the Characteriſtics to be an innate propenſity to be pleaſed with the happineſs of others, and to be uneaſy at their miſery. It is found, he ſays, in a greater or leſs degree in all men, and was ſometimes called κοινονοημα, or *ſenſus communis*, by ancient writers.

Of the reality of this public ſenſe we have great doubts. The conduct of ſavages, who are more under the influence of original inſtinct than civilized men, gives no countenance to it. Their affections ſeem all to be ſelfiſh, or at leaſt to ſpring from ſelf-love variouſly modified. For the happineſs of their wives they have very little regard, conſidering them merely as inſtruments of their own pleaſure, and valuing them for nothing elſe. Hence they make them toil, while they themſelves indulge in liſtleſs idleneſs. To their children we believe they exhibit ſtrong ſymptoms of attachment, as ſoon as they derive aſſiſtance from them in war, or in the buſineſs of the chace; but during the helpleſs years of infancy, the child is left by the ſelfiſh father wholly to the care and protection of its wretched mother; who, impelled by the *ſtorge* of all females to their young, cheriſhes her offspring with great fondneſs.—The ſavage is, indeed, ſuſceptible of ſtrong attachments, ſimilar to that which we call friendſhip; but ſuch attachments are not proofs of diſintereſted benevolence, or what his lordſhip calls the *public ſenſe.* Two barbarous heroes are probably firſt linked together by the obſervation of each other's proweſs in war, or their ſkill in purſuing their game; for ſuch obſervation cannot fail to ſhow them that they may be uſeful to one another; and we have elſewhere ſhown how real friendſhip may ſpring from ſentiments originally ſelfiſh. The ſavage is very much attached to his horde or tribe, and this attachment reſembles patriotiſm: but patriotiſm itſelf is not a ſentiment of pure benevolence delighting in the happineſs of others, and grieving at their miſery; for the patriot prefers his own country to all others, and is not very ſcrupulous with reſpect to the rectitude of the means by which he promotes its intereſt, or depreſſes its rivals. The ſavage purſues with relentleſs rigour the enemies of himſelf or of the tribe to which he belongs; ſhows no mercy to them when in his power, but puts them to the cruelleſt death, and carries their ſcalps to the leader of his party. Theſe facts, which cannot be controverted, are perfectly irreconcileable with innate benevolence, or a public ſenſe comprehending the whole race of men; and ſhow the truth of that theory by which we have in another place endeavoured to account for all the paſſions, ſocial as well as ſelfiſh. See PASSION.

SENSES, PLEASURES AND PAINS OF. The natural agreeableneſs, diſagreeableneſs, and indifference of our ſenſations and perceptions, preſent to the mind an important and extenſive field of inquiry; and on this ſubject we ſhall here make a few obſervations. All our ſenſes have been certainly beſtowed upon us for wiſe and beneficent purpoſes; and, accordingly, we find, that all of them, when properly cultivated, or exerciſed and improved, are capable of affording us much pleaſure. The ſenſes of ſmell and of taſte ſeem rather intended for the preſervation of our animal exiſtence, and in this point of view are properly an object of the natural hiſtory of man; whilſt the other three ſeem to be more peculiarly intended for our mental improvement, and accordingly form an object of intellectual and of moral philoſophy. And agreeably to this we know that we derive a great deal of very uſeful knowledge, in an eaſy and ſimple manner, concerning the objects that ſurround us, in the early part of life, from all the ſenſes, particularly from ſight and touch, and this too without labour or ſtudy. But this is not the only purpoſe for which the ſenſes were deſigned.

It being thus certain, that the ſenſes were beſtowed upon us partly to preſerve our animal exiſtence, and partly for our mental improvement, it ſeems reaſonable, even *à priori*, to expect that nature would attach ſome pleaſure to ſuch uſe and exerciſe of them, as are calculated to promote theſe ends, and pain to the contrary; particularly in thoſe inſtances in which ſhe has left the management of them ſubject to our own controul. And accordingly we cannot but obſerve what delight we derive from our ſenſes, eſpecially in the morning of life, by which it would ſeem, that nature intended thus winningly to invite us to the proper exerciſe and improvement of them; and as it were unconſciouſly, acquire much uſeful knowledge. It is this ſpecies of pleaſure that ſupports and excites boys in the conſtant and often immoderate exerciſe of their organs of voluntary motion; the powers of which are thus increaſed and invigorated.

The exerciſe and improvement of the ſenſes being ſubſervient to our intellectual improvement, nature has alſo kindly attached much refined and rational pleaſure to the mental exertions; ſo that we are thus ſeduced, as it were, to the cultivation of the various extraordinary powers and faculties of the mind.

It is evident that nature has given ſuch organs and faculties to man, as are calculated not only to make him live, but alſo to render life agreeable. Here too we obtain a ſlight glimpſe at leaſt of ſome of the final cauſes of the pleaſures of ſenſe. But if it be aſked how it happens, that there are ſuch wide diverſities between our ſenſations, ſome being by nature very agreeable to all men, and ſome as diſagreeable, whilſt there are others ſo indifferent, as to give neither pleaſure nor pain, we muſt confeſs, that we can give no ſatisfactory anſwer, to ſhew how ſo many very different ſenſations are produced by various kinds of impreſſions made on certain organs of the body, and how all theſe different impreſſions excite ſuch ſenſations as ſuggeſt not only correſponding perceptions and external qualities, but at the ſame time affect the mind with pleaſure, pain, trouble, anxiety, or diſguſt. To be ſucceſsful in theſe inquiries, we muſt preſuppoſe ſome knowledge of the nature of the connection ſubſiſting between the mind and body, which there is reaſon to think is placed beyond the limits preſcribed by nature to human reſearch.

The pleaſure or pain which conſtantly attends certain ſenſations is not uniform in degree, but varies conſiderably, not only in different individuals, but even in the ſame perſons at different times. It is not thus with the ſenſations themſelves. Theſe are always conſtant and uniform. The ſame kind of impreſſion, when the organs, &c. are ſound, uniformly and invariably produces ſimilar ſenſations; and theſe are as invariably followed by the perception of their own peculiar exciting cauſes. For any particular impreſſion is never known to excite in the ſame perſon a new ſenſation, or the perceptions of an external object different from that which it previouſly

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ſuggeſted, excepting in caſes of diſeaſe. And when it does rarely occur, as in thoſe who cannot diſtinguiſh a particular colour, ſmell or taſte, from certain others, we uniformly attribute it to diſeaſe or malconformation. Were we not thus to have uniformly ſimilar ſenſations and perceptions of external objects from ſimilar impreſſions, the ſenſes would not be at all ſubſervient to our intellectual improvement; ſince, by giving different leſſons concerning the ſame or ſimilar objects at different times, they would render it impoſſible for us to be certain of any thing, or to benefit by experience.

The effects of cuſtom, which are at all times ſo conſiderable and evident with reſpect both to the mind and body, (as in the caſe of particular organs or faculties much improved by attention and exerciſe), have little or no influence at all in interrupting or modifying this uniformity in our ſenſations and perceptions. For no ſound or properly organized perſon will, either naturally or by cuſtom, ever miſtake hardneſs for ſoftneſs, red for green, or ſweet for bitter. But the influence of cuſtom in modifying the pains and pleaſures of ſenſe is well known and conſiderable. For a perſon, who can moſt accurately diſtinguiſh ſweetneſs from ſourneſs, will at the ſame time, either by particular conformation, or more frequently in conſequence of uſe and habit, prefer wormwood or tobacco to honey.

But although we may deſpair of being ever able to diſcover the phyſical cauſe of the pleaſures and pains of the ſenſes, we may, however, advance a little by obſerving and regiſtering particular facts. It is, accordingly, of uſe to remark, that every ſpecies of ſenſation, if its nature be otherwiſe unchanged, is agreeable or diſagreeable in proportion to its ſtrength or intenſeneſs. For there is no ſenſation, however agreeable, that will not become diſagreeable, and even intolerable, if it be immoderately intenſe. Whilſt on the contrary, thoſe, which by their ſtrength and nature are very troubleſome, if rendered more mild and moderate become not only tolerable, but agreeable. Thus, with reſpect to the ſenſes it would ſeem, that pain and pleaſure are only different degrees of the ſame feeling, and when we conſider the great varieties of which the ſenſation, not only of different organs, but even of any one of them, is ſuſceptible, and that each degree of theſe may be accompanied with pleaſure or pain, more or leſs, we muſt conclude that the pains and pleaſures of ſenſe are capable of numberleſs modifications both in degree and in kind.

We frequently obſerve, that ſenſations which were at firſt agreeable, if often repeated, loſe their reliſh, though the nature and ſtrength of the impreſſions be the ſame; whilſt others from being at firſt very diſagreeable, as the taſte of tobacco and opium, become very pleaſing, though the nature and ſtrength of the impreſſions have ſuffered no change. For the explanation of ſuch facts as theſe we muſt have recourſe to the effects of cuſtom. Thus, in both theſe oppoſite caſes, the ſenſations, from being often repeated, loſe part of the ſtrength, and of the novelty, of courſe, of their firſt impreſſions; and, with reſpect to the former inſtance, being unable to command the attention, become in the courſe of time almoſt wholly, or altogether neglected, whilſt in the latter caſe, from being very offenſive, they become highly agreeable. But if it be aſked why habit and cuſtom produce theſe effects, and in what manner, we are unable to explain it farther, than by ſaying, ſince the fact is unqueſtionable, that ſuch is the nature of the human conſtitution. Of the effects themſelves, no man can entertain a doubt; and their cauſes, though at preſent unknown, may by time and inquiry be further developed and ſimplified. "The labyrinth," ſays Dr Reid, "may be too intricate, and the thread too fine, to be traced through all its windings; but if we ſtop where we can trace it no farther, and ſecure the ground we have gained, there is no harm done; a quicker eye may in time trace it further."

Theſe principles are capable of affording us ſtill farther explanations. Why are new ſenſations always more agreeable and variety ſo pleaſing? Becauſe they fix the attention more, and are not as yet blunted by frequent repetition or by habit. It is becauſe ſome ſenſations loſe their wonted effect by cuſtom and by repetition, that we require ſtronger ones, or at leaſt ſtronger impreſſions on the organs and nerves, to increaſe or continue our pleaſures. It is alſo in conſequence of their becoming leſs poignant through habit that we neglect ſo many pleaſures, which we hardly know to be ſuch, till they have flown for ever; and it is becauſe in the morning of life every thing has more novelty, and becauſe habit has not deſtroyed their reliſh, that the pleaſures of youth are much more intenſe than thoſe of age. The degree of pleaſure is ſimilar to that which a blind man would feel on being made to ſee, or to that which a man would enjoy on ſuddenly acquiring a new ſenſitive faculty, although by long uſe and habit theſe pleaſures are at preſent for the moſt part or wholly blotted away.

Although moſt ſenſations, when ſtrong and lively enough to make themſelves accurately and eaſily diſtinguiſhed, generally pleaſe moſt, each in its own kind and manner; ſtill, as there are different kinds of pleaſure, different ſenſations may pleaſe the mind in various ways; and accordingly, it is not from the luſtre of the midday ſun, nor from the beautiful and lively appearance of all nature at noon, ſolely that the eyes derive pleaſure, any more than grand muſical ſounds are the only things that pleaſe the ear. For we often contemplate with a very different and a very conſiderable degree of pleaſure the ſublime and awful ſcenes of nature, the twilight darkneſs of the ſhady grove, and even the gloomy horror of night itſelf. We liſten with delight to the tempeſt ſhaking the foreſt, as well as to the gentle murmurs of the paſſing ſtream. There is even a time when nothing gives ſo much pleaſure as darkneſs, ſilence, and the abſence of all ſenſation.

Amidſt the great variety of good and evil with which we are every where ſurrounded, it is a matter of the higheſt importance to be able to diſcern aright. This we ſhould be incapable of doing were we not endowed with agreeable as well as painful ſenſations. Theſe ſerve to direct our choice. Whatever contributes in any degree to our preſervation and to the improvement of our organs and faculties, is accompanied with pleaſure; and on the contrary, when we are threatened with danger a painful ſenſation gives us the alarm. It is to the eſtabliſhment of this law that we are indebted for the duration of our lives, the improved and vigorous ſtate of our faculties, and the enjoyment of that ſmall portion of happineſs allotted to us by nature. "God, (ſays a French writer) having endowed man with various faculties, bodily as well as intellectual, in order to promote his happineſs, Senſes.

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pineſs, alſo vouchſafes to conduct him to this noble end, not only by the deductions of reaſon, but alſo by the force of inſtinct and ſenſation, which are more powerful and efficacious principles. Thus nature, by a ſenſation of pain, inſtantaneouſly appriſes us of what might prove hurtful to us; and, on the contrary, by an agreeable ſenſation, gently leads us to whatever may tend to the preſervation of our exiſtence, and to the perfect ſtate of our faculties, theſe being the two points on which our happineſs depends. Our faculties can neither be of uſe, nor diſplay themſelves farther than as we exerciſe them; motion or action is therefore ſo neceſſary to us, that without it we muſt inevitably ſink into a deplorable ſtate of inſenſibility and languor. On the other hand, as we are weak and limited creatures, all exceſſive and violent action would impair and deſtroy our organs; we muſt therefore uſe only moderate motion or exerciſe, ſince by theſe means the uſe or perfection of our faculties is reconciled with our chief intereſt, which is ſelf-preſervation. Now it is to this happy medium, I mean to a moderate exerciſe of our faculties, that the author of our nature has ſo wiſely annexed pleaſure.

The pleaſures of ſenſe are thus confined within narrow limits; for they cannot be much increaſed without pain, or often repeated without loſing their reliſh, at leaſt in a great meaſure; nor can they be long continued, partly for the ſame reaſon, and becauſe they exhauſt the mind, or rather the nervous ſyſtem. Hence we ſee that our animal appetites are confined within a narrow range, as is evident from the effects of exceſs in eating and drinking. All our ſenſitive powers are impaired; whilſt, on the contrary, our intellectual powers are ſtrengthened and improved by uſe and exerciſe. And in proportion as we indulge our ſenſitive powers, our deſires of indulgence increaſe, whilſt the pleaſures, which are the objects of theſe deſires, become regularly leſs poignant. Theſe, indeed, are wiſe regulations of nature; for it would ſeem as if ſhe intended to whiſper gently to us in this way, by means of practical experience, that we are not born ſolely for the enjoyment of pleaſure, at leaſt not for that of the pleaſures of the ſenſes; for all of them, as we have already remarked, if much indulged, lead to liſtleſsneſs and diſguſt, and ſometimes to conſiderable pain. And indeed, juſt as pleaſure paſſes thus readily into trouble and pain, ſo does the ſudden ceſſation of pain, at leaſt when this has been conſiderable, produce often extraordinary pleaſure. So that we may here apply the beautiful allegory of the divine Socrates, "that although pleaſure and pain are contrary in their nature, and have their faces turned different ways, yet that Jupiter hath tied them ſo together, that he who lays hold of the one draws the other along with it."

We have juſt ſaid, that the *ſudden* ceſſation of pain, at leaſt when this has been conſiderable, produces often extraordinary pleaſure. But this opinion ſeems to be denied in a late inquiry concerning taſte. "Among the pleaſures of ſenſe," ſays Mr Knight, "more particularly among thoſe belonging to touch, there is a certain claſs, which, though ariſing from negative cauſes, are nevertheleſs real and poſitive pleaſures: as when we gradually ſink from any violent or exceſſive degree of action or irritation into a ſtate of tranquillity and repoſe. I ſay *gradually;* for if the tranſition be ſudden and abrupt, it will not be pleaſant; the pleaſure ariſing from the inverted action of the nerves, and not from the utter ceſſation of action. From this inverted action ariſes the gratification which we receive from a cool breeze, when the body has been exceſſively heated; or from the rocking of a cradle, or the gentle motion of a boat, or eaſy carriage, after having been fatigued with violent exerciſe. Such, too, is that which twilight, or the gloomy ſhade of a thicket, affords to the eye after it has been dazzled by the blaze of the mid-day ſun; and ſuch, likewiſe, is that which the ear receives from the gradual diminution of loudneſs of tone in muſic." That pleaſure follows a gradual ceſſation of any violent action or irritation, we mean not to deny; but we are at a loſs to comprehend how it follows, that the tranſition from ſtrong pain, if it be ſudden and abrupt, will not be pleaſant.

But although the pleaſures of ſenſe be thus limited, theſe limits are very different with reſpect to the different ſenſes. Some of them are ſoon exhauſted, and do not any longer diſtinguiſh well the objects that correſpond to them; nor are they pleaſed with thoſe objects which were at firſt very agreeable, and which they diſtinguiſh with ſufficient accuracy; whilſt others continue to perform their functions longer, and enjoy a more continued pleaſure. Thus the ſenſes of ſmell and of taſte are almoſt immediately ſatiated; the ſenſe of hearing more ſlowly; but the ſight is in this reſpect the laſt of all to be fatigued or ſatiated: whilſt the pleaſures that ariſe from the exerciſe of our mental faculties are by far the moſt durable of all. "Exerciſe of the mind is as neceſſary as that of the body to preſerve our exiſtence. The ſenſes of other animals, being more quick than ours, are ſufficient to direct them to follow what is agreeable to their nature, or to ſhun whatever is contrary thereto. But we are endowed with reaſon in order to ſupply the deficiency of our ſenſes; and pleaſure preſents herſelf as an incitement to exerciſe, in order to keep the mind from a ſtate of hurtful inactivity. Pleaſure is not only the parent of ſports and amuſements, but alſo of arts and ſciences: and as the whole univerſe is, as it were, forced by our induſtry to pay tribute to our wants and deſires, we cannot but acknowledge our obligation to that law of nature, which has annexed a degree of pleaſure to whatever exerciſes without fatiguing the mind. The pleaſure accompanying it is ſometimes ſo great that it tranſports the very ſoul, ſo that ſhe ſeems as it were diſengaged from the body. We know what is recorded in hiſtory concerning Archimedes (A), and ſeveral other geometricians both ancient and modern. If we

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(A) When Syracuſe was taken by the Romans under Marcellus, Archimedes was in his ſtudy, ſo intent upon ſome geometrical problems, that he neither heard the clamour of the Romans, nor perceived that the city was taken. In this tranſport of ſtudy and contemplation a ſoldier came on him with his drawn ſword; Archimedes, on ſeeing him, beſought him to hold his hand till he had finiſhed the problem he was about. But the ſoldier, deaf to his intreaty, ran him through the body, although Marcellus, upon entering the city, had given orders that Archimedes ſhould be ſpared.

we doubt the truths of ſuch facts, we muſt at leaſt acknowledge their probability, ſince we meet every day with a number of ſimilar examples. When we ſee a cheſs-player ſo deeply immerſed in thought as to be in a manner loſt to his outward ſenſes, ſhould we not imagine him to be wholly engroſſed with the care of his own private affairs, or of the public weal? But the object of all this profound meditation is the pleaſure of exerciſing the mind by the movement of a piece of ivory. From this exerciſe of the mind alſo ariſes the pleaſure we ſometimes take in refined and delicate ſentiments, which, after the manner of Virgil's ſhepherdeſs, (*Et fugit ad ſalices, ſed ſe cupit ante videri*), are ſometimes artfully concealed, but ſo as to afford us the pleaſure of diſcovering them *."

From ſome of the foregoing remarks we alſo ſee that nature points out to us the ſuperiority and excellence of our mental faculties, thus ſuggeſting to us that we ought to cultivate them moſt, as being our better and our nobler part, to the cultivation of which that of our ſenſitive faculties ſhould be merely ſubſervient. But, although our pleaſures are thus by nature rendered in a great degree independent of ourſelves, ſtill we have it in our power to make them all more durable, by varying and mixing them with one another, or by interpoſing between thoſe that are very agreeable others that are leſs pleaſing, ſo as that no individual pleaſure ſhall be in exceſs.

Beſides the circumſtances already noticed, there are others of a very different kind, which have alſo conſiderable influence on the pleaſures of the ſenſes; ſuch as different conditions of the whole body, particularly of the nerves, or of certain organs or functions, to which functions ſome organs of ſenſe, and perhaps even the ſenſation of theſe, are in a great meaſure ſubſervient. This is one of the cauſes why many pleaſures, which we cultivate with all our might, cannot be immortal. If a perſon be thirſty, ſpring water is nectar to him; if hungry, any kind of food is agreeable, even the ſmell of food is grateful. To a man in a heat, or in a fever, cold is pleaſing; and to one in a cold fit nothing is ſo agreeable as heat. To theſe ſame perſons, at other times, ſo far are theſe things from being agreeable, that they are often diſguſting. The moſt decided glutton cannot always reliſh a ſumptuous feaſt.

Beſides the ſenſations excited by external objects, there are others alſo which cauſe pain and pleaſure. If the action of the muſcles be ſtrong, eaſy, and cheerful, and not continued ſo as to fatigue us, it cauſes pleaſure. On the contrary, when this action is attended with a ſenſe of liſtleſſneſs, laſſitude, difficulty, and debility, it cauſes pain more or leſs. In fine, various ſtates and affections of the mind, ſuch as the exerciſe of memory, imagination, and judgment, nearly for ſimilar reaſons, are ſometimes painful, at other times agreeable. "Animi affectus, qui modici gratè excitant, vehementes, aut graves et diuturni, hujus pariter ac corporis vires frangunt; hominem interdum ſtatim extinguunt, ſæpius longa valetudine maecerant. Somni etiam, quo ad exhauſtas vires reficiendas egemus, exceſſus, vel defectus, et animo et corpori nocet."—"Deſidia, ſive animi ſive corporis, utriuſque vires langueſcunt: nimia exercitatione haud minus læduntur. Statuit enim provida rerum parens, ut ſingularum partium, et univerſi corporis animique vires uſu roborentur et acuantur; et huic iterum certos fines poſuit: ita ut neque quem voluit natura uſus impune omittatur, neque ultra modum intendatur *."

"Of ſuch ſenſations and feelings as are agreeable or diſagreeable, we may remark," ſays Dr Reid, "that they differ much, not only in degree, but in kind and in dignity. Some belong to the animal part of our nature, and are common to us with the brutes; others belong to the rational and moral part. The firſt are more properly called *ſenſations*, the laſt *feelings*. The French word *ſentiment* is common to both."

"The Author of nature, in the diſtribution of agreeable and painful feelings, hath wiſely and benevolently conſulted the good of the human ſpecies; and hath even ſhewn us, by the ſame means, what tenor of conduct we ought to hold. For, *firſt*, The painful ſenſations of the animal kind are admonitions to avoid what would hurt us; and the agreeable ſenſations of this kind invite us to thoſe actions that are neceſſary to the preſervation of the individual, or of the kind. *Secondly*, By the ſame means nature invites us to moderate bodily exerciſe, and admoniſhes us to avoid idleneſs and inactivity on the one hand, and exceſſive labour and fatigue upon the other. *Thirdly*, The moderate exerciſe of all our rational powers gives pleaſure. *Fourthly*, Every ſpecies of beauty is beheld with pleaſure, and every ſpecies of deformity with diſguſt; and we ſhall find all that we call beautiful, to be ſomething eſtimable, or uſeful in itſelf, or a ſign of ſomething that is eſtimable or uſeful. *Fifthly*, The benevolent affections are all accompanied with an agreeable feeling, the malevolent with the contrary. And, *Sixthly*, The higheſt, the nobleſt and moſt durable pleaſure is that of doing well and acting the part that becomes us; and the moſt bitter and painful ſentiment is the anguiſh and remorſe of a guilty conſcience." Theſe obſervations with regard to the economy of nature in the diſtribution of our painful and agreeable ſenſations and feelings are ſo well illuſtrated by the elegant and judicious author of *Theorie des Sentiments Agreables*, that we deem it unneceſſary to make any further remarks on this ſubject. (See HAPPINESS and PLEASURE). A little reflection may ſatisfy us, that the number and variety of our ſenſations and feelings are prodigious. For, to omit all thoſe which accompany our appetites, paſſions, and affections, our moral ſentiments and ſentiments of taſte, even our external ſenſes, furniſh a great variety of ſenſations differing in kind, and almoſt in every kind an endleſs variety of degrees. Every variety we diſcern, with regard to taſte, ſmell, ſound, colour, heat, and cold, and in the tangible qualities of bodies, is indicated by a ſenſation correſponding to it.

The moſt general and the moſt important diviſion of our ſenſations and feelings is into the agreeable, the diſagreeable, and the indifferent. Every thing we call pleaſure, happineſs, or enjoyment on the one hand; and, on the other, every thing we call miſery, pain, or uneaſineſs, is ſenſation or feeling: For no man can for the preſent be more happy, or more miſerable, than he feels himſelf to be. He cannot be deceived with regard to the enjoyment or ſuffering of the preſent moment.

But, beſides the ſenſations that are agreeable or diſagreeable, there is ſtill a greater number that are indifferent. To theſe we give ſo little attention, that they have no name, and are immediately forgotten as if they

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* *Theorie des Sentiments agréables.*

* *Conſpect. Medicin.*

had never been; it even requires attention to the operations of our minds to be convinced of their exiſtence. For this end we may obſerve, that to a good ear every human voice is diſtinguiſhable from all others. Some voices are pleaſant, ſome diſagreeable; but the far greater part cannot be ſaid to be one or the other. The ſame thing may be ſaid of other ſounds, and no leſs of taſtes, ſmells, and colours; and if we conſider, that our ſenſes are in continual exerciſe while we are awake, that ſome ſenſation attends every object they preſent to us, and that familiar objects ſeldom raiſe any emotion pleaſant or painful; we ſhall ſee reaſon, beſides the agreeable and diſagreeable, to admit a third claſs of ſenſations, that may be called indifferent. But theſe ſenſations that are indifferent are far from being uſeleſs. They ſerve as ſigns to diſtinguiſh things that differ; and the information we have concerning things external comes by theſe means. Thus, if a man had not a muſical ear ſo as to receive pleaſure from the harmony or melody of ſounds, he would ſtill find the ſenſe of hearing of great utility. Though ſounds gave him neither pleaſure nor pain, of themſelves, they would give him much uſeful information; and the ſame may be ſaid of the ſenſations we have by all the other ſenſes.

SENSIBLE NOTE, in *Muſic*, is that which conſtitutes a third major above the dominant, and a ſemitone beneath the tonic. *Si*, or B, is the ſenſible note in the tone of *ut* or C *ſol* ※: or G ſharp, in the tone of *la* or A.

They call it the *ſenſible note* on this account, that it cauſes to be perceived the tone or natural ſeries of the key and the tonic itſelf; upon which, after the chord of the dominant, the ſenſible note taking the ſhorteſt road, is under a neceſſity of riſing; which has made ſome authors treat this ſenſible note as a major diſſonance, for want of obſerving, that diſſonance, being a relation, cannot be conſtituted unleſs by two notes between which it ſubſiſts.

It is not meant that the ſenſible note is the ſeventh of the tone, becauſe, in the minor mode, this ſeventh cannot be a ſenſible note but in aſcending; for, in deſcending, it is at the diſtance of a full note from the tonic, and of a third minor from the dominant.

SENSIBILITY, is a nice and delicate perception of pleaſure or pain, beauty or deformity. It is very nearly allied to taſte; and, as far as it is natural, ſeems to depend upon the organization of the nervous ſyſtem. It is capable, however, of cultivation, and is experienced in a much higher degree in civilized than in ſavage nations, and among perſons liberally educated than among boors and illiterate mechanics. The man who has cultivated any of the fine arts has a much quicker and more exquiſite perception of beauty and deformity in the execution of that art, than another of equal or even greater natural powers, who has but caſually inſpected its productions. He who has been long accuſtomed to that decorum of manners which characterizes the polite part of the world, perceives almoſt inſtantaneouſly the ſmalleſt deviation from it, and feels himſelf almoſt as much hurt by behaviour harmleſs in itſelf, as by the groſſeſt rudeneſs; and the man who has long proceeded ſteadily in the paths of virtue, and often painted to himſelf the deformity of vice, and the miſeries of which it is productive, is more quickly alarmed at any deviation from rectitude, than another who, though his life has been ſtained by no crime, has yet thought leſs upon the principles of virtue and conſequences of vice.

Every thing which can be called ſenſibility, and is not born with man, may be reſolved into aſſociation, and is to be regulated accordingly; for ſenſibilities may be acquired which are inimical to happineſs and to the practice of virtue. The man is not to be envied who has ſo accuſtomed himſelf to the forms of polite addreſs as to be hurt by the unaffected language and manners of the honeſt peaſant, with whom he may have occaſion to tranſact buſineſs; nor is he likely to acquire much uſeful knowledge who has ſo ſedulouſly ſtudied the beauties of compoſition as to be unable to read without diſguſt a book of ſcience or of hiſtory, of which the ſtyle comes not up to his ſtandard of perfection. That ſenſibility which we either have from nature, or neceſſarily acquire, of the miſeries of others, is of the greateſt uſe when properly regulated, as it powerfully impels us to relieve their diſtreſs; but if it by any means become ſo exquiſite as to make us ſhun the ſight of miſery, it counteracts the end for which it was implanted in our nature, and only deprives us of happineſs, while it contributes nothing to the good of others. Indeed there is reaſon to believe that all ſuch extreme ſenſibilities are ſelfiſh affectations, employed as apologies for withholding from the miſerable that relief which it is in our power to give; for there is not a fact better eſtabliſhed in the ſcience of human nature, than that paſſive perceptions grow gradually weaker by repetition, while active habits daily acquire ſtrength.

It is of great importance to a literary man to cultivate his taſte, becauſe, it is the ſource of much elegant and refined pleaſure, (ſee TASTE); but there is a degree of faſtidiouſneſs which renders that pleaſure impoſſible to be obtained, and is the certain indication of expiring letters. It is neceſſary to ſubmit to the artificial rules of politeneſs, for they tend to promote the peace and harmony of ſociety, and are ſometimes a uſeful ſubſtitute for moral virtue; but he who with reſpect to them has ſo much ſenſibility as to be diſguſted with all whoſe manners are not equally poliſhed with his own, is a very troubleſome member of ſociety. It is every man's duty to cultivate his moral ſenſibilities, ſo as to make them ſubſervient to the purpoſes for which they were given to him; but if he either feel, or pretend to feel, the miſeries of others to ſo exquiſite a degree as to be unable to afford them the relief which they have a right to expect, his ſenſibilities are of no good tendency.

That the man of true ſenſibility has more pains and more pleaſures than the callous wretch, is univerſally admitted, as well as that his enjoyments and ſufferings are more exquiſite in their kinds; and as no man lives for himſelf alone, no man will acknowledge his want of ſenſibility, or expreſs a wiſh that his heart were callous. It is, however, a matter of ſome moment to diſtinguiſh real ſenſibilities from ridiculous affectations; thoſe which tend to increaſe the ſum of human happineſs from ſuch as have a contrary tendency; and to cultivate them all in ſuch a manner as to make them anſwer the ends for which they were implanted in us by the beneficent Author of nature. This can be done only by watching over them as over other aſſociations, (ſee METAPHYSICS, N° 98.); for exceſſive ſenſibility, as it is not the gift of nature, is the bane of human happineſs. “ Too much tenderneſs (as Rouſſeau well obſerves) proves the bittereſt curſe inſtead of the moſt fruitful bleſſing ; vexation and diſappointment are its certain conſequences. The temperature of the air, the change of the ſeaſons, the brilliancy of the ſun, or thickneſs of the fogs, are ſo many moving ſprings to the unhappy poſſeſſor, and he becomes the wanton ſport of their arbitration."

SENSITIVE-plant. See Mimosa, Dionæa, and Hedysarum, Botany *Index*.

The ſenſitive plants are well known to poſſeſs a kind of motion, by which the leaves and ſtalks are contracted and fall down on being ſlightly touched, or ſhaken with ſome degree of violence.

The contraction of the leaves and branches of the ſenſitive plant when touched, is a very ſingular phenomenon. Different hypotheſes have been formed by botaniſts in order to explain it ; but we are diſpoſed to believe that theſe have generally been deduced rather from analogical reaſoning than from a collection of facts and obſervations. We ſhall therefore give an account of all the important facts which we have been able to collect upon this curious ſubject ; and then draw ſuch concluſions as obviouſly reſult from them, without, however, attempting to ſupport any old, or to eſtabliſh a new, hypotheſis.

1. It is difficult to touch the leaf of a healthy ſenſitive plant ſo delicately that it will not immediately collapſe, the foliola or little leaves moving at their baſe till they come into contact, and then applying themſelves cloſe together. If the leaf be touched with a little more force, the oppoſite leaf will exhibit the ſame appearance. If a little more force be applied, the partial footſtalks bend down towards the common footſtalk from which they iſſue, making with it a more acute angle than before. If the touch be more violent ſtill, all the leaves ſituated on the ſame ſide with the one that has been touched will inſtantly collapſe, and the partial footſtalk will approach the common footſtalk to which it is attached, in the ſame manner as the partial footſtalk of the leaf approaches the ſtem or branch from which it iſſues ; ſo that the whole plant, from having its branches extended, will immediately appear like a weeping birch.

2. Theſe motions of the plant are performed by means of three diſtinct and ſenſible articulations. The firſt, that of the foliola or lobes to the partial footſtalk ; the ſecond, that of the partial footſtalk to the common one ; the third, that of the common footſtalk to the trunk. The primary motion of all which is the cloſing of the leaf upon the partial footſtalk, which is performed in a ſimilar manner, and by a ſimilar articulation. This, however, is much leſs viſible than the others. Theſe motions are wholly independent on one another, as may be proved by experiment. It appears that if the partial footſtalks are moved, and collapſe toward the petioli, or theſe toward the trunk, the little leaves, whoſe motion is uſually primary to theſe, ſhould be affected alſo ; yet experiment proves that it is poſſible to touch the footſtalks in ſuch a manner as to affect them only, and make them apply themſelves to the trunk, while the leaves feel nothing of the touch ; but this cannot be, unleſs the footſtalks are ſo diſpoſed as that they can fall to the trunk, without ſuffering their leaves to touch any part of the plant in their paſſage, becauſe, if they do, they are immediately affected.

3. Winds and heavy rains make the leaves of the ſenſitive plant contract and cloſe ; but no ſuch effect is produced from ſlight ſhowers.

4. At night, or when expoſed to much cold in the day, the leaves meet and cloſe in the ſame manner as when touched, folding their upper ſurfaces together, and in part over each other, like ſcales or tiles, ſo as to expoſe as little as poſſible of the upper ſurface to the air. The oppoſite ſides of the leaves (foliola) do not come cloſe together in the night, for when touched they apply themſelves cloſer together. Dr Darwin kept a ſenſitive plant in a dark place for ſome hours after daybreak ; the leaves and footſtalks were collapſed as in its moſt profound ſleep ; and, on expoſing it to the light, above 20 minutes paſſed before it was expanded.

5. In the month of Auguſt, a ſenſitive plant was carried in a pot out of its uſual place into a dark cave, the motion that it received in the carriage ſhut up its leaves, and they did not open till 24 hours afterwards ; at this time they became moderately open, but were afterwards ſubject to no changes at night or morning, but remained three days and nights with their leaves in the ſame moderately open ſtate. At the end of this time they were brought out again into the air, and there recovered their natural periodical motions, ſhutting every night, and opening every morning, as naturally and as ſtrongly as if the plant had not been in this forced ſtate ; and while in the cave, it was obſerved to be very little leſs affected with the touch than when abroad in the open air.

6. The great heats of ſummer, when there is open ſunſhine at noon, affect the plant in ſome degree like cold, cauſing it to ſhut up its leaves a little, but never in any very great degree. The plant, however, is leaſt of all affected about nine o'clock in the morning, and that is conſequently the propereſt time to make experiments on it. A branch of the ſenſitive plant cut off, and laid by, retains yet its property of ſhutting up and opening in the morning for ſome days ; and it holds it longer if kept with one end in water, than if left to dry more ſuddenly.

7. The leaves only of the ſenſitive plant ſhut up in the night, not the branches ; and if it be touched at this time, the branches are affected in the ſame manner as in the day, ſhutting up, or approaching to the ſtalk or trunk, in the ſame manner, and often with more force. It is of no conſequence what the ſubſtance is with which the plant is touched, it anſwers alike to all ; but there may be obſerved a little ſpot, diſtinguiſhable by its paler colour in the articulations of its leaves, where the greateſt and niceſt ſenſibility is evidently placed.

8. Duhamel having obſerved, about the 15th of September, in moderate weather, the natural motion of a branch of a ſenſitive plant, remarked, that at nine in the morning it formed with the ſtem an angle of 100 degrees ; at noon, 112 degrees ; at three afternoon, it returned to 100 ; and after touching the branch, the angle was reduced to 90. Three quarters of an hour after it had mounted to 112 ; and, at eight at night, it deſcended again, without being touched, to 90. The day after, in finer weather, the ſame branch, at eight in the morning, made an angle of 135 degrees with the ſtem ; after being touched, the angle was diminiſhed to 80 ; an hour after, it roſe again to 135 ; being touched a ſecond time, it deſcended again to 80 ; an hour and a half after, it had riſen to 145 ; and on being

touched a third time, deſcended to 135; and remained in that poſition till five o'clock in the afternoon, when being touched a fourth time it fell to 110.

9. The parts of the plants which have collapſed afterwards unfold themſelves, and return to their former expanded ſtate. The time required for that purpoſe varies, according to the vigour of the plant, the ſeaſon of the year, the hour of the day, the ſtate of the atmoſphere. Sometimes half an hour is requiſite, ſometimes only ten minutes. The order in which the parts recover themſelves varies in like manner: ſometimes it is the common footſtalk; ſometimes the rib to which the leaves are attached; and ſometimes the leaves themſelves are expanded, before the other parts have made any attempt to be reinſtated in their former poſition.

10. If, without ſhaking the other ſmaller leaves, we cut off the half of a leaf or lobe belonging to the laſt pair, at the extremity or ſummit of a wing, the leaf cut, and its antagoniſt, that is to ſay, the firſt pair, begin to approach each other; then the ſecond, and ſo on ſucceſſively, till all the leſſer leaves, or lobes of that wing, have collapſed in like manner. Frequently, after 12 or 15 ſeconds, the lobes of the other wings, which were not immediately affected by the ſtroke, ſhut; whilſt the ſtalk and its wing, beginning at the bottom, and proceeding in order to the top, gradually recover themſelves. If, inſtead of one of the leſſer extreme leaves, we cut off one belonging to the pair that is next the footſtalk, its antagoniſt ſhuts, as do the other pairs ſucceſſively, from the bottom to the top. If all the leaves of one ſide of a wing be cut off, the oppoſite leaves are not affected, but remain expanded. With ſome addreſs, it is poſſible even to cut off a branch without hurting the leaves, or making them fall. The common footſtalk of the winged leaves being cut as far as three-fourths of its diameter, all the parts which hang down collapſe, but quickly recover without appearing to have ſuffered any conſiderable violence by the ſhock. An inciſion being made into one of the principal branches to the depth of one half the diameter, the branches ſituated betwixt the ſection and the root will fall down; thoſe above the inciſion remain as before, and the leſſer leaves continue open; but this direction is ſoon deſtroyed, by cutting off one of the lobes at the extremity, as was obſerved above. Laſtly, a whole wing being cut off with precaution near its inſertion into the common footſtalk, the other wings are not affected by it, and its own lobes do not ſhut. No motion enſues from piercing the branch with a needle or other ſharp inſtrument.

11. If the end of one of the leaves be burned with the flame of a candle, or by a burning glaſs, or by touching it with hot iron, it cloſes up in a moment, and the oppoſite leaf does the ſame, and after that the whole ſeries of leaves on each ſide of the partial or little footſtalk; then the footſtalk itſelf; then the branch or common footſtalk; all do the ſame, if the burning has been in a ſufficient degree. This proves that there is a very nice communication between all the parts of the plant, by means of which the burning, which only is applied to the extremity of one leaf, diffuſes its influence through every part of the ſhrub. If a drop of aquafortis be carefully laid upon a leaf of the ſenſitive plant, ſo as not to ſhake it in the leaſt, the leaf does not begin to move till the acrid liquor corrodes the ſubſtance of it; but at that time, not only that particular leaf, but all the leaves placed on the ſame footſtalk, cloſe themſelves up. The vapour of burning ſulphur has alſo this effect on many leaves at once, according as they are more or leſs expoſed to it; but a bottle of very acrid and ſulphureous ſpirit of vitriol, placed under the branches unſtopped, produces no ſuch effect. Wetting the leaves with ſpirit of wine has been obſerved alſo to have no effect, nor the rubbing oil of almonds over them; though this laſt application deſtroys many plants.

From the preceding experiments the following concluſions may be fairly drawn: 1. The contraction of the parts of the ſenſitive plant is occaſioned by an external force, and the contraction is in proportion to the force. 2. All bodies which can exert any force affect the ſenſitive plant; ſome by the touch or by agitation, as the wind, rain, &c.; ſome by chemical influence, as heat and cold. 3. Touching or agitating the plant produces a greater effect than an inciſion or cutting off a part, or by applying heat or cold.

Attempts have been made to explain theſe curious phenomena. Dr Darwin, in the notes to his admired poem, entitled, *The Botanic Garden*, lays it down as a principle, that "the ſleep of animals conſiſts in a ſuſpenſion of voluntary motion; and as vegetables are ſubject to ſleep as well as animals, there is reaſon to conclude (ſays he) that the various action of cloſing their petals and foliage may be juſtly aſcribed to a voluntary power; for without the faculty of volition ſleep would not have been neceſſary to them." Whether this definition of ſleep when applied to animals be juſt, we ſhall not inquire; but it is evident the ſuppoſed analogy between the ſleep of animals and the ſleep of plants has led Dr Darwin to admit this aſtoniſhing concluſion, that plants have volition. As volition preſuppoſes a mind or ſoul, it were to be wiſhed that he had given us ſome information concerning the nature of a vegetable ſoul, which can think and will. We ſuſpect, however, that this vegetable ſoul will turn out to be a mere mechanical or chemical one; for it is affected by external forces uniformly in the ſame way, its volition is merely paſſive, and never makes any ſucceſsful reſiſtance againſt thoſe cauſes by which it is influenced. All this is a mere abuſe of words. The ſleep of plants is a metaphorical expreſſion, and has not the leaſt reſemblance to the ſleep of animals. Plants are ſaid to ſleep when the flowers or leaves are contracted or folded together; but we never heard that there is any ſimilar contraction in the body of an animal during ſleep.

The fibres of vegetables have been compared with the muſcles of animals, and the motions of the ſenſitive plant have been ſuppoſed the ſame with muſcular motion. Between the fibres of vegetables and the muſcles of animals, however, there is not the leaſt ſimilarity. If muſcles be cut through, ſo as to be ſeparated from the joints to which they are attached, their powers are completely deſtroyed; but this is not the caſe with vegetable fibres. The following very ingenious experiment, which was communicated to us by a reſpectable member of the Univerſity of Edinburgh, is deciſive on this ſubject. He ſelected a growing poppy at that period of its growth, before unfolding, when the head and neck are bent down almoſt double. He cut the ſtalk where it was curved half through on the under ſide, and half through

through at a ſmall diſtance on the upper ſide, and half through in the middle point between the two ſections, ſo that the ends of the fibres were ſeparated from the ſtalk. Notwithſtanding theſe ſeveral cuttings on the neck, the poppy raiſed its head, and aſſumed a more erect poſition. There is, therefore, a complete diſtinction between muſcular motion and the motions of a plant, for no motion can take place in the limb of an animal when the muſcles of that limb are cut.

In fine, we look upon all attempts to explain the motions of plants as abſurd, and all reaſoning from ſuppoſed analogy between animals and vegetables as the ſource of wild conjecture, and not of ſound philoſophy. We view the contraction and expanſion of the ſenſitive plant in the ſame light as we do gravitation, chemical attraction, electricity, and magnetiſm, as a ſingular fact, the circumſtances of which we may be fully acquainted with, but muſt deſpair of underſtanding its cauſe.

What has been ſaid under this article chiefly refers to the *mimoſa ſenſitiva* and *pudica*. For a full account of the motions of vegetables in general, see *Vegetable Motion*, under the article MOTION.

SENTENCE, in *Law*, a judgment paſſed in court by the judge in ſome proceſs, either civil or criminal. See JUDGMENT.

SENTENCE, in *Grammar*, denotes a period, or a ſet of words comprehending ſome perfect ſenſe or ſentiment of the mind. The buſineſs of pointing is to diſtinguiſh the ſeveral parts and members of ſentences, ſo as to render the ſenſe thereof as clear, diſtinct, and full as poſſible. See PUNCTUATION.

In every ſentence there are two parts neceſſarily required; a noun for the ſubject, and a definite verb: whatever is found more than theſe two, affects one of them, either immediately, or by the intervention of ſome other, whereby the firſt is affected.

Again, every ſentence is either ſimple or compound: a ſimple ſentence is that conſiſting of one ſingle ſubject, and one finite verb.—A compound ſentence contains ſeveral ſubjects and finite verbs, either expreſsly or implicitly.

A ſimple ſentence needs no point or diſtinction; only a period to cloſe it: as, "A good man loves virtue for itſelf."—In ſuch a ſentence, the ſeveral adjuncts affect either the ſubject or the verb in a different manner. Thus the word *good* expreſſes the quality of the ſubject, *virtue* the object of the action, and *for itſelf* the end thereof.—Now none of theſe adjuncts can be ſeparated from the reſt of the ſentence: for if one be, why ſhould not all the reſt? and if all be, the ſentence will be minced into almoſt as many parts as there are words.

But if ſeveral adjuncts be attributed in the ſame manner either to the ſubject or the verb, the ſentence becomes compound, and is to be divided into parts.

In every compound ſentence, as many ſubjects, or as many finite verbs as there are, either expreſsly or implied, ſo many diſtinctions may there be. Thus, "My hopes, fears, joys, pains, all centre in you." And thus *Catilina abiit, exceſſit, evaſit, erupit.*—The reaſon of which pointing is obvious; for as many ſubjects or finite verbs as there are in a ſentence, ſo many members does it really contain. Whenever, therefore, there occur more nouns than verbs, or contrariwiſe, they are to be conceived as equal. Since, as every ſubject requires its verbs, ſo every verb requires its ſubject, wherewith it may agree: excepting, perhaps, in ſome figurative expreſſions.

Cicero.

SENTICOSÆ (from *ſentis*, a "briar or bramble"); the name of the 35th order in Linnæus's fragments of a natural method, conſiſting of roſe, bramble, and other plants, which reſemble them in port and external ſtructure. See BOTANY, *Natural Method*.

SENTIMENT, according to Lord Kames, is a term appropriated to ſuch thoughts as are prompted by paſſion. It differs from a perception; for a perception ſignifies the act by which we become conſcious of external objects. It differs from conſciouſneſs of an internal action, ſuch as thinking, ſuſpending thought, inclining, reſolving, willing, &c. And it differs from the conception of a relation among objects; a conception of that kind being termed *opinion*.

SENTIMENTS, in *Poetry*. To talk in the language of muſic, each paſſion has a certain tone, to which every ſentiment proceeding from it ought to be tuned with the greateſt accuracy: which is no eaſy work, eſpecially where ſuch harmony ought to be ſupported during the courſe of a long theatrical repreſentation. In order to reach ſuch delicacy of execution, it is neceſſary that a writer aſſume the preciſe character and paſſion of the perſonage repreſented; which requires an uncommon genius. But it is the only difficulty; for the writer, who, annihilating himſelf, can thus become another perſon, need be in no pain about the ſentiments that belong to the aſſumed character: theſe will flow without the leaſt ſtudy, or even preconception; and will frequently be as delightfully new to himſelf as to his reader. But if a lively picture even of a ſingle emotion require an effort of genius, how much greater the effort to compoſe a paſſionate dialogue with as many different tones of paſſion as there are ſpeakers? With what ductility of feeling muſt that writer be endued, who approaches perfection in ſuch a work; when it is neceſſary to aſſume different and even oppoſite characters and paſſions in the quickeſt ſucceſſion? Yet this work, difficult as it is, yields to that of compoſing a dialogue in genteel comedy, exhibiting characters without paſſion. The reaſon is, that the different tones of character are more delicate, and leſs in ſight, than thoſe of paſſion; and, accordingly, many writers, who have no genius for drawing characters, make a ſhift to repreſent, tolerably well, an ordinary paſſion in its ſimple movements. But of all works of this kind, what is truly the moſt difficult, is a characteriſtical dialogue upon any philoſophical ſubject; to interweave characters with reaſoning, by ſuiting to the character of each ſpeaker a peculiarity not only of thought but of expreſſion, requires the perfection of genius, taſte, and judgement.

How difficult dialogue-writing is, will be evident, even without reaſoning, from the miſerable compoſitions of that kind found without number in all languages. The art of mimicking any ſingularity in geſture or in voice, is a rare talent, though directed by ſight and hearing, the acuteſt and moſt lively of our external ſenſes: how much more rare muſt that talent, of imitating characters and internal emotions, tracing all their different tints, and repreſenting them in a lively manner by natural ſentiments properly expreſſed? The truth is, ſuch execution is too delicate for an ordinary genius;

and

and for that reaſon the bulk of writers, inſtead of expreſſing a paſſion as one does who feels it, content themſelves with deſcribing it in the language of a ſpectator. To awake paſſion by an internal effort merely, without any external cauſe, requires great ſenſibility; and yet that operation is neceſſary, not leſs to the writer than to the actor; becauſe none but thoſe who actually feel a paſſion can repreſent it to the life. The writer's part is the more complicated: he muſt add compoſition to paſſion: and muſt, in the quickeſt ſucceſſion, adopt every different character. But a very humble flight of imagination may ſerve to convert a writer into a ſpectator, ſo as to figure, in ſome obſcure manner, an action as paſſing in his ſight and hearing. In that figured ſituation, being led naturally to write like a ſpectator, he entertains his readers with his own reflections, with cool deſcription, and florid declamation; inſtead of making them eye-witneſſes, as it were, to a real event, and to every movement of genuine paſſion. Thus moſt of our plays appear to be caſt in the ſame mould; perſonages without character, the mere outlines of paſſion, a tireſome monotony, and a pompous declamatory ſtyle.

This deſcriptive manner of repreſenting paſſion is a very cold entertainment; our ſympathy is not raiſed by deſcription; we muſt firſt be lulled into a dream of reality, and every thing muſt appear as paſſing in our ſight. Unhappy is the player of genius who acts a part in what may be termed a *deſcriptive tragedy;* after aſſuming the very paſſion that is to be repreſented, how is he cramped in action, when he muſt utter, not the ſentiments of the paſſion he feels, but a cold deſcription in the language of a byſtander? It is that imperfection, undoubtedly, in the bulk of our plays, which confines our ſtage almoſt entirely to Shakeſpeare, notwithſtanding his many irregularities. In our late Engliſh tragedies, we ſometimes find ſentiments tolerably well adapted to a plain paſſion: but we muſt not in any of them expect a ſentiment expreſſive of character: and, upon that very account, our late performances of the dramatic kind are for the moſt part intolerably inſipid.

But it may be proper to illuſtrate this ſubject by examples. The firſt example ſhall be of ſentiments that appear the legitimate offspring of paſſion; to which ſhall be oppoſed what are deſcriptive only, and illegitimate; and in making this compariſon, the inſtances ſhall be borrowed from Shakeſpeare and Corneille, who for genius in dramatic compoſition ſtand uppermoſt in the rolls of fame.

I. Shakeſpeare ſhall furniſh the firſt example, being of ſentiments dictated by a violent and perturbed paſſion:

Lear.——————— Filial ingratitude!
Is it not as if this mouth ſhould tear this hand
For lifting food to't?—But I'll puniſh home;
No, I will weep no more.——In ſuch a night,
To ſhut me out!——Pour on, I will endure.
In ſuch a night as this! O Regan, Gonerill,
Your old kind father, whoſe frank heart gave all—
O! that way madneſs lies; let me ſhun that;
No more of that.————
Kent. Good, my lord, enter here.
Lear. Prithee, go in thyſelf, ſeek thine own eaſe,
This tempeſt will not give me leave to ponder
On things would hurt me more:—but I'll go in;
In, boy, go firſt. You houſeleſs poverty——
Nay, get thee in; I'll pray, and then I'll ſleep——
Poor naked wretches, whereſoe'er you are,
That bide the pelting of this pitileſs ſtorm!
How ſhall your houſeleſs heads, and unfed ſides,
Your loop'd and window'd raggedneſs, defend you
From ſeaſons ſuch as theſe!——O I have ta'en
Too little care of this! take phyſic, Pomp;
Expoſe thyſelf to feel what wretches feel,
That thou may'ſt ſhake the ſuperflux to them,
And ſhow the heav'ns more juſt.
King Lear, act iii. ſc. 5.

With regard to the French author, truth obliges us to acknowledge, that he deſcribes in the ſtyle of a ſpectator, inſtead of expreſſing paſſion like one who feels it; which naturally betrays him into a tireſome monotony, and a pompous declamatory ſtyle. It is ſcarcely neceſſary to give examples, for he never varies from that tone. We ſhall, however, take two paſſages at a venture, in order to be confronted with thoſe tranſcribed above. In the tragedy of Cinna, after the conſpiracy was diſcovered, Æmilia, having nothing in view but racks and death to herſelf and her lover, receives a pardon from Auguſtus, attended with the brighteſt circumſtances of magnanimity and tenderneſs. This is a lucky ſituation for repreſenting the paſſions of ſurpriſe and gratitude in their different ſtages, which ſeem naturally to be what follow. Theſe paſſions, raiſed at once to the utmoſt pitch, and being at firſt too big for utterance, muſt, for ſome moments, be expreſſed by violent geſtures only: ſo ſoon as there is vent for words, the firſt expreſſions are broken and interrupted: at laſt, we ought to expect a tide of intermingled ſentiments, occaſioned by the fluctuation of the mind between the two paſſions. Æmilia is made to behave in a very different manner: with extreme coolneſs ſhe deſcribes her own ſituation, as if ſhe were merely a ſpectator; or rather the poet takes the taſk off her hands:

Et je me rends, Seigneur, à ces hautes bontés:
Je recouvre la vûe auprès de leurs clartés.
Je connois mon forfait qui me ſembloit juſtice;
Et ce que n'avoit pû la terreur du ſupplice,
Je ſens naitre en mon ame un repentir puiſſant,
Et mon cœur en ſecret me dit, qu'il y conſent.
Le ciel a réſolu votre grandeur ſuprême;
Et pour preuve, Seigneur, je n'en veux que moi-même.
J'oſe avec vanité me donner cet éclat,
Puiſqu'il change mon cœur, qu'il veut changer l'état.
Ma haine va mourir, que j'ai crue immortelle;
Elle eſt morte, et ce cœur devient ſujet fidele;
Et prenant déſormais cette haine en horreur,
L'ardeur de vous ſervir ſuccede à ſa fureur.
Act v. ſc. 3.

So much in general on the genuine ſentiments of paſſion. We proceed to particular obſervations. And, firſt, paſſions ſeldom continue uniform any conſiderable time: they generally fluctuate, ſwelling and ſubſiding by turns, often in a quick ſucceſſion; and the ſentiments cannot be juſt unleſs they correſpond to ſuch fluctuation. Accordingly, a climax never ſhows better than in expreſſing a ſwelling paſſion: the following paſſages may ſuffice for an illuſtration.

Almeria. ————How haſt thou charm'd
The wildneſs of the waves and rocks to this;
That thus relenting they have giv'n thee back
To earth, to light and life, to love and me?
Mourning Bride, act i. ſc. 7.

I would not be the villain that thou think'ſt
For the whole ſpace that's in the tyrant's graſp,
And the rich earth to boot.
Macbeth, act iv. ſc. 4.

The following paſſage expreſſes finely the progreſs of conviction.

Let me not ſtir, nor breathe, leſt I diſſolve
That tender, lovely form, of painted air,
So like Almeria. Ha! it ſinks, it falls;
I'll catch it e'er it goes, and graſp her ſhade.
'Tis life! 'tis warm! 'tis ſhe! 'tis ſhe herſelf!
It is Almeria! 'tis, it is my wife!
Mourning Bride, act ii. ſc. 6.

In the progreſs of thought our reſolutions become more vigorous as well as our paſſions.

If ever I do yield or give conſent,
By any action, word, or thought, to wed
Another lord; may then juſt heav'n ſhow'r down, &c.
Mourning Bride, act i. ſc. 1.

And this leads to a ſecond obſervation, That the different ſtages of a paſſion, and its different directions, from birth to extinction, muſt be carefully repreſented in their order; becauſe otherwiſe the ſentiments, by being miſplaced, will appear forced and unnatural.—Reſentment, for example, when provoked by an atrocious injury, diſcharges itſelf firſt upon the author: ſentiments therefore of revenge come always firſt, and muſt in ſome meaſure be exhauſted before the perſon injured think of grieving for himſelf. In the Cid of Corneille, Don Diegue having been affronted in a cruel manner, expreſſes ſcarcely any ſentiment of revenge, but is totally occupied in contemplating the low ſituation to which he is reduced by the affront:

O rage! ô deſeſpoir! ô vieilleſſe ennemie!
N'ai-je donc tant vecu que pour cette infamie?
Et ne ſuis-je blanchi dans les travaux guerriers,
Que pour voir en un jour flétrit tant de lauriers?
Mon bras, qu'avec reſpect tout l'Eſpagne admire,
Mon bras qui tant de fois a ſauvé cet empire,
Tant de fois affermi le trône de ſon roi,
Trahit donc ma querelle, et ne fait rien pour moi!
O cruel ſouvenir de ma gloire paſſé!
Oeuvre de tant de jours en un jour effacée!
Nouvelle dignité fatale à mon bonheur!
Precipice élevé d'où tombe mon honneur!
Faut-il de votre éclat voir triompher le comte,
Et mourir ſans vengeance, ou vivre dans la honte?
Comte, ſois de mon prince à preſent gouverneur,
Ce haut rang n'admet point un homme ſans honneur;
Et ton jaloux orgueil par cet affront inſigne,
Malgré le choix du roi, m'en a ſû rendre indigne.
Et toi, de mes exploits glorieux inſtrument,
Mais d'un corps tout de glace inutile ornement,
Fer jadis tant à craindre, et qui dans cette offenſe,
M'as ſervi de parade, et non pas de defenſe,
Va, quitte deſormais le dernier des humains,
Paſſe pour me venger en de meilleures mains.
Le Cid, act i. ſc. 7.

Theſe ſentiments are certainly not the firſt that are ſuggeſted by the paſſion of reſentment. As the firſt movements of reſentment are always directed to its object, the very ſame is the caſe of grief. Yet with relation to the ſudden and ſevere diſtemper that ſeized Alexander bathing in the river Cydnus, Quintus Curtius deſcribes the firſt emotions of the army as directed to themſelves, lamenting that they were left without a leader, far from home, and had ſcarce any hopes of returning in ſafety: their king's diſtreſs, which muſt naturally have been their firſt concern, occupies them but in the ſecond place according to that author. In the Aminta of Taſſo, Sylvia, upon a report of her lover's death, which ſhe believed certain, inſtead of bemoaning the loſs of her beloved, turns her thoughts upon herſelf, and wonders her heart does not break:

Ohime, ben ſon di ſaſſo,
Poi che queſta novella non m'uccide.
Act iv. ſc. 2.

In the tragedy of Jane Shore, Alicia, in the full purpoſe of deſtroying her rival, has the following reflection:

O Jealouſy! thou bane of pleaſing friendſhip,
Thou worſt invader of our tender boſoms;
How does thy rancour poiſon all our ſoftneſs,
And turn our gentle nature into bitterneſs!
See where ſhe comes! Once my heart's deareſt bleſſing,
Now my chang'd eyes are blaſted with her beauty,
Loathe that known face, and ſicken to behold her.
Act iii. ſc. 1.

Theſe are the reflections of a cool ſpectator. A paſſion, while it has the aſcendant, and is freely indulged, ſuggeſts not to the perſon who feels it any ſentiment to its own prejudice: reflections like the foregoing occur not readily till the paſſion has ſpent its vigour.

A perſon ſometimes is agitated at once by different paſſions; and the mind in that caſe, vibrating like a pendulum, vents itſelf in ſentiments that partake of the ſame vibration. This we give as a third obſervation:

Queen. Would I had never trod this Engliſh earth,
Or felt the flatteries that grow upon it!
Ye've angels faces, but heav'n knows your hearts.
What ſhall become of me now? wretched lady!
I am the moſt unhappy woman living.
Alas! poor wenches, where are now your fortunes?
[*To her women.*
Shipwreck'd upon a kingdom, where no pity,
No friends, no hope, no kindred, weep for me:
Almoſt no grave allow'd me.
Henry VIII. act iii. ſc. 1.

Othello. Oh devil, devil!
If that the earth could teem with woman's tears,
Each drop ſhe falls would prove a crocodile.
Out of my ſight!
Déſdemona. I will not ſtay t'offend you. [*Going.*
Lodovico. Truly, an obedient lady:
I do beſeech your lordſhip, call her back.
Oth. Miſtreſs——

Sentiments.

Deſ. My lord.
Oth. What would you with her, Sir?
Lod. Who, I, my lord?
Oth. Ay; you did wiſh that I would make her turn.
Sir, ſhe can turn and turn, and yet go on;
And turn again. And ſhe can weep, Sir, weep;
And ſhe's obedient: as you ſay, obedient:
Very obedient—proceed you in your tears—
Concerning this, Sir,—oh well painted paſſion!—
I am commanded home—get you away,
I'll ſend for you anon—Sir, I obey the mandate,
And will return to Venice.——Hence, avaunt!
[*Exit* Deſdemona.
Othello, act iv. ſc. 6.

Æmilia. Oh! my good lord, I would ſpeak a word with you.
Othello. Yes, 'tis Æmilia—By and by.—She's dead.
'Tis like ſhe comes to ſpeak of Caſſio's death;
The noiſe was high.—Ha! no more moving?
Still as the grave. Shall ſhe come in? wer't good?
I think ſhe ſtirs again—No—what's the beſt?
If ſhe come in, ſhe'll, ſure, ſpeak to my wife:
My wife! my wife! what wife? I have no wife;
Oh inſupportable! oh heavy hour!
Othello, act v. ſc. 7,

A fourth obſervation is, That nature, which gave us paſſions, and made them extremely beneficial when moderate, intended undoubtedly that they ſhould be ſubjected to the government of reaſon and conſcience. It is therefore againſt the order of nature, that paſſion in any caſe ſhould take the lead in contradiction to reaſon and conſcience: ſuch a ſtate of mind is a ſort of anarchy which every one is aſhamed of and endeavours to hide or diſſemble. Even love, however laudable, is attended with a conſcious ſhame when it becomes immoderate: it is covered from the world, and diſcloſed only to the beloved object:

Et que l'amour ſouvent de remors combattu
Paroiſſe une foibleſſe, et non une vertu.
BOILEAU, *l'Art. Poet.* chant. iii. l. 101.

O, they love leaſt that let men know they love.
Two Gentlemen of Verona, act i. ſc. 3.

Hence a capital rule in the repreſentation of immoderate paſſions, that they ought to be hid or diſſembled as much as poſſible. And this holds in an eſpecial manner with reſpect to criminal paſſions: one never counſels the commiſſion of a crime in plain terms; guilt muſt not appear in its native colours, even in thought; the propoſal muſt be made by hints, and by repreſenting the action in ſome favourable light. Of the propriety of ſentiment upon ſuch an occaſion, Shakeſpeare, in the *Tempeſt*, has given us a beautiful example, in a ſpeech by the uſurping duke of Milan, adviſing Sebaſtian to murder his brother the king of Naples:

Antonio ————————What might,
Worthy Sebaſtian,—O, what might—no more.
And yet, methinks, I ſee it in thy face
What thou ſhouldſt be: the occaſion ſpeaks thee, and
My ſtrong imagination ſees a crown
Dropping upon thy head. Act ii. ſc. 2.

A picture of this kind, perhaps ſtill finer, is exhibited in *King John*, where that tyrant ſolicits (act iii. ſc. 5.) Hubert to murder the young prince Arthur; but it is too long to be inſerted here.

Sentiments.

II. As things are beſt illuſtrated by their contraries, we proceed to faulty ſentiments, diſdaining to be indebted for examples to any but the moſt approved authors. The firſt claſs ſhall conſiſt of ſentiments that accord not with the paſſion; or, in other words, ſentiments that the paſſion does not naturally ſuggeſt. In the ſecond claſs ſhall be ranged ſentiments that may belong to an ordinary paſſion, but unſuitable to it as tinctured by a ſingular character. Thoughts that properly are not ſentiments, but rather deſcriptions, make a third. Sentiments that belong to the paſſion repreſented, but are faulty as being introduced too early or too late, make a fourth. Vicious ſentiments expoſed in their native dreſs, inſtead of being concealed or diſguiſed, make a fifth. And in the laſt claſs ſhall be collected ſentiments ſuited to no character nor paſſion, and therefore unnatural.

The *firſt* claſs contains faulty ſentiments of various kinds, which we ſhall endeavour to diſtinguiſh from each other.

1. Of ſentiments that are faulty by being above the tone of the paſſion, the following may ſerve as an example:

Othello. ——————O my ſoul's joy!
If after every tempeſt come ſuch calms,
May the winds blow till they have waken'd death:
And let the labouring bark climb hills of ſeas
Olympus high, and duck again as low
As hell's from heaven? *Othello*, act ii. ſc. 6.

This ſentiment may be ſuggeſted by violent and inflamed paſſion; but is not ſuited to the ſatisfaction, however great, that one feels upon eſcaping danger.

2. Inſtance of ſentiments below the tone of the paſſion. Ptolemy, by putting Pompey to death, having incurred the diſpleaſure of Cæſar, was in the utmoſt dread of being dethroned: in that agitating ſituation, Corneille makes him utter a ſpeech full of cool reflection, that is in no degree expreſſive of the paſſion.

Ah! ſi je t'avois crû, je n'aurois pas de maitre,
Je ſerois dans le trône où le ciel m'a fait naître;
Mais c'eſt une imprudence aſſez commune aux rois,
D'écouter trop d'avis, et ſe tromper au choix.
Le Deſtin les aveugle au bord du précipice,
Ou ſi quelque lumiere en leur ame ſe gliſſe,
Cette fauſſe clarté dont il les eblouit,
Le plonge dans une gouffre, et puis s'evanouit.
La Mort de Pompée, act iv. ſc. 1.

3. Sentiments that agree not with the tone of the paſſion; as where a pleaſant ſentiment is grafted upon a painful paſſion, or the contrary. In the following inſtances, the ſentiments are too gay for a ſerious paſſion:

No happier taſk theſe faded eyes purſue;
To read and weep is all they now can do.
Eloiſa to Abelard, l. 47.

Again;

Heav'n firſt taught letters for ſome wretch's aid,
Some baniſh'd lover, or ſome captive maid:

They

They live, they ſpeak, they breathe what love inſpires,
Warm from the ſoul, and faithful to its fires;
The virgin's wiſh without her fears impart,
Excuſe the bluſh, and pour out all the heart;
Speed the ſoft intercourſe from ſoul to ſoul,
And waft a ſigh from Indus to the pole.
Eloiſa to Abelard, l. 51.

Theſe thoughts are pretty: they ſuit Pope, but not Eloiſa.

Satan, enraged by a threatening of the angel Gabriel, anſwers thus:

Then when I am thy captive, talk of chains,
Proud limitary cherub; but ere then
Far heavier load thyſelf expect to feel
From my prevailing arm, though heaven's King
Ride on thy wings, and thou with thy compeers,
Us'd to the yoke, draw'ſt his triumphant wheels
In progreſs thro' the road of heav'n *ſtar pav'd*.
Paradiſe Loſt, book iv.

The concluding epithet forms a grand and delightful image, which cannot be the genuine offspring of rage.

4. Sentiments too artificial for a ſerious paſſion. The firſt example is a ſpeech of Percy expiring.

O, Harry, thou haſt robb'd me of my growth:
I better brook the loſs of brittle life,
Than thoſe proud titles thou haſt won of me:
They wound my thoughts worſe than thy ſword my fleſh.
But thought's the ſlave of life, and life time's fool;
And time, that takes ſurvey of all the world,
Muſt have a ſtop.
Firſt Part, Henry IV. act v. ſc. 9.

The ſentiments of the *Mourning Bride* are for the moſt part no leſs delicate than juſt copies of nature: in the following exception the picture is beautiful, but too artful to be ſuggeſted by ſevere grief.

Almeria. O no! Time gives increaſe to my afflictions.
The circling hours, that gather all the woes
Which are diffus'd through the revolving year,
Come heavy laden with th' oppreſſive weight
To me; with me, ſucceſſively, they leave
The ſighs, the tears, the groans, the reſtleſs cares,
And all the damps of grief, that did retard their flight;
They ſhake their downy wings, and ſcatter all
The dire collected dews on my poor head;
Then fly with joy and ſwiftneſs from me. Act i. ſc. 1.

In the ſame play, Almeria ſeeing a dead body, which ſhe took to be Alphonſo's, expreſſes ſentiments ſtrained and artificial, which nature ſuggeſts not to any perſon upon ſuch an occaſion;

Had they or hearts or eyes, that did this deed?
Could eyes endure to guide ſuch cruel hands?
Are not my eyes guilty alike with theirs,
That thus can gaze, and yet not turn to ſtone?
—I do not weep! The ſprings of tears are dry'd,
And of a ſudden I am calm, as if
All things were well; and yet my huſband's murder'd!
Yes, yes, I know to mourn: I'll ſluice this heart,
The ſource of wo, and let the torrent in.
Act v. ſc. 11.

Pope's elegy to the memory of an unfortunate lady, expreſſes delicately the moſt tender concern and ſorrow that one can feel for the deplorable fate of a perſon of worth. Such a poem, deeply ſerious and pathetic, rejects with diſdain all fiction. Upon that account, the following paſſage deſerves no quarter; for it is not the language of the heart, but of the imagination indulging its flights at eaſe, and by that means is eminently diſcordant with the ſubject. It would be a ſtill more ſevere cenſure, if it ſhould be aſcribed to imitation, copying indiſcreetly what has been ſaid by others:

What though no weeping loves thy aſhes grace,
Nor poliſh'd marble emulate thy face?
What though no ſacred earth allow thee room,
Nor hallow'd dirge be mutter'd o'er thy tomb?
Yet ſhall thy grave with riſing flow'rs be dreſt,
And the green turf lie lightly on thy breaſt:
There ſhall the morn her earlieſt tears beſtow,
There the firſt roſes of the year ſhall blow;
While angels with their ſilver wings o'erſhade
The ground, now ſacred by thy relics made.

5. Fanciful or finical ſentiments. Sentiments that degenerate into point or conceit, however they may amuſe in an idle hour, can never be the offspring of any ſerious or important paſſion. In the *Jeruſalem* of Taſſo, Tancred, after a ſingle combat, ſpent with fatigue and loſs of blood, falls into a ſwoon; in which ſituation, underſtood to be dead, he is diſcovered by Erminia, who was in love with him to diſtraction. A more happy ſituation cannot be imagined, to raiſe grief in an inſtant to its higheſt pitch; and yet, in venting her ſorrow, ſhe deſcends moſt abominably into antitheſis and conceit even of the loweſt kind:

E in lui versò d'inefficabil vena
Lacrime, e voce di ſoſpiri miſta.
In che miſero punto hor qui me mena
Fortuna? a che veduta amara e triſta?
Dopo gran tempo i' ti ritrovo à pena
Tancredi, e ti riveggio, e non ſon viſta
Viſta non ſon da te, benche preſente
T' trovando ti perdo eternamente.
Canto xix. ſt. 105.

Armida's lamentation reſpecting her lover Rinaldo is in the ſame vicious taſte. *Vid.* canto xx. ſtan. 124, 125, 126.

Queen. Give me no help in lamentation,
I am not barren to bring forth complaints:
All ſprings reduce their currents to mine eyes,
That I, being govern'd by the wat'ry moon,
May ſend forth plenteous tears to drown the world,
Ah, for my huſband, for my dear lord Edward.
King Richard III. act ii. ſc. 2.

Jane Shore utters her laſt breath in a witty conceit:

Then all is well, and I ſhall ſleep in peace——
'Tis very dark, and I have loſt you now——
Was there not ſomething I would have bequeath'd you?
But

Sentiments.

But I have nothing left me to beſtow,
Nothing but one ſad ſigh. Oh mercy, Heav'n! [*Dies.*
Act v.

Guilford to Lady Jane Gray, when both were condemn'd to die:

Thou ſtand'ſt unmov'd;
Calm temper ſits upon thy beauteous brow;
Thy eyes that flow'd ſo faſt for Edward's loſs,
Gaze unconcern'd upon the ruin round thee,
As if thou had'ſt reſolv'd to brave thy fate,
And triumph in the midſt of deſolation.
Ha! ſee, it ſwells, the liquid cryſtal riſes,
It ſtarts in ſpite of thee——but I will catch it,
Nor let the earth be wet with dew ſo rich.
Lady Jane Gray, act iv. near the end.

The concluding ſentiment is altogether finical, unſuitable to the importance of the occaſion, and even to the dignity of the paſſion of love.

Corneille, in his *Examen of the Cid*, anſwering an objection, That his ſentiments are ſometimes too much refined for perſons in deep diſtreſs, obſerves, that if poets did not indulge ſentiments more ingenious or refined than are prompted by paſſion, their performances would often be low, and extreme grief would never ſuggeſt but exclamations merely. This is in plain language to aſſert, that forced thoughts are more agreeable than thoſe that are natural, and ought to be preferred.

The *ſecond* claſs is of ſentiments that may belong to an ordinary paſſion, but are not perfectly concordant with it, as tinctured by a ſingular character.

In the laſt act of that excellent comedy *The Careleſs Huſband*, Lady Eaſy, upon Sir Charles's reformation, is made to expreſs more violent and turbulent ſentiments of joy than are conſiſtent with the mildneſs of her character.

Lady Eaſy. O the ſoft treaſure! O the dear reward of long-deſiring love.—Thus! thus to have you mine, is ſomething more than happineſs; 'tis double life, and madneſs of abounding joy.

The following inſtances are deſcriptions rather than ſentiments, which compoſe a *third* claſs.

Of this deſcriptive manner of painting the paſſions, there is in the *Hippolytus* of Euripides, act v. an illuſtrious inſtance, viz. the ſpeech of Theſeus, upon hearing of his ſon's diſmal exit. In Racine's tragedy of *Eſther*, the queen hearing of the decree iſſued againſt her people, inſtead of expreſſing ſentiments ſuitable to the occaſion, turns her attention upon herſelf, and deſcribes with accuracy her own ſituation.

Juſte ciel! tout mon ſang dans mes veines ſe glace.
Act i. ſc. 3.

Again,

Aman. C'en eſt fait. Mon orgueil eſt forcé de plier.
L'inexorable Amen eſt reduit à prier.
Eſther, act iii. ſc. 5.

Athalie. Quel prodige nouveau me trouble et m'embarraſſe?
La douceur de ſa voix, ſon enfance, ſa grace,
Font inſenſiblement à mon inimitié
Succeder——Je ſerois ſenſible à la pitié?
Athalie, act ii. ſc. 7.

Titus. O de ma paſſion fureur deſeſperée!
Brutus of Voltaire, act iii. ſc. 6.

What other are the foregoing inſtances but deſcribing the paſſion another feels?

The *fourth* claſs is of ſentiments expreſſed too early or too late.

Some examples mentioned above belong to this claſs. Add the following from *Venice Preſerv'd*, act v. at the cloſe of the ſcene between Belvidera and her father Priuli. The account given by Belvidera of the danger ſhe was in, and of her huſband's threatening to murder her, ought naturally to have alarmed her relenting father, and to have made him expreſs the moſt perturbed ſentiments. Inſtead of which, he diſſolves into tenderneſs and love for his daughter, as if he had already delivered her from danger, and as if there were a perfect tranquillity:

Canſt thou forgive me all my follies paſt!
I'll henceforth be indeed a father; never,
Never more thus expoſe, but cheriſh thee,
Dear as the vital warmth that feeds my life,
Dear as thoſe eyes that weep in fondneſs o'er thee:
Peace to thy heart.

Immoral ſentiments expoſed in their native colours, inſtead of being concealed or diſguiſed, compoſe the *fifth* claſs.

The Lady Macbeth, projecting the death of the king, has the following ſoliloquy:

————The raven himſelf's not hoarſe
That croaks the fatal entrance of Duncan
Under my battlements. Come, all you ſpirits
That tend on mortal thoughts, unſex me here,
And fill me from the crown to the toe, top full
Of direſt cruelty; make thick my blood,
Stop up th' acceſs and paſſage to remorſe,
That no compunctious viſitings of nature
Shake my fell purpoſe. *Macbeth*, act i. ſc. 7.

This ſpeech is not natural. A treacherous murder was never perpetrated even by the moſt hardened miſcreant without compunction: and that the lady here muſt have been in horrible agitation, appears from her invoking the infernal ſpirits to fill her with cruelty, and to ſtop up all avenues to remorſe. But in that ſtate of mind it is a never-failing artifice of ſelf-deceit to draw the thickeſt veil over the wicked action, and to extenuate it by all the circumſtances that imagination can ſuggeſt: and if the crime cannot bear diſguiſe, the next attempt is to thruſt it out of mind altogether, and to ruſh on to action without thought. This laſt was the huſband's method.

Strange things I have in head, that will to hand;
Which muſt be acted ere they muſt be ſcann'd.
Act iii. ſc. 5.

The lady follows neither of theſe courſes, but in a deliberate manner endeavours to fortify her heart in the commiſſion of an execrable crime, without even attempting to colour it. This, we think, is not natural; we hope

hope there is no ſuch wretch to be found as is here repreſented.

The *laſt* claſs comprehends ſentiments that are unnatural, as being ſuited to no character or paſſion. Theſe may be ſubdivided into three branches: firſt, ſentiments unſuitable to the conſtitution of man, and to the laws of his nature; ſecond, inconſiſtent ſentiments; third, ſentiments that are pure rant and extravagance.

When the fable is of human affairs, every event, every incident, and every circumſtance, ought to be natural, otherwiſe the imitation is imperfect. But an imperfect imitation is a venial fault, compared with that of running croſs to nature. In the *Hippolytus* of Euripides (act iv. ſc. 5.), Hippolytus, wiſhing for another ſelf in his own ſituation, "How much (ſays he) ſhould I be touched with his misfortune!" as if it were natural to grieve more for the misfortune of another than for one's own.

Oſmyn. Yet I behold her—yet—and now no more.
Turn your lights inward, eyes, and view my thoughts;
So ſhall you ſtill behold her—'twill not be.
O impotence of ſight! mechanic ſenſe,
Which to exterior objects ow'ſt thy faculty,
Not ſeeing of election, but neceſſity.
Thus do our eyes, as do all common mirrors,
Succeſſively reflect ſucceeding images.
Nor what they would, but muſt; a ſtar or toad;
Juſt as the hand of chance adminiſters!
Mourning Bride, act ii. ſc. 8.

No man in his ſenſes ever thought of applying his eyes to diſcover what paſſes in his mind; far leſs of blaming his eyes for not ſeeing a thought or idea. In Moliere's *l'Avare* (act iv. ſc. 7.) Harpagon, being robbed of his money, ſeizes himſelf by the arm, miſtaking it for that of the robber. And again he expreſſes himſelf as follows:

Je veux aller querir la juſtice, et faire donner la queſtion à toute ma maiſon; à ſervantes, à valets, à fils, à fille, et à moi auſſi.

This is ſo abſurd as ſcarcely to provoke a ſmile, if it be not at the author.

Of the ſecond branch the following example may ſuffice:

——————Now bid me run,
And I will ſtrive with things *impoſſible*,
Yea, get the better of them.
Julius Cæſar, act ii. ſc. 3.

Of the third branch, take the following ſamples. Lucan, talking of Pompey's ſepulchre,

——————Romanum nomen, et omne
Imperium magno eſt tumuli modus. Obrue ſaxa
Crimine plena deûm. Si tota eſt Herculis Oete,
Et juga tota vacant Bromio Nyſeia; quare
Unus in Egypto Magno lapis? Omnia Lagi
Rura tenere poteſt, ſi nullo ceſpite nomen
Hæſerit. Erremus populi, cinerumque tuorum,
Magne, metu nullas Nili calcemus arenas.
Lib. viii. l. 798.

Thus, in Rowe's tranſlation:

Where there are ſeas, or air, or earth, or ſkies,
Where'er Rome's empire ſtretches, Pompey lies.
Far be the vile memorial then convey'd!
Nor let this ſtone the partial gods upbraid.
Shall Hercules all Oeta's heights demand,
And Nyſa's hill for Bacchus only ſtand;
While one poor pebble is the warrior's doom
That fought the cauſe of liberty and Rome?
If Fate decrees he muſt in Egypt lie,
Let the whole fertile realm his grave ſupply,
Yield the wide country to his awful ſhade,
Nor let us dare on any part to tread,
Fearful we violate the mighty dead.

The following paſſages are pure rant. Coriolanus, ſpeaking to his mother,

What is this?
Your knees to me? to your corrected ſon?
Then let the pebbles on the hungry beach
Fillop the ſtars: then let the mutinous winds
Strike the proud cedars 'gainſt the fiery ſun:
Murd'ring impoſſibility, to make
What cannot be, ſlight work.
Coriolanus, act i. ſc. 3.

Cæſar. ———Danger knows full well,
That Cæſar is more dangerous than he.
We were two lions litter'd in one day,
And I the elder and more terrible.
Julius Cæſar, act ii. ſc. 4.

Ventidius. But you, ere love miſled your wand'ring eyes,
Were ſure the chief and beſt of human race,
Fram'd in the very pride and boaſt of nature,
So perfect, that the gods who form'd you wonder'd
At their own ſkill, and cry'd, A lucky hit
Has mended our deſign. DRYDEN, *All for Love*, act i.

Not to talk of the impiety of this ſentiment, it is ludicrous inſtead of being lofty.

The famous epitaph on Raphael is not leſs abſurd than any of the foregoing paſſages:

Raphael, timuit, quo ſoſpite, vinci,
Rerum magna parens, et moriente mori.

Imitated by Pope, in his epitaph on Sir Godfrey Kneller:

Living, great Nature fear'd he might outvie
Her works; and dying, fears herſelf may die.

Such is the force of imitation; for Pope of himſelf would never have been guilty of a thought ſo extravagant.

SENTINEL, or SENTRY, in military affairs, a private ſoldier placed in ſome poſt to watch the approach of the enemy, to prevent ſurpriſes, to ſtop ſuch as would paſs without orders or diſcovering who they are. They are placed before the arms of all guards, at the tents and doors of general officers, colonels of regiments, &c.

SENTINEL Perdu, a ſoldier poſted near an enemy, or in ſome very dangerous poſt where he is in hazard of being loſt.

All ſentinels are to be vigilant on their poſts; neither are they to ſing, ſmoke tobacco, nor ſuffer any noiſe to be made near them. They are to have a watchful eye over the things committed to their charge. They are not to ſuffer any light to remain, or any fire to be made, near their poſts in the night-time ; neither is any ſentry to be relieved or removed from his poſt but by the corporal of the guard. They are not to ſuffer any one to touch or handle their arms, or in the night-time to come within ten yards of their poſt.

No perſon is to ſtrike or abuſe a ſentry on his poſt ; but when he has committed a crime, he is to be relieved, and then puniſhed according to the rules and articles of war.

A ſentinel, on his poſt in the night, is to know nobody but by the counter-ſign : when he challenges, and is anſwered *Relief*, he calls out, *Stand, Relief! advance, corporal!* upon which the corporal halts his men, and advances alone within a yard of the ſentry's firelock (firſt ordering his party to reſt, on which the ſentry does the ſame), and gives him the counter-ſign, taking care that no one hear it.

SEPIA, the CUTTLE-FISH, a genus of animals belonging to the claſs of vermes. See HELMINTHOLOGY *Index*.

The officinal cuttle affords the cuttle-bone of the ſhops, which was formerly uſed as an abſorbent. The bones are frequently flung on all our ſhores ; the animal very rarely. The conger eels, it is ſaid, bite off their arms, or feet : but it is added they grow again, as does the lizard's tail (Plin. ix. 29.). They are preyed upon by the plaiſe. This fiſh emits (in common with the other ſpecies), when alarmed or purſued, the black liquor which the ancients ſuppoſed darkened the circumambient wave, and concealed it from the enemy.

The endanger'd cuttle thus evades his fears,
And native hoards of fluid ſafety bears.
A pitchy ink peculiar glands ſupply,
Whoſe ſhades the ſharpeſt beam of light defy.
Purſu'd, he bids the ſable fountains flow,
And, wrapt in clouds, eludes th' impending foe.
The fiſh retreats unſeen, while ſelf-born night,
With pious ſhade befriends her parent's flight.

The ancients ſometimes made uſe of it inſtead of ink. Perſius mentions the ſpecies in his deſcription of the noble ſtudent.

Jam liber, et bicolor poſitis membrana capillis,
Inque manus chartæ, nodoſaque venit arundo.
Tum querimur, craſſus calamo quod pendeat humor ;
Nigra quod infuſa veneſcat ſepia *lympha.*
At length, his book he ſpreads, his pen he takes ;
His papers here in learned order lays,
And there his parchment's ſmoother ſide diſplays.
But oh ! what croſſes wait on ſtudious men !
The *cuttle's* juice hangs clotted at our pen.
In all my life ſuch ſtuff I never knew,
So gummy thick—Dilute it, it will do.
Nay, now 'tis water ! DRYDEN.

This animal was eſteemed a delicacy by the ancients, and is eaten even at preſent by the Italians. Rondeletius gives us two receipts for the dreſſing, which may be continued to this day. Athenæus alſo leaves us the method of making an antique cuttle fiſh ſauſage ; and we learn from Ariſtotle, that thoſe animals are in higheſt ſeaſon when pregnant.

SEPIARIÆ, (from *ſepes*, "a hedge"), the name of the 44th order of Linnæus's Fragments of a Natural Method, conſiſting of a beautiful collection of woody plants, ſome of which, from their ſize and elegance, are very proper furniture for hedges. See BOTANY *Index*.

SEPS, a ſpecies of LACERTA. See ERPETOLOGY *Index*.

SEPTARIÆ, in *Natural Hiſtory*, an old term for a variety of iron-ſtone, called alſo *ludus Helmontii*. This mineral is of a round compreſſed form, and is internally divided by ſepta or thin partitions of lime ſpar or pyrites ; hence the name.

SEPTAS, a genus of plants belonging to the claſs of *Heptandria ;* and in the natural ſyſtem ranged under the 13th order, *Succulentæ*. See BOTANY *Index*.

SEPTEMBER, the ninth month of the year, conſiſting of thirty days ; it took its name as being the ſeventh month, reckoning from March, with which the Romans began their year.

SEPTENNIAL, any thing laſting ſeven years.

SEPTENNIAL Elections. Blackſtone, in his Commentaries, vol. i. p. 189. ſays, (after obſerving that the utmoſt extent of time allowed the ſame parliament to ſit by the ſtat. 6. W. and M. c. 2. was three years). " But, by the ſtatute 1 Geo. I. ſt. 2. c. 38. (in order *profeſſedly* to prevent the great and continued expences of frequent elections, and the violent heats and animoſities conſequent thereupon, and for the peace and ſecurity of the government, juſt then recovering from the late rebellion), this term was prolonged to ſeven years ; and what alone is an inſtance of the vaſt authority of parliament, the very ſame houſe that was choſen for three years enacted its own continuance for ſeven."

SEPTENTRIO, in *Aſtronomy*, a conſtellation, more uſually called *urſa minor*.

In coſmography, the term *ſeptentrio* denotes the ſame with *north :* and hence ſeptentrional is applied to any thing belonging to the north : as *ſeptentrional ſigns, parallels*, &c.

SEPTICS, are thoſe ſubſtances which promote putrefaction, chiefly the calcareous earths, magneſia, and teſtaceous powders. From the many curious experiments made by Sir John Pringle to aſcertain the *ſeptic* and *antiſeptic* virtues of natural bodies, it appears that there are very few ſubſtances of a truly *ſeptic* nature. Thoſe commonly reputed ſuch by authors, as the alkaline and volatile ſalts, he found to be no wiſe *ſeptic*. However, he diſcovered ſome, where it ſeemed leaſt likely to find any ſuch quality ; theſe were chalk, common ſalt, and teſtaceous powders. He mixed twenty grains of crabs eyes, prepared with ſix drams of ox's gall, and an equal quantity of water. Into another phial he put an equal quantity of gall and water, but no crabs-eyes. Both theſe mixtures being placed in the furnace, the putrefaction began much ſooner, where the powder was, than in the other phial. On making a like experiment with chalk, its *ſeptic* virtue was found to be much greater than that of the crabs-eyes : nay, what the doctor never met with before, in a mixture of two drams of fleſh, with two ounces of water and thirty grains of prepared chalk, the fleſh was reſolved into a perfect mucus in a few days.

To try whether the teſtaceous powders would alſo diſſolve vegetable ſubſtances, the doctor mixed them with barley and water, and compared this mixture with another of barley and water alone. After a long maceration

ceration by a fire, the plain water was found to ſwell the barley, and turn mucilaginous and ſour; but that with the powder kept the grain to its natural ſize, and though it ſoftened it, yet made no mucilage, and remained ſweet.

Nothing could be more unexpected, than to find ſea ſalt a haſtener of putrefaction; but the fact is thus; one dram of ſalt preſerves two drams of freſh beef in two ounces of water, above thirty hours, uncorrupted, in a heat equal to that of the human body; or, which is the ſame thing, this quantity of ſalt keeps fleſh ſweet twenty hours longer than pure water; but then half a dram of ſalt does not preſerve it above two hours longer. Twenty-five grains have little or no antiſeptic virtue, and ten, fifteen, or even twenty grains, manifeſtly both haſten and heighten the corruption. The quantity which had the moſt putrefying quality, was found to be about ten grains to the above proportion of fleſh and water.

Some inferences have been drawn from this experiment: one is, that ſince ſalt is never taken in aliment beyond the proportion of the corrupting quantities, it would appear that it is ſubſervient to digeſtion chiefly by its *ſeptic* virtue, that is, by ſoftening and reſolving meats; but in making this inference, the powers of the digeſtive organs in modifying chemical action are not taken into account.

It is to be obſerved, that the above experiments were made with the ſalt kept for domeſtic uſes. See Pringle's Obſerv. on the Diſeaſes of the Army.

SEPTIZON, or **SEPTIZONIUM**, in Roman antiquity, a celebrated mauſoleum, built by Septimius Severus, in the tenth region of the city of Rome: it was ſo called from *ſeptem* and *zona*, by reaſon it conſiſted of ſeven ſtories, each of which was ſurrounded by a row of columns.

SEPTUAGESIMA, in the kalendar, denotes the third Sunday before Lent, or before Quadrageſima Sunday: ſuppoſed by ſome to take its name from its being about ſeventy days before Eaſter.

SEPTUAGINT, the name given to a Greek verſion of the books of the Old Teſtament, from its being ſuppoſed to be the work of ſeventy Jews, who are uſually called the *ſeventy interpreters*, becauſe ſeventy is a round number.

The hiſtory of this verſion is expreſsly written by Ariſtæas, an officer of the guards to Ptolemy Philadelphus, the ſubſtance of whoſe account is as follows:—Ptolemy having erected a fine library at Alexandria, which he took care to fill with the moſt curious and valuable books from all parts of the world, was informed that the Jews had one containing the laws of Moſes, and the hiſtory of that people; and being deſirous of enriching his library with a Greek tranſlation of it, applied to the high-prieſt of the Jews; and to engage him to comply with his requeſt, ſet at liberty all the Jews whom his father Ptolemy Soter had reduced to ſlavery. After ſuch a ſtep, he eaſily obtained what he deſired; Eleazar the Jewiſh high-prieſt ſent back his ambaſſadors with an exact copy of the Moſaical law, written in letters of gold, and ſix elders of each tribe, in all ſeventy-two; who were received with marks of reſpect by the king, and then conducted into the iſle of Pharos, where they were lodged in a houſe prepared for their reception, and ſupplied with every thing neceſſary. They ſet about the tranſlation without loſs of time, and finiſhed it in ſeventy-two days; and the whole being read in the preſence of the king, he admired the profound wiſdom of the laws of Moſes: and ſent back the deputies laden with preſents, for themſelves, the high-prieſt, and the temple.

Ariſtobulus, who was tutor to Ptolemy Phyſcon, Philo who lived in our Saviour's time, and was contemporary with the apoſtles, and Joſephus, ſpeak of this tranſlation as made by ſeventy-two interpreters, by the care of Demetrius Phalereus in the reign of Ptolemy Philadelphus. All the Chriſtian writers, during the firſt 15 centuries of the Chriſtian era, have admitted this account of the Septuagint as an undoubted fact. But ſince the reformation, critics have boldly called it in queſtion, becauſe it was attended with circumſtances which they think inconſiſtent, or, at leaſt, improbable. Du Pin has aſked, why were ſeventy-two interpreters employed, ſince twelve would have been ſufficient? Such an objection is trifling. We may as well aſk, why did King James I. employ fifty-four tranſlators in rendering the Bible into Engliſh, ſince Du Pin thinks twelve would have been ſufficient?

1. Prideaux objects, that the Septuagint is not written in the Jewiſh, but in the Alexandrian, dialect; and could not therefore be the work of natives of Paleſtine. But theſe dialects were probably at that time the ſame, for both Jews and Alexandrians had received the Greek language from the Macedonians about 50 years before.

2. Prideaux farther contends, that all the books of the Old Teſtament could not be tranſlated at the ſame time; for they exhibit great difference of ſtyle. To this it is ſufficient to reply, that they were the work of ſeventy-two men, each of whom had ſeparate portions aſſigned them.

3. The Dean alſo urges, that Ariſtæas, Ariſtobulus, Philo, and Joſephus, all directly tell us, that the law was tranſlated, without mentioning any of the other ſacred books. But nothing was more common among writers of the Jewiſh nation than to give this name to the Scriptures as a whole. In the New Teſtament, law is uſed as ſynonymous with what we call the Old Teſtament. Beſides, it is expreſsly ſaid by Ariſtobulus, in a fragment quoted by Euſebius (*Præp. Evan.* l. 1.), that the whole Sacred Scripture was rightly tranſlated through the means of Demetrius Phalereus, and by the command of Philadelphus. Joſephus indeed, ſays the learned Dean, aſſerts, in the preface to his Antiquities, that the Jewiſh interpreters did not tranſlate for Ptolemy the whole Scriptures, but the law only. Here the evidence is contradictory, and we have to determine, whether Ariſtobulus or Joſephus be moſt worthy of credit. We do not mean, however, to accuſe either of forgery, but only to inquire which had the beſt opportunities of knowing the truth. Ariſtobulus was an Alexandrian Jew, tutor to an Egyptian king, and lived within 100 years after the tranſlation was made, and certainly had acceſs to ſee it in the royal library. Joſephus was a native of Paleſtine, and lived not until 300 years or more after the tranſlation was made, and many years after it was burnt along with the whole library of Alexandria in the wars of Julius Cæſar. Suppoſing the veracity of theſe two writers equal, as we have no proof of the contrary, which of them ought we to conſider as the beſt evidence? Ari-

ſtobulus ſurely. Prideaux, indeed, ſeems doubtful whether there was ever ſuch a man; and Dr Hody ſuppoſes that the Commentaries on the five books of Moſes, which bear the name of Ariſtobulus, were a forgery of the ſecond century. To prove the exiſtence of any human being, who lived 2000 years before us, and did not perform ſuch works as no mere man ever performed, is a taſk which we are not diſpoſed to undertake; and we believe it would not be leſs difficult to prove that Philo and Joſephus exiſted, than that ſuch a perſon as Ariſtobulus did not exiſt. If the writings which have paſſed under his name were a forgery of the ſecond century, it is ſurpriſing that they ſhould have impoſed upon Clemens Alexandrinus, who lived in the ſame century, and was a man of abilities, learning, and well acquainted with the writings of the ancients. Euſebius, too, in his *Præp. Evan.* quotes the Commentaries of Ariſtobulus. But, continues the learned Dean, "Clemens Alexandrinus is the firſt author that mentions them. Now, had any ſuch commentaries exiſted in the time of Philo and Joſephus, they would ſurely have mentioned them. But is the circumſtance of its not being quoted by every ſucceeding author a ſufficient reaſon to diſprove the authenticity of any book? Neither Philo nor Joſephus undertook to give a liſt of preceding authors, and it was by no means the uniform practice of theſe times always to name the authors from whom they derived their information."

4. Prideaux farther contends, that the ſum which Ptolemy is ſaid to have given to the interpreters is too great to be credible. If his computation were juſt, it certainly would be ſo. He makes it 2,000,000l. ſterling, but other writers* reduce it to 85,421l. and ſome to 56,947l.; neither of which is a ſum ſo very extraordinary in ſo great and magnificent a prince as Philadelphus, who ſpent, according to a paſſage in Athenæus (lib. v.) not leſs than 10,000 talents on the furniture of one tent; which is ſix times more than what was ſpent in the whole of the embaſſy and tranſlation, which amounted only to 1552 talents.

Stillingfleet's Origines Sacræ.

5. Prideaux ſays, "that what convicts the whole ſtory of Ariſtæas of falſity is, that he makes Demetrius Phalereus to be the chief actor in it, and a great favourite of the king; whereas Philadelphus, as ſoon as his father was dead, caſt him into priſon, where he ſoon after died." But it may be replied, that Philadelphus reigned two years jointly with his father Lagus, and it is not ſaid by Hermippus that Demetrius was out of favour with Philadelphus during his father's life. Now, if the Septuagint was tranſlated in the beginning of the reign of Philadelphus, as Euſebius and Jerome think, the difficulty will be removed. Demetrius might have been librarian during the reign of Philadelphus, and yet impriſoned on the death of Lagus. Indeed, as the cauſe of Philadelphus's diſpleaſure was the advice which Demetrius gave to his father, to prefer the ſons of Arſinoë before the ſon of Bernice, he could ſcarcely ſhow it till his father's death. The Septuagint tranſlation might therefore be begun while Philadelphus reigned jointly with his father, but not be finiſhed till after his father's death.

Prideaux's Connections, vol. iii b. 1.

6. Beſides the objections which have been conſidered, there is only one that deſerves notice. The ancient Chriſtians not only differ from one another concerning the time in which Ariſtobulus lived, but even contradict themſelves in different parts of their works. Sometimes they tell us, he dedicated his book to Ptolemy Philometer, at other times they ſay, it was addreſſed to Philadelphus and his father. Sometimes they make him the ſame perſon who is mentioned in 2 Maccabees, chap. 1. and ſometimes one of the 72 interpreters 152 years before. It is difficult to explain how authors fall into ſuch inconſiſtencies, but it is probably occaſioned by their quoting from memory. This was certainly the practice of almoſt all the early Chriſtian writers, and ſometimes of the apoſtles themſelves. Miſtakes were therefore inevitable. Joſephus has varied in the circumſtances of the ſame event, in his antiquities and wars of the Jews, probably from the ſame cauſe; but we do not hence conclude, that every circumſtance of ſuch a relation is entirely falſe. In the account of the Marquis of Argyle's death in the reign of Charles II. we have a very remarkable contradiction. Lord Clarendon relates, that he was condemned to be hanged, which was performed the ſame day: on the contrary, Burnet, Woodrow, Heath, Echard, concur in ſtating, that he was beheaded; and that he was condemned upon the Saturday and executed upon the Monday*. Was any reader of Engliſh hiſtory ever ſceptic enough to raiſe from hence a queſtion, whether the Marquis of Argyle was executed or not? Yet this ought to be left in uncertainty according to the way of reaſoning in which the facts reſpecting the tranſlation of the Septuagint are attempted to be diſproved.

Such are the objections which the learned and ingenious Prideaux has raiſed againſt the common account of the Septuagint tranſlation, and ſuch are the anſwers which may be given to them. We have choſen to ſupport that opinion which is ſanctioned by hiſtorical evidence, in preference to the conjectures of modern critics, however ingenious; being perſuaded, that there are many things recorded in hiſtory, which, though perfectly true, yet, from our imperfect knowledge of the concomitant circumſtances, may, at a diſtant period, ſeem liable to objections. To thoſe who require poſitive evidence, it may be ſtated thus. Ariſtæas, Ariſtobulus, Philo, and Joſephus, aſſure us, that the law was tranſlated. Taking the law in the moſt reſtricted ſenſe, we have at leaſt ſufficient authority to aſſert, that the Pentateuch was rendered into Greek under Ptolemy Philadelphus. Ariſtobulus affirms, that the whole Scriptures were tranſlated by the ſeventy-two. Joſephus confines their labours to the books of Moſes. He therefore who cannot determine to which of the two the greateſt reſpect is due, may ſuſpend his opinion. It is certain, however, that many of the other books were tranſlated before the age of our Saviour; for they are quoted both by him and his apoſtles: and, perhaps, by a minute examination of ancient authors, in the ſame way that Dr Lardner has examined the Chriſtian fathers to prove the antiquity of the New Teſtament, the preciſe period in which the whole books of the Septuagint were compoſed might, with conſiderable accuracy, be aſcertained.

For 400 years this tranſlation was in high eſtimation with the Jews. It was read in their ſynagogues in preference to the Hebrew; not only in thoſe places where Greek was the common language, but in many ſynagogues of Jeruſalem and Judea. But when they ſaw that it was equally valued by the Chriſtians, they became

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* *Blair's Lectures on the Canon.*

* *Biograph. Britan.*

came jealous of it, and at length, in the ſecond century, Aquila, an apoſtate Chriſtian, attempted to ſubſtitute another Greek tranſlation in its place. In this work he was careful to give the ancient prophecies concerning the Meſſiah a different turn from the Septuagint, that they might not be applicable to Chriſt. In the ſame deſign he was followed by Symmachus and Theodotion, who alſo, as St Jerome informs us, wrote out of hatred to Chriſtianity.

In the mean time, the Septuagint, from the ignorance, boldneſs, and careleſſneſs of tranſcribers, became full of errors. To correct theſe, Origen publiſhed a new edition in the beginning of the third century, in which he placed the tranſlations of Aquila, Symmachus, and Theodotion. This edition was called *Tetrapla*, the tranſlations being arranged oppoſite to one another in four columns. He alſo added one column, containing the Hebrew text in Hebrew letters, and another exhibiting it in Greek. In a ſecond edition he publiſhed two additional Greek verſions; one of which was found at Nicopolis, and the other at Jericho; this was called the *Hexapla*. By comparing ſo many tranſlations, Origen endeavoured to form a correct copy of the Scriptures. Where they all agreed, he conſidered them right. The paſſages which he found in the LXX, but not in the Hebrew text, he marked with an obeliſk: what he found in the Hebrew, but not in the LXX, he marked with an aſteriſk. St Jerome ſays, that the additions which Origen made to the LXX, and marked with an aſteriſk, were taken from Theodotion. From this valuable work of Origen the verſion of the LXX was tranſcribed in a ſeparate volume, with the aſteriſks and obeliſks for the uſe of the churches; and from this circumſtance the great work itſelf was neglected and loſt.

About the year 300 two new editions of the LXX were publiſhed; the one by Heſychius an Egyptian biſhop, and the other by Lucian a preſbyter of Antioch. But as theſe authors did not mark with any note of diſtinction the alterations which they had made, their edition does not poſſeſs the advantages of Origen's.

The beſt edition of the LXX is that of Dr Grabe, which was publiſhed in the beginning of the preſent century. He had acceſs to two MSS. nearly of equal antiquity, the one found in the Vatican library at Rome, the other in the royal library at St James's, which was preſented to Charles I. by Cyril, patriarch of Alexandria, and hence is commonly called the *Alexandrian MS.* Anxious to diſcover which of theſe was according to the edition of Origen, Dr Grabe collected the fragments of the Hexapla, and found they agreed with the Alexandrian MS. but not with the Vatican where it differed with the other. Hence he concluded that the Alexandrian MS. was taken from the edition of Origen. By comparing the quotations from ſcripture in the works of Athanaſius and St Cyril (who were patriarchs of Alexandria at the time St Jerome ſays Heſychius's edition of the LXX was there uſed) with the Vatican MS. he found they agreed ſo well that he juſtly inferred that that MS. was taken from the edition of Heſychius.

This verſion was in uſe to the time of our bleſſed Saviour, and is that out of which moſt of the citations in the New Teſtament, from the Old, are taken. It was alſo the ordinary and canonical tranſlation made uſe of by the Chriſtian church in the earlieſt ages; and it ſtill ſubſiſts in the churches both of the eaſt and weſt.

Thoſe who deſire a more particular account of the Septuagint tranſlation may conſult Hody *de Bibliorum Textibus*, Prideaux's Connections, Owen's Inquiry into the Septuagint Verſion, Blair's Lectures on the Canon, and Michaelis's Introduction to the New Teſtament, laſt edition.

SEPTUAGINT Chronology, the chronology which is formed from the dates and periods of time mentioned in the Septuagint tranſlation of the Old Teſtament. It reckons 1500 years more from the creation to Abraham than the Hebrew bible. Dr Kennicot, in the diſſertation prefixed to his Hebrew bible, has ſhown it to be very probable that the chronology of the Hebrew ſcriptures, ſince the period juſt mentioned, was corrupted by the Jews, between the years 175 and 200, and that the chronology of the Septuagint is more agreeable to truth. It is a fact, that during the ſecond and third centuries the Hebrew ſcriptures were almoſt entirely in the hands of the Jews, while the Septuagint was confined to the Chriſtians. The Jews had therefore a very favourable opportunity for this corruption. The following is the reaſon which is given by oriental writers: It being a very ancient tradition, that the Meſſiah was to come in the ſixth chiliad, becauſe he was to come in the laſt days (founded on a myſtical application of the ſix days creation), the contrivance was *to ſhorten the age of the world from about 5500 to 3760; and thence to prove that Jeſus could not be the Meſſiah.* Dr Kennicot adds, that ſome Hebrew copies having the larger chronology were extant till the time of Euſebius, and ſome till the year 700.

SEPTUM, in *Anatomy*, an incloſure or partition; a term applied to ſeveral parts of the body, which ſerve to ſeparate one part from another; as, *ſeptum narium*, or partition between the noſtrils, &c.

SEPULCHRAL, ſomething belonging to ſepulchres or tombs: thus a ſepulchral column is a column erected over a tomb, with an inſcription on its ſhaft; and ſepulchral lamps, thoſe ſaid to have been found burning in the tombs of ſeveral martyrs and others. See LAMP.

SEPULCHRE, a tomb or place deſtined for the interment of the dead. This term is chiefly uſed in ſpeaking of the burying-places of the ancients, thoſe of the moderns being uſually called *tombs*.

Sepulchres were held ſacred and inviolable; and the care taken of them has always been held a religious duty, grounded on the fear of God, and the belief of the ſoul's immortality. Thoſe who have ſearched or violated them have been thought odious by all nations, and were always ſeverely puniſhed.

The Egyptians called ſepulchres *eternal houſes*, in contradiſtinction to their ordinary houſes or palaces, which they called *inns*, on account of the ſhort ſtay in the one in compariſon of their long abode in the other. See TOMB.

Regular Canons of St SEPULCHRE, a religious order, formerly inſtituted at Jeruſalem, in honour of the holy ſepulchre, or the tomb of Jeſus Chriſt.

Many of theſe canons were brought from the Holy Land into Europe, particularly into France, by Louis the Younger; into Poland, by Jaxa, a Poliſh gentleman; and into Flanders, by the counts thereof; many alſo came into England. This order, was, however, ſuppreſſed by Pope Innocent VIII. who gave its revenues and effects to that of our Lady of Bethlehem: which alſo becoming extinct, they were beſtowed on the knights of St John of Jeruſalem. But the ſuppreſſion did not take effect in Poland, where they ſtill ſubſiſt, as alſo in ſeveral provinces of Germany. Theſe canons follow the rule of St Auguſtine.

Knights of the Holy SEPULCHRE, a military order, eſtabliſhed in Paleſtine about the year 1114.

The knights of this order in Flanders choſe Philip II. king of Spain, for their maſter, in 1558, and afterwards his ſon; but the grand-maſter of the order of Malta prevailed on the laſt to reſign; and when afterwards the duke of Nevers aſſumed the ſame quality in France, the ſame grand-maſter, by his intereſt and credit, procured a like renunciation of him, and a confirmation of the union of this order to that of Malta.

SEQUANI, a people anciently forming a part of Gallia Celtica, but annexed to Belgica by Auguſtus, ſeparated from the Helvetii by Mount Jura, with the Rhine on the eaſt (Strabo), bordering on the Ædui and Seguſtiani to the ſouth, and Lingones to the weſt (Tacitus). Now Franche Compte.

SEQUESTRATION, in *Common Law*, is ſetting aſide the thing in controverſy from the poſſeſſion of both the parties that contend for it. In which ſenſe its is either voluntary, as when done by the conſent of the parties; or neceſſary, as where it is done by the judge, of his own authority, whether the parties will or not.

SEQUESTRATION, in the *Civil Law*, is the act of the ordinary, diſpoſing of the goods and chattels of one deceaſed, whoſe eſtate no man will meddle with.

A widow is alſo ſaid to ſequeſter, when ſhe diſclaims having any thing to do with the eſtate of her deceaſed huſband.

Among the Romaniſts, in queſtions of marriage, where the wife complains of impotency in the huſband, ſhe is to be ſequeſtered into a convent, or into the hands of matrons, till the proceſs be determined.

SEQUESTRATION is alſo uſed for the act of gathering the fruits of a benefice void, to the uſe of the next incumbent.

Sometimes a benefice is kept under ſequeſtration for many years, when it is of ſo ſmall value, that no clergyman fit to ſerve the cure will be at the charge of taking it by inſtitution; in which caſe the ſequeſtration is committed either to the curate alone, or to the curate and church-wardens jointly. Sometimes the profits of a living in controverſy, either by the conſent of the parties, or the judge's authority, are ſequeſtered and placed for ſafety in a third hand, till the ſuit is determined, a miniſter being appointed by the judge to ſerve the cure, and allowed a certain ſalary out of the profits. Sometimes the profits of a living are ſequeſtered for neglect of duty, for dilapidations, or for ſatisfying the debts of the incumbent.

SEQUESTRATION, in chancery, is a commiſſion uſually directed to ſeven perſons therein named, empowering them to ſeize the defendant's perſonal eſtate, and the profits of his real, and to detain them, ſubject to the order of the court. It iſſues on the return of the ſerjeant at arms, wherein it is certified, that the defendant had ſecreted himſelf.

Sequeſtrations were firſt introduced by Sir Nicholas Bacon, lord keeper in the reign of Queen Elizabeth; before which the court found ſome difficulty in enforcing its proceſs and decrees; and they do not ſeem to be in the nature of proceſs to bring in the defendant, but only intended to enforce the performance of the court's decree.

A ſequeſtration is alſo made, in London, upon an action of debt; the courſe of proceeding in which caſe is this: The action being entered, the officer goes to the defendant's ſhop or warehouſe, when no perſon is there, and takes a padlock, and hangs it on the door, uttering theſe words: "I do ſequeſter this warehouſe, and the goods and merchandiſe therein, of the defendant in this action, to the uſe of the plaintiff," &c. after which he ſets on his ſeal, and makes a return of the ſequeſtration in the compter; and four days being paſſed after the return made, the plaintiff may, at the next court, have judgment to open the ſhop or warehouſe, and to have the goods appraiſed by two freemen, who are to be ſworn at the next court held for that compter; and then the ſerjeant puts his hand to the bill of appraiſement, and the court grants judgment thereon; but yet the defendant may put in bail before ſatisfaction, and by that means diſſolve the ſequeſtration; and after ſatisfaction, may put in bail to diſprove the debt, &c.

In the time of the civil wars, ſequeſtration was uſed for a ſeizing of the eſtates of delinquents for the uſe of the commonwealth.

SEQUESTRATION, in *Scots Law*. See LAW *Index*.

SEQUIN, a gold coin, ſtruck at Venice, and in ſeveral parts of the Grand Signior's dominions. In Turkey, it is called *dahob*, or piece of gold, and according to Volney is in value about 6s. 3d. ſterling. It varies, however, conſiderably in its value in different countries. At Venice it is equal to about 9s. 2d. ſterling.

The Venetian ſequins are in great requeſt in Syria, from the fineneſs of their ſtandard, and the practice they have of employing them for women's trinkets. The faſhion of theſe trinkets does not require much art; the piece of gold is ſimply pierced, in order to ſuſpend it by a chain, likewiſe of gold, which flows upon the breaſt. The more ſequins that are attached to this chain, and the greater the number of theſe chains, the more is a woman thought to be ornamented. This is the favourite luxury, and the emulation of all ranks. Even the female peaſants, for want of gold, wear piaſtres or ſilver pieces; but the women of a certain rank diſdain ſilver; they will accept of nothing but ſequins of Venice, or large Spaniſh pieces, and cruſadoes. Some of them wear 260 or 300, as well lying flat, as ſtrung one on another, and hung near the forehead, at the edge of the head-dreſs. It is a real load: but they do not think they can pay too dearly for the ſatisfaction of exhibiting this treaſure at the public bath, before a crowd of rivals, to awaken whoſe jealouſy conſtitutes their chief pleaſure. The effect of this luxury on commerce, is the withdrawing conſiderable ſums from circulation, which remain dead; beſides, that when any of theſe pieces return into common uſe, having loſt their

their weight by being pierced, it becomes neceſſary to weigh them. The practice of weighing money is general in Syria, Egypt, and all Turkey. No piece, however effaced, is refuſed there; the merchant draws out his ſcales and weighs it, as in the days of Abraham, when he purchaſed his ſepulchre. In conſiderable payments, an agent of exchange is ſent for, who counts paras by thouſands, rejects a great many pieces of falſe money, and weighs all the ſequins, either ſeparately or together.

SERAGLIO, formed from the Perſian word *ſeraw*, or Turkiſh word *ſarai*, which ſignifies a houſe, and is commonly uſed to expreſs the houſe or palace of a prince. In this ſenſe it is frequently uſed at Conſtantinople; the houſes of foreign ambaſſadors are called *ſeraglios*. But it is commonly uſed by way of eminence for the palace of the grand ſignior at Conſtantinople, where he keeps his court, and where his concubines are lodged, and where the youth are trained up for the chief poſts of the empire.

It is a triangle about three Italian miles round, wholly within the city, at the end of the promontory Chryſoceras, now called the *Seraglio Point*. The buildings run back to the top of the hill, and from thence are gardens that reach to the edge of the ſea. It is incloſed with a very high and ſtrong wall, upon which there are ſeveral watch towers: and it has many gates, ſome of which open towards the ſea ſide, and the reſt into the city; but the chief gate is one of the latter, which is conſtantly guarded by a company of capoochees, or porters; and in the night it is well guarded towards the ſea. The outward appearance is not very beautiful, the architecture being irregular, conſiſting of ſeparate edifices in the form of pavilions and domes.

The ladies of the ſeraglio are a collection of beautiful young women, chiefly ſent as preſents from the provinces and the Greek iſlands, moſt of them the children of Chriſtian parents. The brave prince Heraclius hath for ſome years paſt aboliſhed the infamous tribute of children of both ſexes, which Georgia formerly paid every year to the Porte. The number of women in the harem depends on the taſte of the reigning monarch or ſultan. Selim had 2000, Achmet had but 300, and his ſucceſſor had nearly 1600. On their admiſſion they are committed to the care of old ladies, taught ſewing and embroidery, muſic, dancing, and other accompliſhments, and furniſhed with the richeſt clothes and ornaments. They all ſleep in ſeparate beds, and between every fifth there is a preceptreſs. Their chief governeſs is called *Katon Kiaga*, or governeſs of the noble young ladies. There is not one ſervant among them, for they are obliged to wait on one another, by rotation; the laſt that is entered ſerves her who preceded her and herſelf. Theſe ladies are ſcarcely ever ſuffered to go abroad, except when the grand ſignior removes from one place to another, when a troop of black eunuchs conveys them to the boats, which are incloſed with lattices and linen curtains; and when they go by land they are put into cloſe chariots, and ſignals are made at certain diſtances, to give notice that none approach the roads through which they march. The boats of the harem, which carry the grand ſignior's wives, are manned with 24 rowers, and have white covered tilts, ſhut alternately by Venetian blinds. Among the emperor's attendants are a number of mutes, who act and converſe by ſigns with great quickneſs, and ſome dwarfs, who are exhibited for the diverſion of his Majeſty.

When he permits the women to walk in the gardens of the ſeraglio, all people are ordered to retire, and on every ſide there is a guard of black eunuchs, with ſabres in their hands, while others go their rounds in order to hinder any perſon from ſeeing them. If, unfortunately, any one is found in the garden, even through ignorance or inadvertence, he is undoubtedly killed, and his head brought to the feet of the grand ſignior, who gives a great reward to the guard for their vigilance. Sometimes the grand ſignior paſſes into the gardens to amuſe himſelf when the women are there; and it is then that they make uſe of their utmoſt efforts, by dancing, ſinging, ſeducing geſtures, and amorous blandiſhments, to enſnare the affections of the monarch. It is not permitted that the monarch ſhould take a virgin to his bed, except during the ſolemn feſtivals, and on occaſion of ſome extraordinary rejoicings, or the arrival of ſome good news. Upon ſuch occaſions, if the ſultan chooſe a new companion to his bed, he enters into the apartment of the women, who are ranged in files by the governeſſes, to whom he ſpeaks, and intimates the perſon he likes beſt; the ceremony of the handkerchief which the grand ſignior is ſaid to throw to the girl that he elects, is an idle tale, without any foundation. As ſoon as the grand ſignior has choſen the girl that he has deſtined to be the partner of his bed, all the others follow her to the bath, waſhing and perfuming her, and dreſſing her ſuperbly, conducting her ſinging, dancing, and rejoicing, to the bed chamber of the grand ſignior, who is generally, on ſuch an occaſion, already in bed. Scarcely has the new-elected favourite entered the chamber, introduced by the grand eunuch who is upon guard, than ſhe kneels down, and when the ſultan calls her, ſhe creeps into bed to him by the foot of the bed, if the ſultan does not order her, by eſpecial grace, to approach by the ſide: after a certain time, upon a ſignal given by the ſultan, the governeſs of the girls, with all her ſuite, enters the apartment, and takes her back again, conducting her with the ſame ceremony to the women's apartments; and if by good fortune ſhe becomes pregnant, and is delivered of a boy, ſhe is called *aſaki ſultaneſs*, that is to ſay, ſultaneſs mother; for the firſt ſon ſhe has the honour to be crowned, and ſhe has the liberty of forming her court. Eunuchs are alſo aſſigned for her guard, and for her particular ſervice. No other ladies, though delivered of boys, are either crowned or maintained with ſuch coſtly diſtinction as the firſt; however, they have their ſervice apart, and handſome appointments. After the death of the ſultan, the mothers of the male children are ſhut up in the old ſeraglio, from whence they can never come out any more, unleſs any of their ſons aſcend the throne. Baron de Tott informs us, that the female ſlave who becomes the mother of a ſultan, and lives long enough to ſee her ſon mount the throne, is the only woman who at that period alone acquires the diſtinction of *ſultana-mother*; ſhe is till then in the interior of her priſon with her ſon. The title of *bache kadun*, principal woman, is the firſt dignity of the grand ſignior's harem; and ſhe has a larger

allowance

allowance than thoſe who have the title of ſecond, third, and fourth woman, which are the four free women the Koran allows.

This is a deſcription of the grand ſignior's ſeraglio : we ſhall now add an account of the ſeraglio or *harem*, as it is often called, of the emperor of Morocco, from the very intereſting tour of Mr Lempriere. This gentleman being a ſurgeon by profeſſion, was admitted into the harem to preſcribe for ſome of the ladies who were indiſpoſed, and was therefore enabled to give a particular account of this female priſon, and, what is ſtill more curious, of the manners and behaviour of its inhabitants.

The harem forms a part of the palace. The apartments, which are all on the ground floor, are ſquare, very lofty, and four of them incloſe a ſpacious ſquare court, into which they open by means of large folding doors. In the centre of theſe courts, which are floored with blue and white chequered tiling, is a fountain, ſupplied by pipes from a large reſervoir on the outſide of the palace, which ſerves for the frequent ablutions recommended by the Mahometan religion, as well as for other purpoſes. The whole of the harem conſiſts of about twelve of theſe ſquare courts, communicating with each other by narrow paſſages, which afford a free acceſs from one part of it to another, and of which all the women are allowed to avail themſelves.

The apartments are ornamented on the outſide with beautiful carved wood. In the inſide moſt of the rooms are hung with rich damaſk of various colours ; the floors are covered with beautiful carpets, and there are matreſſes diſpoſed at different diſtances, for the purpoſe of ſitting and ſleeping.

Beſides theſe, the apartments are furniſhed at each extremity with an elegant European mahogany bedſtead, hung with damaſk, having on it ſeveral mattreſſes placed one over the other, which are covered with various coloured ſilks ; but theſe beds are merely placed there to ornament the room. In all the apartments, without exception, the ceiling is wood, carved and painted. The principal ornaments in ſome were large and valuable looking-glaſſes, hung on different parts of the walls. In others, clocks and watches of different ſizes, in glaſs caſes, were diſpoſed in the ſame manner.

The ſultana Lalla Batoom and another favourite were indulged with a whole ſquare to themſelves ; but the concubines were only each allowed a ſingle room.

Each female had a ſeparate daily allowance from the emperor, proportioned to the eſtimation in which they were held by him. The late emperor's allowance was very trifling : Lalla Douyaw, the favourite ſultana, had very little more than half-a-crown Engliſh a-day, and the others leſs in proportion. It muſt be allowed, that the emperor made them occaſional preſents of money, dreſs, and trinkets ; but this could never be ſufficient to ſupport the number of domeſtics and other expences they muſt incur. Their greateſt dependence therefore was on the preſents they received from thoſe Europeans and Moors who viſited the court, and who employed their influence in obtaining ſome particular favour from the emperor. This was the moſt ſucceſsful mode that could be adopted. When Mr Lempriere was at Morocco, a Jew, deſirous of obtaining a very advantageous favour from the emperor, for which he had been a long time unſucceſsfully ſoliciting, ſent to all the principal ladies of the harem preſents of pearls to a very large amount ; the conſequence was, that they all went in a body to the emperor, and immediately obtained the wiſhed-for conceſſion.

The ladies ſeparately furniſh their own rooms, hire their own domeſtics, and, in fact, do what they pleaſe in the harem, but are not permitted to go out without an expreſs order from the emperor, who very ſeldom grants them that favour, except when they are to be removed from one palace to another. In that caſe, a party of ſoldiers is diſpatched a little diſtance before them, to diſperſe the male paſſengers in particular, and to prevent the poſſibility of their being ſeen. This previous ſtep being taken, a piece of linen cloth is tied round the lower part of the face, and afterwards theſe miſerable females cover themſelves entirely with their haicks, and either mount mules, which they ride like men, or what is more uſual, are put into a ſquare carriage or litter, conſtructed for this purpoſe, which by its lattice-work allows them to ſee without being ſeen. In this manner they ſet off, under the charge of a guard of black eunuchs. This journey, and ſometimes a walk within the bounds of the palace, with which they are, however, ſeldom indulged, is the only exerciſe they are permitted to take.

The late emperor's harem conſiſted of between 60 and 100 females, beſides their domeſtics and ſlaves, which were very numerous. Many of the concubines were Mooriſh women, who had been preſented to the emperor, as the Moors conſider it an honour to have their daughters in the harem ; ſeveral were European ſlaves, who had either been made captives, or purchaſed by the emperor ; and ſome were Negroes.

In this group the Europeans, or their deſcendants, had by far the greateſt claim to the character of handſome. There was one in particular, who was a native of Spain, and taken into the harem at about the ſame age as Lalla Douyaw, who was indeed a perfect beauty. Nor was this lady quite ſingular in that reſpect, for many others were almoſt equally handſome.

The eunuchs, who have the entire charge of the women, and who in fact live always among them, are the children of Negro ſlaves. They are generally either very ſhort and fat, or elſe tall, deformed, and lame. Their voices have that particular tone which is obſervable in youths who are juſt arriving at manhood ; and their perſons altogether afford a diſguſting image of weakneſs and effeminacy.

The ſame gentleman gives us a very curious account of the manners and ignorance of theſe immured females, from his own obſervation, when viſiting the prince's harem. " Attended by an eunuch (ſays he), after paſſing the gate of the harem, which is always locked, and under the care of a guard of eunuchs, we entered a narrow and dark paſſage, which ſoon brought us to the court, into which the women's chambers open. We here ſaw numbers of both black and white women and children ; ſome concubines, ſome ſlaves, and others hired domeſtics.

" Upon their obſerving the unuſual figure of an European, the whole multitude in a body ſurrounded me, and expreſſed the utmoſt aſtoniſhment at my dreſs and appearance. Some ſtood motionleſs, with their hands lifted up, their eyes fixed, and their mouths open, in the

the uſual attitude of wonder and ſurpriſe. Some burſt into immoderate fits of laughter; while others again came up, and with uncommon attention eyed me from head to foot. The parts of my dreſs which ſeemed moſt to attract their notice were my buckles, buttons, and ſtockings; for neither men nor women in this country wear any thing of the kind. With reſpect to the club of my hair, they ſeemed utterly at a loſs in what view to conſider it; but the powder which I wore they conceived to be employed for the purpoſe of deſtroying vermin. Moſt of the children, when they ſaw me, ran away in the moſt perfect conſternation; and on the whole, I appeared as ſingular an animal, and I dare ſay had the honour of exciting as much curioſity and attention, as a lion or man-tiger juſt imported from abroad, and introduced into a country town in England on a market-day. Every time I viſited the harem, I was ſurrounded and laughed at by this curious mob, who, on my entering the gate, followed me cloſe to the very chamber to which I was proceeding, and on my return univerſally eſcorted me out.

"The greateſt part of the women were uncommonly fat and unwieldy; had black and full eyes, round faces, with ſmall noſes. They were of different complexions; ſome very fair, ſome ſallow, and others again perfect Negroes.

"One of my new patients being ready to receive me, I was deſired to walk into her room; where, to my great ſurpriſe, I ſaw nothing but a curtain drawn quite acroſs the apartment, ſimilar to that of a theatre which ſeparates the ſtage from the audience. A female domeſtic brought a very low ſtool, placed it near the curtain, and told me I was to ſit down there, and feel her miſtreſs's pulſe.

"The lady, who had by this time ſummoned up courage to ſpeak, introduced her hand from the bottom of the curtain, and deſired me to inform her of all her complaints, which ſhe conceived I might perfectly do by merely feeling the pulſe. It was in vain to aſk her where her pain was ſeated, whether in her ſtomach, head, or back; the only anſwer I could procure was a requeſt to feel the pulſe of the other hand, and then point out the ſeat of the diſeaſe, and the nature of the pain.

"Having neither ſatisfied my curioſity by exhibiting her face, nor made me acquainted with the nature of her complaint, I was under the neceſſity of informing her in poſitive terms, that to underſtand the diſeaſe it was abſolutely neceſſary to ſee the tongue as well as to feel the pulſe; and that without it I could do nothing for her. My eloquence, or rather that of my Jewiſh interpreter, was, however, for a long time exerted in vain; and I am perſuaded ſhe would have diſmiſſed me without any further inquiry, had not her invention ſupplied her with a happy expedient to remove her embarraſſment. She contrived at laſt to cut a hole through the curtain, through which ſhe extruded her tongue, and thus complied with my injunction as far as it was neceſſary in a medical view, but moſt effectually diſappointed my curioſity.

"I was afterwards ordered to look at another of the prince's wives, who was affected with a ſcrophulous ſwelling in her neck. This lady was, in the ſame manner as the other, at firſt excluded from my ſight; but as ſhe was obliged to ſhow me her complaint, I had an opportunity of ſeeing her face, and obſerved it to be very handſome."

It is curious to obſerve the ſtrange and childiſh notions of perſons who have been wholly ſecluded from the world. All the ladies of the harem expected that our author ſhould have inſtantly diſcovered their complaints upon feeling the pulſe, and that he could cure every diſeaſe inſtantaneouſly. He found them proud and vain of their perſons, and extremely ignorant. "Among many ridiculous queſtions, they aſked my interpreter (ſays Mr Lempriere) if I could read and write; upon being anſwered in the affirmative, they expreſſed the utmoſt ſurpriſe and admiration at the abilities of the Chriſtians. There was not one among them who could do either; theſe rudiments of learning are indeed only the lot of a few of their men, who on that account are named *Talbs*, or explainers of the Mahometan law."

It is melancholy to reflect on the ſituation of theſe unfortunate women. Being conſidered as the mere inſtruments of pleaſure, no attention is paid to the improvement of their minds. They have no employment to occupy their time. Their needle-work is performed by Jeweſſes; their food is dreſſed, and their chambers taken care of, by ſlaves and domeſtics. They have no amuſement but a rude and barbarous kind of melancholy muſic, without melody, variety, or taſte; and converſation with one another, which muſt indeed be very confined, uniform, and inanimate, as they never ſee a new object. Excluded from the enjoyment of freſh air and exerciſe, ſo neceſſary for the ſupport of health and life; deprived of all ſociety but that of their fellow-ſufferers, a ſociety to which moſt of them would prefer ſolitude itſelf; they are only to be conſidered as the moſt abject of ſlaves—ſlaves to the vices and caprice of a licentious tyrant, who exacts even from his wives themſelves a degree of ſubmiſſion and reſpect which borders upon idolatry, and which God and nature never meant ſhould be paid to a mortal.

SERAI, a building on the high road, or in large cities in India, erected for the accommodation of travellers.

SERAPH, or SERAPHIM, ſpirits of the higheſt rank in the hierarchy of angels; who are thus called from their being ſuppoſed to be moſt inflamed with divine love, by their nearer and more immediate attendance at the throne of God, and to communicate their fervour to the remoter and inferior orders. Seraphim is the Hebrew plural of ſeraph. See ANGEL.

SERAPHIC, burning or inflamed with love or zeal, like a ſeraph: thus St Bonaventure is called the *ſeraphic doctor*, from his abundant zeal and fervour.

SERAPIAS, a genus of plants belonging to the claſs of gynandria; and in the natural ſyſtem arranged under the ſeventh order, *Orchideæ*. See BOTANY *Index*.

SERAPION, a phyſician of Alexandria. He and Philinus of the iſle of Cos, were both ſcholars of Herophilus, and were founders of the empiric ſect; which happened about 287 B. C.

SERAPIS, in *Mythology*, an Egyptian deity, who was worſhipped under various names and attributes, as the tutelary god of Egypt in general, and as the patron of ſeveral of their principal cities. Tacitus informs us, that he was worſhipped as a kind of univerſal deity that repreſented Eſculapius, Oſiris, Jupiter, and Pluto; and he he was ſometimes taken for Jupiter Ammon, the Sun, and Neptune: and the honours that were rendered to him at Alexandria were more ſolemn and extraordinary than thoſe of any other place.

Plutarch and Clemens of Alexandria, as well as Tacitus*, inform us, that while the firſt Ptolemy was employed in fortifying Alexandria with walls, adorning it with temples and ſtately buildings, there appeared to him in his ſleep a young man of extraordinary beauty, of a ſtature more than human, admoniſhing him to diſpatch into Pontus ſome of his moſt truſty friends to bring from thence his ſtatue: he aſſured him, that the city and kingdom which poſſeſſed it ſhould prove happy, glorious, and powerful. The young man having thus ſpoken, diſappeared, mounting up into heaven in a blaze of fire.

Ptolemy diſcovered his viſion to the prieſts; but finding them ignorant of Pontus, he had recourſe to an Athenian, who informed him that near Sinope, a city of Pontus, there was a temple much reſorted to by the natives, which was conſecrated to Pluto, where he had a ſtatue, near which ſtood that of a woman. Ptolemy, neglecting the injunctions of the apparition, it again appeared to him in a menacing attitude; and the king immediately diſpatched ambaſſadors to the Serapian monarch, loaded with preſents. The king of Sinope conſented; but his ſubjects oppoſed the removal of the ſtatue. The god, however, of his own accord, as we are informed, conveyed himſelf to the ambaſſador's ſhip, and in three days landed in Alexandria. The ſtatue of Serapis was erected in one of the ſuburbs of the city, where a magnificent temple was afterwards reared.

The ſtatue of Serapis, according to Macrobius, was of a human form, with a baſket or buſhel on his head, ſignifying plenty; his right hand leaned on the head of a ſerpent, whoſe body was wound round a figure with three heads, of a dog, a lion, and a wolf; in his left hand he held a meaſure of a cubit length, as it were to take the height of the waters of the Nile. The figure of Serapis is found on many ancient medals.

The famous temple of Serapis at Alexandria was deſtroyed by order of Theodoſius; and the celebrated ſtatue of this deity was broken in pieces, and its limbs carried firſt in triumph by the Chriſtians through the city, and then thrown into a fierce fire, kindled for that purpoſe in the amphitheatre. As the Egyptians aſcribed the overflowing of the Nile, to which was owing the fertility of their country, to the benign influence of their god Serapis, they concluded, that now he was deſtroyed, the river would no longer overflow, and that a general famine would enſue; but when they obſerved, on the contrary, that the Nile ſwelled to a greater height than had been known in the memory of man, and thereby produced an immenſe plenty of all kinds of proviſions, many of the pagans renouncing the worſhip of idols, adored the God of the Chriſtians.

SERENA GUTTA, the ſame as *amauroſis*. See MEDICINE, N° 360.

SERENADE, a kind of concert given in the night by a lover to his miſtreſs, under her window. Theſe ſometimes only conſiſt of inſtrumental muſic, but at other times voices are added: the muſic and ſongs compoſed for theſe occaſions are alſo called *ſerenades*.

SERENE, a title of honour given to ſeveral princes, and to the principal magiſtrates of republics. The king of Britain, the republic and doge of Venice, and the children of the king of Spain, are called *moſt ſerene*; and when the pope or the ſacred college write to the emperor, to kings, or to the doge, they give them no other title. In like manner, the emperor gives no other title to any king, except to the king of France.

SERENUS SAMMONICUS, a celebrated phyſician in the reigns of the emperors Severus and Caracalla, in and about the year 200. He wrote ſeveral treatiſes on hiſtory and the works of nature; but there is only one of them extant, which is a very indifferent poem on the Remedies of Diſeaſes. He was murdered at a feſtival by the order of Caracalla. He had a library that contained 62,000 volumes, which Quintus Serenus Sammonicus his ſon gave to Gordian the Younger, to whom he was preceptor.

SERES (Ptolemy); a people of the Farther Aſia; bounded on the weſt by Scythia extra Imaum; on the north and eaſt, by Terra Incognita; and on the ſouth, by India extra Gangem. According to theſe limits, their country anſwers nearly to Cathoy or North China. Other authors vary greatly in placing them, though the generality agree in placing them far to the eaſt. Mela places them between the Indi and Scythæ; and perhaps beyond the Indi, if we diſtinguiſh the Sinæ from them. The ancients commend them for their cotton manufactures, different from the produce of the bombyces or ſilk-worms, called *ſeres* by the Greeks; whence *ſerica*, "ſilk."

SERGE, a woollen quilted ſtuff, manufactured on a loom with four treddles, after the manner of rateens, and other ſtuffs that have the whale. The goodneſs of ſerges is known by the quilting, as that of cloths by the ſpinning. Of ſerges there are various kinds, denominated either from the different qualities thereof, or from the places where they are wrought. The moſt conſiderable is the London ſerge, now highly valued abroad, particularly in France, where a manufacture is carried on with conſiderable ſucceſs, under the title of *ſerge façon de Londres*.

The method of making the London ſerge we ſhall now deſcribe: For wool, the longeſt is choſen for the warp, and the ſhorteſt for the woof. Before either kind is uſed, it is firſt ſcoured, by putting it in a copper of liquor, ſomewhat more than lukewarm, compoſed of three parts of fair water and one of urine. After having ſtayed long enough therein for the liquor to diſſolve, and take off the greaſe, &c. it is ſtirred briſkly about with a wooden peel; taken out of the liquor, drained, and waſhed in a running water, dried in the ſhade, beaten with ſticks on a wooden rack to drive out the coarſer duſt and filth, and then picked clean with the hands. Thus far prepared, it is greaſed with oil of olives, and the longeſt part, deſtined for the warp, is combed with large combs, heated in a little furnace for the purpoſe. To clear off the oil again, the wool is put in a liquor compoſed of hot water, with ſoap melted therein: whence being taken out, wrung, and dried, it is ſpun on the wheel.

As to the ſhorter wool, intended for the woof, it is only carded on the knee with ſmall cards, and then ſpun on the wheel, without being ſcoured of its oil. It muſt be remarked, that the thread for the warp is always to be ſpun much finer, and better twiſted than that of the woof. The wool both for the warp and

* *Tac. Hiſt. lib. iv. cap. 3. Plut. de Iſide et Oſiride. Clem. Alex in Protrep.*

the woof being ſpun, and the thread divided into ſkains, that of the woof is put on ſpools (unleſs it have been ſpun upon them) fit for the cavity or eye of the ſhuttle; and that for the warp is wound on a kind of wooden bobbins to fit it for warping. When warped, it is ſtiffened with a kind of ſize, whereof that made of the ſhreds of parchment is held the beſt; and when dry is put on the loom.

When mounted on the loom, the workman raiſing and lowering the threads (which are paſſed through a reed), by means of four treddles placed underneath the loom, which he makes to act tranſverſely, equally, and alternately, one after another with his feet, in proportion as the threads are raiſed and lowered, throws the ſhuttle acroſs from one ſide to the other; and each time that the ſhuttle is thrown, and the thread of the woof is croſſed between thoſe of the warp, ſtrikes it with the frame to which the reed is faſtened, through thoſe teeth the threads of the warp paſs; and this ſtroke he repeats twice or thrice, or even more, till he judges the croſſing of the ſerge ſufficiently cloſe: thus he proceeds till the warp is all filled with woof.

The ſerge now taken off the loom is carried to the fuller, who ſcours it in the trough of his mill with a kind of fat earth, called *fuller's earth*, firſt purged of all ſtones and filth. After three or four hours ſcouring, the fuller's earth is waſhed out in fair water, brought by little and little into the trough, out of which it is taken when all the earth is cleared; then, with a kind of iron pincers or plyers, they pull off all the knots, ends, ſtraws, &c. ſticking out on the ſurface on either ſide; and then returning it into the fulling trough, where it is worked with water ſomewhat more than lukewarm, with ſoap diſſolved therein for near two hours: it is then waſhed out till ſuch time as the water becomes quite clear, and there be no ſigns of ſoap left; then it is taken out of the trough, the knots, &c. again pulled off, and then put on the tenter to dry, taking care as faſt as it dries to ſtretch it out both in length and breadth till it be brought to its juſt dimenſions. When well dried, it is taken off the tenter, and dyed, ſhorn, and preſſed.

SERGEANT, or SERJEANT *at Law*, or *of the Coif*, is the higheſt degree taken at the common law, as that of Doctor is of the civil law; and as theſe are ſuppoſed to be the moſt learned and experienced in the practice of the courts, there is one court appointed for them to plead in by themſelves, which is the common pleas, where the common law of England is moſt ſtrictly obſerved: but they are not reſtricted from pleading in any other court, where the judges, who cannot have that honour till they have taken the degree of ſerjeant at law, call them *brothers*.

SERGEANT at Arms, or *Mace*, an officer appointed to attend the perſon of the king; to arreſt traitors, and ſuch perſons of quality as offend; and to attend the lord high ſteward, when ſitting in judgment on a traitor.

Of theſe, by ſtatute 13 Richard II. cap. 6. there are not to be above 30 in the realm. There are now nine at court at 100l. per annum ſalary each; they are called the *king's ſergeants at arms*, to diſtinguiſh them from others: they are created with great ceremony; the perſon kneeling before the king, his majeſty lays the mace on his right ſhoulder, and ſays, *Riſe up, ſergeant at arms, and eſquire for ever*. They have, beſides, a patent for the office, which they hold for life.

They have their attendance in the preſence-chamber, where the band of gentlemen-penſioners wait; and, receiving the king at the door, they carry the maces before him to the chapel door, whilſt the band of penſioners ſtand foremoſt, and make a lane for the king, as they alſo do when the king goes to the houſe of lords.

There are four other ſergeants at arms, created in the ſame manner; one, who attends the lord chancellor; a ſecond, the lord treaſurer; a third, the ſpeaker of the houſe of commons; and a fourth, the lord mayor of London on ſolemn occaſions.

They have a conſiderable ſhare of the fees of honour, and travelling charges allowed them when in waiting, viz. five ſhillings per day when the court is within ten miles of London, and ten ſhillings when twenty miles from London. The places are in the lord chamberlain's gift.

There are alſo ſergeants of the mace of an inferior kind, who attend the mayor or other head officer of a corporation.

Common SERGEANT, an officer in the city of London, who attends the lord mayor and court of aldermen on court days, and is in council with them on all occaſions, within and without the precincts or liberties of the city. He is to take care of orphans eſtates, either by taking account of them, or to ſign their indentures, before their paſſing the lord mayor and court of aldermen: and he was likewiſe to let and manage the orphan eſtates, according to his judgment to their beſt advantage. See RECORDER.

SERGEANT, in *War*, is an uncommiſſioned officer in a company of foot or troop of dragoons, armed with an halbert, and appointed to ſee diſcipline obſerved, to teach the ſoldiers the exerciſe of their arms, to order, ſtraiten, and form their ranks, files, &c. He receives the orders from the adjutant, which he communicates to his officers. Each company generally has two ſergeants.

SERGEANTY (*Serjeantia*), ſignifies, in law, a ſervice that cannot be due by a tenant to any lord but the king; and this is either *grand ſergeanty*, or *petit*. The firſt is a tenure by which the one holds his lands of the king by ſuch ſervices as he ought to do in perſon to the king at his coronation; and may alſo concern matters military, or ſervices of honour in peace; as to be the king's butler, carver, &c. *Petit ſergeanty* is where a man holds lands of the king to furniſh him yearly with ſome ſmall thing towards his wars; and in effect payable as rent. Though all tenures are turned into *ſoccage* by the 12 Car. II. cap. 24. yet the honorary ſervices of grand ſergeanty ſtill remain, being therein excepted. See *KNIGHT-Service*.

SERIES, in general, denotes a continual ſucceſſion of things in the ſame order, and having the ſame relation or connection with each other: in this ſenſe we ſay, a ſeries of emperors, kings, biſhops, &c.

In natural hiſtory, a ſeries is uſed for an order or ſubdiviſion of ſome claſs of natural bodies; comprehending all ſuch as are diſtinguiſhed from the other bodies of that claſs, by certain characters which they poſſeſs in common, and which the reſt of the bodies of that caſt have not.

(1.) SERIES, in *Arithmetic* or *Algebra*, a rank or progreſſion of quantities which ſucceed one another according to ſome determinate law. For example, the numbers

$$3,\ 5,\ 7,\ 9,\ 11,\ 13,\ 15,\ \&c.$$

conſtitute a ſeries, the law of which is that each term exceeds that before it by a given number, viz. 2. Again, the numbers

$$3,\ 6,\ 12,\ 24,\ 48,\ 96,\ 192,\ \&c.$$

conſtitute a ſeries of a different kind, each term being the product of the term before it, and the given number 2.

(2.) As the law according to which the terms of a ſeries are formed may be infinitely varied, there may be innumerable kinds of ſeries; we ſhall enumerate a few of the moſt common.

1. *Arithmetical Series.* The general form of a ſeries of this kind is

$$a,\ a+d,\ a+2d,\ a+3d,\ a+4d,\ \&c.$$

and its law is that the difference between any two adjacent terms is the ſame quantity, viz. d. The firſt of the two preceding examples is a ſeries of this nature.

2. *Geometrical Series.* Its general form is

$$a,\ ar,\ ar^2,\ ar^3,\ ar^4,\ \&c.$$

In this kind of ſeries each term is the product of that which precedes it and a conſtant number r, which is called the common ratio of the terms. The ſecond of the above examples is a particular caſe of a geometrical ſeries.

3. *Harmonic Series* is that in which the firſt of any three of its conſecutive terms is to the third, as the difference between the firſt and ſecond to the difference between the ſecond and third: hence we readily find that putting a and b for its two firſt terms, its general form will be

$$a,\ b,\ \frac{ab}{2a-b},\ \frac{ab}{3a-2b},\ \frac{ab}{4a-3b},\ \&c.$$

If we ſuppoſe $a=1$ and $b=\frac{1}{2}$, we get

$$1,\ \tfrac{1}{2},\ \tfrac{1}{3},\ \tfrac{1}{4},\ \tfrac{1}{5},\ \tfrac{1}{6},\ \&c.$$

as a particular example of a harmonic ſeries.

4. *Recurring Series.* Let its terms be denoted by

$$A,\ B,\ C,\ D,\ E,\ F,\ \&c.$$

Then, we ſhall form a recurring ſeries, if m and n being put for given quantities, we take

$$\begin{array}{ll} C=mA+nB, & E=mC+nD, \\ D=mB+nC, & F=mD+nE. \end{array}$$

For example, let us ſuppoſe $A=1$, $B=2x$, $m=4x^2$, $n=3x$; then $C=10x^2$, $D=38x^3$, $E=154x^4$, $F=614x^5$, ſo that the firſt ſix terms of the ſeries are

$$1,\ 2x,\ 10x^2,\ 38x^3,\ 154x^4,\ 614x^5.$$

We have here ſuppoſed each term to be formed from the two which come immediately before it; but the name *recurring ſeries* is given to every one in which the terms are formed in like manner from ſome aſſigned number of the terms which precede that ſought. Thus, putting as before A, B, C, D, &c. for the terms of the ſeries, and m, n, p, q for given quantities, we ſhall have another recurring ſeries, if we ſuppoſe them ſo related that

$$\begin{array}{l} mA+nB+pC+qD=0, \\ mB+nC+pD+qE=0, \\ mC+nD+pE+qF=0. \end{array}$$

The two ſeries of quantities ſin. a, ſin. $2a$, ſin. $3a$, &c. and coſ. a, coſ. $2a$, coſ. $3a$, &c. are both recurring, as is manifeſt from the law which connects the quantities one with another. (See ALGEBRA, § 358.).

(3.) As in general it is the ſum of the terms of a ſeries which is the object of inveſtigation, it is uſual to connect them by the ſign + or —, and to apply the name *ſeries* to the expreſſion thus formed. Accordingly

$$1+3+5+7+9\cdots+\left\{1+2(n-1)\right\}$$

(where n denotes the number of terms) is called an arithmetical ſeries; and in like manner

$$1+\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}\cdots+\frac{1}{2^{n-1}}$$

is a geometrical ſeries.

(4.) A ſeries may either conſiſt of a definite number of terms, or their number may be ſuppoſed greater than any that can be aſſigned, and in this caſe the ſeries is ſaid to be *infinite*. The number of terms of a ſeries may be infinite, and yet their ſum finite. This is true: for example, of the ſeries

$$\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}+\tfrac{1}{16}+,\ \&c.$$

which is equivalent to unity, or 1.

(5.) We have already treated of ſeveral branches of the doctrine of ſeries in the articles ALGEBRA, FLUXIONS, and LOGARITHMS; and in particular we have given four different methods for expanding a quantity into a ſeries, viz.

1. By *Diviſion* or *Evolution*. (See ALGEBRA, § 78, and § 260.).

2. By *the Method of Indeterminate Coefficients*. (ALGEBRA, § 261.).

3. By *the Binomial Theorem*. (ALGEBRA, § 263—§ 269.).

4. By *Taylor's Theorem*. (FLUXIONS, § 66—§ 72.).

We ſhall here treat briefly of another branch of the theory, namely, how to find the ſum of any propoſed number of terms of certain ſeries, or the ſum of their terms continued *ad infinitum*, when that ſum is finite.

(6.) There is a great analogy between the terms of a ſeries and the ordinates of a curve which are ſuppoſed to ſtand upon the axis at equal diſtances from one another, the firſt ordinate reckoned from the extremity of the axes being analogous to the firſt term of the ſeries, the ſecond ordinate to the ſecond term, and ſo on. From this analogy it follows immediately, that like as the nature of a curve is indicated by an equation expreſſing the value of an indefinite ordinate in terms of its correſponding abſciſſa, ſo alſo the nature of a ſeries may be ſhown by an equation which ſhall expreſs the relation between any term; and the number that denotes the place or order of that term in the ſeries. In conformity to this method, putting the ſymbols $T_{(1)}$, $T_{(2)}$, $T_{(3)}$, &c. to denote the terms of any ſeries whatever, we may expreſs it generally thus.

$$T_{(1)}, + T_{(2)}, + T_{(3)}, \cdots + T_{(v)}$$

where the characters (1), (2), are meant to denote the place or order of the terms to which they are joined, (the firſt term being ſuppoſed to have the place 1, the ſecond term the place 2, and ſo on), and (v) is put for any indefinite number.

The nature of the arithmetical ſeries

$$a+(a+d)+(a+2d)+(a+3d)+, \&c.$$

will be defined by the equation

$$T_{(v)} = a+(v-1)d,$$

and, in like manner, the nature of the geometrical ſeries

$$a+ar+ar^2+ar^3+, \&c.$$

will be expreſſed by the equation

$$T_{(v)} = ar^{v-1}.$$

(7.) As the expreſſion for the value of the indefinite term $T_{(v)}$ becomes identical with all the terms of the ſeries in ſucceſſion, by ſubſtituting the numbers 1, 2, 3, &c. one after another for v, that expreſſion is called the *general term* of the ſeries. In the ſeries

$$a+b+\frac{ab}{2a-b}+\frac{ab}{3a-2b}+\frac{ab}{4a-3b}+, \&c.$$

the general term is evidently $\frac{ab}{(v-1)a-(v-2)b}$.

(8.) We ſhall now inveſtigate the ſum of any number of terms of ſuch ſeries as have their general terms expreſſed by any one of the following algebraic functions

$$v, \frac{v(v+1)}{1\cdot 2}, \frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}, \frac{v(v+1)(v+2)(v+3)}{1\cdot 2\cdot 3}, \&c.$$

PROBLEM I. It is propoſed to find the ſum of n terms of the ſeries of which the general term is the firſt function.

By putting 1, 2, 3, &c. to n ſucceſſively for v, it appears that the ſeries to be ſummed is

$$1+2+3+4\cdots+n.$$

Now, as $v=\frac{v(v+1)}{2}-\frac{(v-1)v}{2}$, we have, by putting in this formula 1, 2, 3, $\cdots$ to n ſucceſſively for v,

$$1=\frac{1\cdot 2}{2}-0,$$
$$2=\frac{2\cdot 3}{2}-\frac{1\cdot 2}{2},$$
$$3=\frac{3\cdot 4}{2}-\frac{2\cdot 3}{2},$$
$$4=\frac{4\cdot 5}{2}-\frac{3\cdot 4}{2},$$
$$\cdots$$
$$n-1=\frac{(n-1)n}{2}-\frac{(n-2)(n-1)}{2},$$
$$n=\frac{n(n+1)}{2}-\frac{(n-1)n}{2}.$$

Let the ſum of the quantities on each ſide of the ſign $=$ be now taken; then, obſerving that each of the fractions on the right hand ſide, with the exception of $\frac{n(n+1)}{1\cdot 2}$, occurs twice, once with the ſign $+$, and again with the ſign $-$, by which it happens that their aggregate is $=0$, it is evident that we have

$$1+2+3+4\cdots+n=\frac{n(n+1)}{1\cdot 2}.$$

PROB. II. It is propoſed to ſum n terms of the ſeries, having for its general term the ſecond function

$$\frac{v(v+1)}{1\cdot 2}.$$

This ſeries, by ſubſtituting 1, 2, 3, &c. ſucceſſively for v, is found to be

$$\frac{1\cdot 2}{1\cdot 2}+\frac{2\cdot 3}{1\cdot 2}+\frac{3\cdot 4}{1\cdot 2}\cdots+\frac{n(n+1)}{1\cdot 2}.$$

We now, following the mode of proceeding employed in laſt problem, put the expreſſion $\frac{v(v+1)}{1\cdot 2}$ under this form,

$$\frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}-\frac{(v-1)v(v+1)}{1\cdot 2\cdot 3},$$

to which it is evidently equivalent, and, ſubſtituting 1, 2, 3, &c. ſucceſſively for v, find

$$\frac{1\cdot 2}{1\cdot 2}=\frac{1\cdot 2\cdot 3}{1\cdot 2\cdot 3}-0,$$
$$\frac{2\cdot 3}{1\cdot 2}=\frac{2\cdot 3\cdot 4}{1\cdot 2\cdot 3}-\frac{1\cdot 2\cdot 3}{1\cdot 2\cdot 3},$$
$$\frac{3\cdot 4}{1\cdot 2}=\frac{3\cdot 4\cdot 5}{1\cdot 2\cdot 3}-\frac{2\cdot 3\cdot 4}{1\cdot 2\cdot 3},$$
$$\frac{4\cdot 5}{1\cdot 2}=\frac{4\cdot 5\cdot 6}{1\cdot 2\cdot 3}-\frac{3\cdot 4\cdot 5}{1\cdot 2\cdot 3},$$
$$\cdots\cdots$$
$$\frac{n(n+1)}{1\cdot 2}=\frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}-\frac{(n-1)n(n+1)}{1\cdot 2\cdot 3}.$$

In this problem, as in the former, it appears that each quantity on the right ſide of the equations, except $\frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}$, occurs twice, and with contrary ſigns; therefore, taking the aggregate of the terms on each ſide, we have

$$\frac{1\cdot 2}{1\cdot 2}+\frac{2\cdot 3}{1\cdot 2}+\frac{3\cdot 4}{1\cdot 2}+\frac{4\cdot 5}{1\cdot 2}\cdots+\frac{n(n+1)}{1\cdot 2}$$
$$=\frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}.$$

(9.) It will be obvious, by a little attention to the ſolutions of theſe two problems, that in each the terms of the ſeries to be ſummed are the differences betwixt the adjacent

adjacent terms of another ſeries, namely, that which has for its general term the function next in order to the general term of the ſeries under conſideration; that is, the terms of the ſeries whoſe general term is v, are the differences betwixt thoſe of the ſeries having $\frac{v(v+1)}{1 \cdot 2}$ for its general terms; and, again, the terms of this laſt are the differences of the terms of the ſeries having $\frac{v(v+1)(v+2)}{1 \cdot 2 \cdot 3}$ for its general term. Now as the ſum of the differences of any ſeries of quantities whatever which begins with 0 muſt neceſſarily be the laſt term of that ſeries *, it follows, that the ſum of all the terms of each of the ſeries we have conſidered muſt be equal to the laſt term of the next following ſeries; and this term is neceſſarily the expreſſion formed by ſubſtituting n for v in its general term, that is, the ſum of the ſeries $1+2+3 \cdots +n$, which has v for its general term, is $\frac{n(n+1)}{1 \cdot 2}$; and the ſum of the ſeries

$$\frac{1 \cdot 2}{1 \cdot 2}+\frac{2 \cdot 3}{1 \cdot 2}+\frac{3 \cdot 4}{1 \cdot 2} \cdots + + \frac{n(n+1)}{1 \cdot 2}$$

$$\text{is } \frac{n(n+1)(n+2)}{1 \cdot 2 \cdot 3}.$$

The next ſeries which has $\frac{v(v+1)(v+2)}{1 \cdot 2 \cdot 3}$ for its general term, as well as all that ſucceed, will be found to have the very ſame property, as may be proved as follows. Let p denote any term of the ſeries of natural numbers 1, 2, 3, &c. Then, becauſe

$$1=\frac{v+p}{p+1}-\frac{v-1}{p+1},$$

if we multiply theſe equals by the product of all the factors v, $\frac{v+1}{2}$, $\frac{v+2}{3}$, &c. to $\frac{v+p-1}{p}$, we get

$$\frac{v(v+1)(v+2) \cdots (v+p-1)}{1 \cdot 2 \cdot 3 \cdots p}$$

$$=\begin{cases} \frac{v(v+1)(v+2) \cdots (v+p)}{1 \cdot 2 \cdot 3 \cdot \cdot (p+1)} \\ -\frac{(v-1)v(v+1) \cdots (v+p-1)}{1 \cdot 2 \cdot 3 \cdots (p+1)}. \end{cases}$$

Now, if in this identical equation we ſubſtitute the numbers 1, 2, 3, &c. to n ſucceſſively for v, the reſults obtained from its firſt member

$$\frac{v(v+1)(v+2) \cdots (v+p-1)}{1 \cdot 2 \cdot 3 \cdots p}$$

will be a ſeries having this function for its general term, and the terms of which will evidently be the difference between the terms of another ſeries having the firſt part of the ſecond member of the equation, viz.

$$\frac{v(v+1)(v+2) \cdots (v+p)}{1 \cdot 2 \cdot 3 \cdots (p+1)},$$

for its general term: Hence it will happen, as in the two foregoing problems, that the ſum of all the terms of the former ſeries will be equal to the laſt term of the latter; which concluſion may be expreſſed in the form of a theorem, as follows:

THEOREM. *The ſum of* n *terms of a ſeries having for its general term the function,*

$$\frac{v(v+1)(v+2) \cdots (v+p-1)}{1 \cdot 2 \cdot 3 \cdots p}$$

is equal to

$$\frac{n(n+1)(n+2) \cdots\cdot (n+p}{1 \cdot 2 \cdot 3 \cdots (p+1)}.$$

Or, ſetting aſide the denominators of the terms, we may expreſs the theorem thus: *The ſum of* n *terms of a ſeries, having for its general term the expreſſion*

$$v(v+1)(v+2) \cdots (v+p-1),$$

is equal to

$$\frac{n(n+1)(n+2) \cdots (n+p)}{p+1}.$$

We ſhall here give a few particular caſes of this laſt general formula.

I. $1+2+3+4 \cdots +n=\frac{n(n+1)}{2}.$

II. $1 \cdot 2+2 \cdot 3+3 \cdot 4+4 \cdot 5 \cdots +n(n+1)$
$=\frac{n(n+1)(n+2)}{3}.$

III. $1 \cdot 2 \cdot 3+2 \cdot 3 \cdot 4+3 \cdot 4 \cdot 5 \cdots +n(n+1)(n+2)$
$=\frac{n(n+1)(n+2)(n+3)}{4}.$

(10.) By means of the above general theorem we may find the ſum of any number of terms of a ſeries compoſed of the powers of the terms of an arithmetical progreſſion, the general term of which will, in the ſimpleſt caſe, be v^p, p being a given number. The manner of doing this will appear from the following problems.

PROB. III. It is propoſed to find the ſum of n terms of the ſeries of ſquares $1+4+9+16+25+$, &c. or $1^2+2^2+3^2+4^2+5^2+$, &c.

The general term of this ſeries being v^2, we put it under this form, $v(v+1)-v$; hence we get by ſubſtituting 1, 2, 3, &c. for v,

$$\begin{aligned} 1^2&=1 \cdot 2-1, \\ 2^2&=2 \cdot 3-2, \\ 3^2&=3 \cdot 4-3, \\ 4^2&=4 \cdot 5-4, \\ &\cdots\cdot \\ n^2&=n(n+1)-n. \end{aligned}$$

Therefore adding, we find

$$1^2+2^2+3^2+4^2 \cdots\cdot +n^2$$
$$=\begin{cases} 1 \cdot 2+2 \cdot 3+3 \cdot 4+4 \cdot 5 \cdots +n(n+1) \\ -(1+2+3+4 \cdots +n). \end{cases}$$

But

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* For example, let the quantities be 0, a, b, c, d, then it is manifeſt that $(a-0)+(b-a)+(c-b)+(d-c)=d$.

But by the general theorem (9.)

$$1\cdot 2+2\cdot 3+3\cdot 4\cdots+n(n+1)=\frac{n(n+1)(n+2)}{3},$$

and, $$1+2+3+4\cdots+n=\frac{n(n+1)}{2};$$

therefore $$1^2+2^2+3^2+4^2\cdots+n^2$$
$$=\frac{n(n+1)(n+2)}{3}-\frac{n(n+1)}{2}$$
$$=\frac{n(n+1)(2n+1)}{6}.$$

We might have arrived at the ſame concluſion by conſidering that ſince v^2, the general term of the ſeries, is equivalent to $v(v+1)-v$, the ſeries muſt be the difference between two others, one having $v(v+1)$ and the other v for its general term; for the ſake of perſpicuity, however, we have put down the terms of all the three ſeries.

PROB. IV. It is propoſed to find the ſum of n terms of the ſeries

$$1^3+2^3+3^3+4^3+5^3 \text{ \&c.}$$

The general term in this caſe is v^3; now to transform this function, ſo as to deduce the ſum of the ſeries from the general theorem, we aſſume

$$v^3=v(v+1)(v+2)+Av(v+1)+Bv,$$

where A and B denote quantities which are to have ſuch values as ſhall render the two ſides of the equation identical whatever be the value of v; taking now the product of the factors, we have

$$v^3=v^3+(A+3)v^2+(A+B+2)v,$$

Therefore, by the theory of indeterminate coefficients, (ALGEBRA, § 261.)

$$A+3=0,\ A+B+2=0:$$

Hence we find $A=-3$, $B=-A-2=1$; thus it appears that v being any number whatever,

$$v^3=v(v+1)(v+2)-3v(v+1)+v.$$

Now, let S denote the ſum of n terms of the ſeries under conſideration, which has v^3 for its general term, and put P, Q, R for the like ſums of the three ſeries, whoſe general terms are the functions $v(v+1)(v+2)$, $v(v+1)$ and v reſpectively; then, it is evident that $S=P-3Q+R$. But by the theorem, (9.)

$$P=\frac{n(n+1)(n+2)(n+3)}{4},$$

$$Q=\frac{n(n+1)(n+2)}{3},$$

$$R=\frac{n(n+1)}{2},$$

therefore, $$S=\frac{n(n+1)(n+2)(n+3)}{4}$$
$$-n(n+1)(n+2)+\frac{n(n+1)}{2},$$

and by proper reduction, S, or

$$1^3+2^3+3^3+4^3\cdots+n^3=\frac{n^2(n+1)^2}{4}.$$

Corollary. We have found (PROB. I.) that

$$1+2+3+4\cdots+n=\frac{n(n+1)}{2},$$

therefore, comparing this with the reſult juſt now obtained, it is evident that

$$(1+2+3+4\cdots+n)^2=1^3+2^3+3^3+4^3\cdots+n^3;$$

this is a very curious and elegant property of numbers.

(11.) It is manifeſt that by the mode of proceeding employed in laſt problem we may inveſtigate the ſum of n terms of the ſeries

$$1^m+2^m+3^m+4^m+, \text{ \&c.}$$

m being any whole poſitive number whatever: and indeed in the very ſame way we may find the ſum of any number of terms of a ſeries, whoſe general term is

$$a+bv+cv^2+dv^3+, \text{ \&c.}$$

where a and b, &c. denote given numbers; namely, by transforming it into a function of the form

$$A+Bv+Cv(v+1)+Dv(v+1)(v+2)+, \text{ \&c.}$$

where A, B, and C, &c. denote conſtant quantities. Our limits, however, will not allow us to go into particulars.

(12.) The next claſs of ſeries we ſhall conſider, comprehends ſuch as may be formed by the ſucceſſive ſubſtitution of a, $a+1$, $a+2$, &c. (a being put for any given quantity whatever) in the ſeries of functions

$$\frac{1}{v(v+1)},\frac{1}{v(v+1)(v+2)},\frac{1}{v(v+1)(v+2)(v+3)}, \text{ \&c.}$$

We ſhall begin with the firſt of theſe.

PROB. V. It is propoſed to find the ſum of n terms of the ſeries

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}+\frac{1}{(a+2)(a+3)}+, \text{ \&c.}$$

which is formed by ſubſtituting a, $a+1$, $a+2$, &c. ſucceſſively for v in the general term $\frac{1}{v(v+1)}$.

Whatever be the value of v, we have

$$\frac{1}{v(v+1)}=\frac{1}{v}-\frac{1}{v+1},$$

therefore, proceeding as in the foregoing problems, we get

$$\frac{1}{a(a+1)}=\frac{1}{a}-\frac{1}{a+1},$$

$$\frac{1}{(a+1)(a+2)}=\frac{1}{a+1}-\frac{1}{a+2},$$

$$\frac{1}{(a+2)(a+3)}=\frac{1}{a+2}-\frac{1}{a+3},$$

$$\cdots\cdots$$

$$\frac{1}{(a+n-2)(a+n-1)}=\frac{1}{a+n-2}-\frac{1}{a+n-1},$$

$$\frac{1}{(a+n-1)(a+n)}=\frac{1}{a+n-1}-\frac{1}{a+n}.$$

Here it is evident that the terms of the ſeries to be

ſummed

ſummed are the differences betwixt every two adjoining terms of this other ſeries.

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}\dots+\frac{1}{a+n};$$

Hence it immediately follows, that the ſum of all the terms of the former is the difference between the two extreme terms of the latter ; that is

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}\dots\dots+\frac{1}{(a+n-1)(a+n)}$$
$$=\frac{1}{a}-\frac{1}{a+n}.$$

If we ſuppoſe the ſeries to be continued *ad infinitum*, then, as n will be indefinitely great, and $\frac{1}{a+n}$ indefinitely ſmall, the ſum will be ſimply $\frac{1}{a}$; or in other words, the fraction $\frac{1}{a}$ is a limit to the ſum of the ſeries.

Prob. VI. Let it be required to find the ſum of n terms of this ſeries.

$$\frac{1}{a(a+1)(a+2)}+\frac{1}{(a+1)(a+2)(a+3)}+$$
$$\frac{1}{(a+2)(a+3)(a+4)}+\text{, \&c.}$$

the general term in this caſe being $\frac{1}{v(v+1)(v+2)}$.

Becauſe $\frac{2}{v(v+2)}=\frac{1}{v}-\frac{1}{v+2}$, therefore, multiplying by $\frac{1}{2(v+1)}$, we have

$$\frac{1}{v(v+1)(v+2)}=\tfrac{1}{2}\left\{\frac{1}{v(v+1)}-\frac{1}{(v+1)(v+2)}\right\},$$

and hence, by ſubſtituting a, $a+1$, $a+2$, &c. ſucceſſively for v,

$$\frac{1}{a(a+1)(a+2)}=\tfrac{1}{2}\left\{\frac{1}{a(a+1)}-\frac{1}{(a+1)(a+2)}\right\}.$$

$$\frac{1}{(a+1)(a+2)(a+3)}=\tfrac{1}{2}\left\{\frac{1}{(a+1)(a+2)}-\right.$$
$$\left.\frac{1}{(a+2)(a+3)}\right\}.$$

$$\frac{1}{(a+2)(a+3)(a+4)}=\tfrac{1}{2}\left\{\frac{1}{(a+2)(a+3)}-\right.$$
$$\left.\frac{1}{(a+3)(a+4)}\right\}$$

. . . . .

$$\frac{1}{(a+n-1)(a+n)(a+n+1)}$$
$$=\tfrac{1}{2}\left\{\frac{1}{(a+n-1)(a+n)}-\frac{1}{(a+n)(a+n+1)}\right\}.$$

Hence it appears that the terms of the ſeries to be ſummed are the halves of the differences of the terms of the ſeries

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}+\frac{1}{(a+2)(a+3)}\dots$$
$$+\frac{1}{(a+n)(a+n+1)};$$

conſequently, the ſum of all the terms of the former is half the difference between the extreme terms of the latter, or is =

$$\tfrac{1}{2}\left\{\frac{1}{a(a+1)}-\frac{1}{(a+n)(a+n+1)}\right\}.$$

(13.) From theſe two particular caſes it is eaſy to ſee how we may ſum the ſeries when the general term is

$$\frac{1}{v(v+1)(v+2)\dots(v+p)},$$

p being any whole number whatever : for ſince

$$\frac{p}{v(v+p)}=\frac{1}{v}-\frac{1}{v+p},$$

therefore, multiplying the denominators by all the factors which are intermediate between v and $v+p$, we have

$$\frac{p}{v(v+1)(v+2)\dots(v+p)}=$$
$$\frac{1}{v(v+1)(v+2)\dots(v+p-1)}-$$
$$\frac{1}{(v+1)(v+2)(v+3)\dots(v+p)}.$$

Now the latter ſide of this equation is a general expreſſion for the difference between any two adjacent terms of a ſeries whoſe general term is

$$\frac{1}{v(v+1)(v+2)\dots(v+p-1)},$$

therefore the difference between the firſt and laſt terms of this ſeries muſt be the ſum of the ſeries whoſe general term is the function on the other ſide of the equation, viz.

$$\frac{p}{v(v+1)(v+2)\dots(v+p)}.$$

Hence we have the following very general theorem.

Theorem. *Let* a *denote any number whatever, and let* 1, 2, 3, . . . p *be a ſeries of numbers, each of which exceeds that before it by unity ; the ſum of* n *terms of a ſeries formed by ſubſtituting the numbers* a, $a+1$, $a+2$, &c. *to* $a+n-1$ *ſucceſſively for* v *in the function*

$$\frac{1}{v(v+1)(v+2)\dots(v+p)}$$

is equal to

$$\frac{1}{p}\left\{\begin{array}{l}\dfrac{1}{a(a+1)(a+2)\dots(a+p-1)}\\[2ex] -\dfrac{1}{(a+n)(a+n+1)(a+n+2)\dots+(a+n+p-1)}\end{array}\right.$$

COROLLARY.

Corollary. *The ſame ſeries continued ad infinitum is equal to*

$$\frac{1}{p}\,\frac{1}{a(a+1)(a+2)\cdots(a+p-1)}.$$

(14.) We ſhall now give a few examples of the application of this theorem.

Example 1. Required the ſum of *n* terms of the ſeries

$$\frac{1}{2\cdot3\cdot4\cdot5}+\frac{1}{3\cdot4\cdot5\cdot6}+\frac{1}{4\cdot5\cdot6\cdot7}+,\ \&c.$$

The terms of this ſeries are evidently produced by the ſucceſſive ſubſtitution of the numbers 2, 3, 4, 5, &c. for *v* in the function

$$\frac{1}{v(v+1)(v+2)(v+3)};$$

therefore, comparing this expreſſion with the general formula, we have $a=2$, $p=3$, and the ſum required

$$=\tfrac{1}{3}\left\{\frac{1}{2\cdot3\cdot4}-\frac{1}{(2+n)(3+n)(4+n)}\right\}.$$

Ex. 2. Required the ſum of the ſeries

$$\frac{1}{1\cdot4\cdot7}+\frac{1}{4\cdot7\cdot10}+\frac{1}{7\cdot10\cdot13}+\frac{1}{10\cdot13\cdot16}+,\ \&c.$$

continued *ad infinitum.*

By a little attention it will appear that its terms are produced by the ſubſtitution of the numbers $\frac{1}{3}$, $1\frac{1}{3}$, $2\frac{1}{3}$, &c. ſucceſſively for *v* in the function

$$\frac{1}{3v(3v+3)(3v+6)}=\frac{1}{27v(v+1)(v+2)};$$

In this caſe then $a=\frac{1}{3}$, $p=2$, therefore the ſum is

$$\frac{1}{2}\times\frac{1}{27}\,\frac{1}{\frac{1}{3}\times1\frac{1}{3}}=\frac{1}{24}.$$

(15.) When the function from which the ſeries is derived has not the very form required in the theorem, it may be brought to that form by employing ſuitable transformations, as in the two following examples.

Ex. 3. It is propoſed to find the ſum of the ſeries

$$\frac{1}{1\cdot4}+\frac{1}{2\cdot5}+\frac{1}{3\cdot6}+\frac{1}{4\cdot7}+,\ \&c.$$

continued *ad infinitum.*

This ſeries is evidently formed by the ſubſtitution of the numbers 1, 2, 3, &c. ſucceſſively for *v* in the function $\frac{1}{v(v+3)}$. This expreſſion, however, does not in its preſent form agree with the general formula, becauſe the factors $v+1$, $v+2$ are wanting; therefore to tranſform it, we multiply its numerator and denominator by $(v+1)(v+2)$, and it becomes

$$\frac{(v+1)(v+2)}{v(v+1)(v+2)(v+3)};$$

we next aſſume its numerator

$$(v+1)(v+2)=A(v+2)(v+3)+B(v+3)+C,$$

and by multiplying get

$$v^2+3v+2=A\,v^2+(5A+B)v+(6A+3B+C);$$

therefore, that *v* may be indeterminate, we muſt make

$$A=1,\ 5A+B=3,\ 6A+3B+C=2,$$

from which equations we get $A=1$, $B=3-5A=-2$, $C=2-6A-3B=2$, ſo that

$$\frac{1}{v(v+3)}=\frac{(v+2)(v+3)-2(v+3)+2}{v(v+1)(v+2)(v+3)}$$

$$=\frac{1}{v(v+1)}-\frac{2}{v(v+1)(v+2)}$$

$$+\frac{2}{v(v+1)(v+2)(v+3)}.$$

Thus it appears that the propoſed ſeries is reſolvable into three others, the general terms of which all agree with the theorem. Now the ſum of the infinite ſeries whoſe general term is $\frac{1}{v(v+1)}$ appears by the theorem to be $\frac{1}{a}$, or 1, becauſe $a=1$, and the ſum of the infinite ſeries whoſe general term is $\frac{-2}{v(v+1)(v+2)}$, is in like manner found to be $\frac{-2}{2}+\frac{1}{1\cdot2}=\frac{-1}{2}$; and laſtly, the infinite ſeries whoſe general term is $\frac{2}{v(v+1)(v+2)(v+3)}$ is $\frac{2}{3}\,\frac{1}{1\cdot2\cdot3}=\frac{1}{9}$; therefore, collecting theſe into one, the ſum of the propoſed ſeries is $1-\frac{1}{2}+\frac{1}{9}=\frac{11}{18}$, the anſwer.

Ex. 4. Required the ſum of the infinite ſeries

$$\frac{1}{2\cdot3\cdot4}+\frac{2}{3\cdot4\cdot5}+\frac{3}{4\cdot5\cdot6}+\frac{4}{5\cdot6\cdot7}+,\ \&c.$$

The terms of this ſeries are evidently formed by the ſubſtitution of the numbers 2, 3, 4, ſucceſſively in the function

$$\frac{v-1}{v(v+1)(v+2)}.$$

Now $v-1=v+2-3$; therefore,

$$\frac{v-1}{v(v+1)(v+2)}=\frac{1}{v(v+1)}-\frac{3}{v(v+1)(v+2)};$$

thus it appears that the propoſed ſeries is reducible to two others, one having its terms produced by the ſubſtitution of 2, 3, &c. for *v* in the function $\frac{1}{v(v+1)}$, and the other by a like ſubſtitution in the function $\frac{-3}{v(v+1)(v+2)}$. Now, by our theorem, the ſum of the firſt of theſe is $\frac{1}{2}$, and that of the ſecond is $\frac{-3}{2}$

$\frac{1}{2\cdot 3}=-\frac{1}{4}$, therefore the ſum of the propoſed ſeries is $\frac{1}{2}-\frac{1}{4}=\frac{1}{4}$.

From theſe examples it is ſufficiently evident how the theorem is to be applied in other caſes; and it appears alſo that by means of it we can ſum any ſeries whatever whoſe general term is of the form

$$\frac{A}{v(1+v)}+\frac{B}{v(1+v)(v+1)}+\frac{C}{v(v+1)(v+2)(v+3)}+, \text{ \&c.}$$

or admits of being reduced to that form.

(16.) It deſerves to be remarked that the ſeries

$$\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+, \text{ \&c.}$$

which is of a very ſimple form, and in appearance of the ſame nature as thoſe we have ſummed, does not however admit of being treated in the ſame manner; and indeed, if it be continued *ad infinitum*, its ſum is infinite, that is, it exceeds any number which can be aſſigned. The truth of this aſſertion will be evident if we can ſhew that a certain definite number of its terms, beginning with any propoſed term, can always be found, the ſum of which ſhall exceed an unit or 1; for this being the caſe, as we can go on continually in aſſigning ſuch ſets of terms, we can conceive as many to be taken as there are units in any propoſed number however great; and therefore their ſum, and much more the ſum of all the terms of the ſeries from its beginning to the end of the laſt ſets of terms, will exceed that number. Now that this can always be done may be proved as follows:

Let the term of the ſeries from which we are to reckon be $\frac{1}{a}$, then, if the thing be poſſible, and if n be the requiſite number of terms, we muſt have

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}\cdots+\frac{1}{a+n-1}>1.$$

Now becauſe

$$a\left(1+\frac{1}{a}\right)^2=a+2+\frac{1}{a},$$

$$a\left(1+\frac{1}{a}\right)^3=a+3+\frac{3}{a}+\frac{1}{a^2},$$

and in general,

$$a\left(1+\frac{1}{a}\right)^p=a+p+\frac{p\cdot p-1}{1\cdot 2}\,\frac{1}{a}+, \text{ \&c.}$$

therefore, p being any whole number,

$$a\left(1+\frac{1}{a}\right)^p>a+p, \text{ and conſequently}$$

$$\frac{1}{a+p}>\frac{1}{a\left(1+\frac{1}{a}\right)^p};$$

hence it follows that the ſeries

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}\cdots+\frac{1}{a+n-1}$$

will be greater than the other ſeries

$$\frac{1}{a}+\frac{1}{a\left(1+\frac{1}{a}\right)}+\frac{1}{a\left(1+\frac{1}{a}\right)^2}+\frac{1}{a\left(1+\frac{1}{a}\right)^3}\cdots$$

$$+\frac{1}{a\left(1+\frac{1}{a}\right)^{n-1}}.$$

Now this laſt being evidently a geometrical ſeries, of which the common ratio is $\frac{1}{1+\frac{1}{a}}$, its ſum is

$$1+\frac{1}{a}-\frac{1}{\left(1+\frac{1}{a}\right)^{n-1}};$$

therefore, the ſum of the ſeries

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}\cdots+\frac{1}{a+n-1}$$

will always be greater than this expreſſion; but if we ſuppoſe n ſo great that the quantity $\left(1+\frac{1}{a}\right)^{n-1}$ is equal to, or exceeds a, which is evidently always poſſible, then the above expreſſion for the ſum of the geometrical ſeries will be equal to 1, or will exceed 1; therefore, the ſame number of terms of the ſeries $\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}+$, &c. will always exceed 1; now this is the property of the ſeries we propoſed to demonſtrate.

When $a=\left(1+\frac{1}{a}\right)^{n-1}$, then $a^2=a\left(1+\frac{1}{a}\right)^{n-1}$, but this quantity is greater than $a+n-1$ the denominator of the laſt term of the ſeries

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}\cdots+\frac{1}{a+n-1},$$

the ſum of which, we have proved, will upon that hypotheſis exceed unity; much more then will the ſum exceed unity if we ſuppoſe the ſeries continued until the denominator of its laſt term be equal to, or greater than a^2.

Hence, beginning with the term $\frac{1}{2}$, it appears that

$$\frac{1}{2}+\frac{1}{3}+\frac{1}{4=2^2}>1,$$

$$\frac{1}{5}+\frac{1}{6}\cdots+\frac{1}{25=5^2}>1,$$

$$\frac{1}{26}+\frac{1}{27}\cdots+\frac{1}{676=26^2}>1,$$

$$\frac{1}{677}+\frac{1}{678}\cdots+\frac{1}{458329=677^2}>1,$$

&c.

Although the ſum of the ſeries we have been conſidering is infinite, yet it evidently increaſes very ſlowly; indeed it is a limit to all ſuch as have a finite ſum; for every

every infinite ſeries, the terms of which decreaſe faſter than the reciprocals of an arithmetical progreſſion, is always finite.

(17.) We have already explained what is meant by a *recurring ſeries*, (2.) we ſhall now treat briefly, firſt, of their origin, next of the way in which they may be ſummed, and laſtly, of the manner of determining the *general term* of any particular ſeries.

The ſeries which is produced by the developement of a rational algebraic fraction has always the property which conſtitutes the characteriſtic of the claſs called *Recurring*, (2.) and on the other hand, any ſeries having that property being propoſed, an algebraic fraction may be found by the expanſion of which the ſeries ſhall be produced.

The fraction $\frac{1+2x}{1-x-x^2}$, for example, by dividing the numerator by the denominator is converted into the infinite ſeries

$$1+3x+4x^2+7x^3+11x^4+18x^5+, \&c.$$

which is of ſuch a nature that if T, T′, T″, denote any three of its ſucceeding terms, their relation to one another is expreſſed by the equation

$$T''=T x^2+T' x.$$

If we employ algebraic diviſion to convert the fraction into a ſeries, the law of its terms will not appear ſo readily as if we uſe the method of indeterminate coefficients. By this method we aſſume the fraction

$$=A+B x+C x^2+D x^3+E x^4, + \&c.$$

and hence, multiplying by the denominator, and bringing all the terms to one ſide, as explained in ALGEBRA, § 261, we have

$$\left.\begin{matrix} A+B \\ -1-A \\ -2 \end{matrix}\right\} \left.\begin{matrix} +C \\ x-B \\ -A \end{matrix}\right\} \left.\begin{matrix} +D \\ x^2-C \\ -B \end{matrix}\right\} x^3+, \&c. =0,$$

and hence,

$$A-1=0, \qquad C-B-A=0,$$
$$B-A-2=0, \qquad D-C-B=0,$$
$$\&c.$$

From theſe equations it appears that the law of the ſeries is ſuch as we have aſſigned.

The equation expreſſing the relation which ſubſiſts among a certain number of ſucceeding terms of a recurring ſeries, is called its *ſcale of Relation*. The ſame name is alſo ſometimes given to the equation expreſſing the connection of the coefficients of the terms. Thus the ſcale of relation of the foregoing ſeries is either

$$T''=T x+T' x^2,$$

where T, T′, and T″ denote any three ſucceeding terms of the ſeries, or it is

$$R=P+Q,$$

where P, Q and R denote their numeral coefficients.

(18.) We come next to ſhew how the ſum of any propoſed number of terms of a recurring ſeries may be found. Let the ſeries continued to *n* terms be

$$T_{(1)}+T_{(2)}+T_{(3)} \cdots +T_{(n-2)}+T_{(n-1)}+T_{(n)},$$

where the characters $T_{(1)}$, $T_{(2)}$, &c. denote the ſucceſſive terms, and the numbers (1), (2), &c. their order or place; and as whatever number of terms is contained in the ſcale, the manner of ſumming the ſeries is the ſame, we ſhall in what follows, for the ſake of brevity, ſuppoſe that it conſiſts of three, in which caſe it may be expreſſed thus,

$$p\, T_{(n-2)}+q\, T_{(n-1)}+r\, T_{(n)}=0,$$

where *p*, *q*, *r* denote certain given quantities.

The ſcale of relation affords the following ſeries of equations,

$$p\, T_{(1)}+q\, T_{(2)}+r\, T_{(3)}=0,$$
$$p\, T_{(2)}+q\, T_{(3)}+r\, T_{(4)}=0,$$
$$p\, T_{(3)}+q\, T_{(4)}+r\, T_{(5)}=0,$$
$$\cdots\cdots\cdots$$
$$p\, T_{(n-2)}+q\, T_{(n-1)}+r\, T_{(n)}=0.$$

Taking now the ſum of theſe equations, we get

$$\left.\begin{matrix} p(T_{(1)}+T_{(2)}+T_{(3)} \cdots +T_{(n-2)}) \\ +q(T_{(2)}+T_{(3)}+T_{(4)} \cdots +T_{(n-1)}) \\ +r(T_{(3)}+T_{(4)}+T_{(5)} \cdots +T_{(n)}) \end{matrix}\right\} =0.$$

But, putting *s* for the ſum of *n* terms of the ſeries, this equation may manifeſtly be expreſſed thus,

$$\left.\begin{matrix} p(s-T_{(n)}-T_{(n-1)}) \\ +q(s-T_{(1)}-T_{(n)}) \\ +r(s-T_{(1)}-T_{(2)}) \end{matrix}\right\} =0.$$

Hence, after reduction, we find $s=$

$$\frac{p(T_{(n-1)}+T_{(n)})+q(T_{(1)}+T_{(n)})+r(T_{(1)}+T_{(2)})}{p\cdot+q+r}.$$

From which it appears that in this caſe the ſum depends only on the two firſt and the two laſt terms of the ſeries.

Example. It is propoſed to find from this formula the ſum of *n* terms of the ſeries

$$1+2x+3x^2+4x^3+5x^4+, \&c.$$

its ſcale of relation being

$$x^2\, T_{(n-2)}-2x\, T_{(n-1)}+T_{(n)}=0.$$

Here $p=x^2$, $q=-2x$, $r=1$, therefore, obſerving that the laſt two terms of the ſeries muſt be $(n-1)x^{n-2}$ and $n x^{n-1}$, we have, after ſubſtituting and reducing,

$$s=\frac{1-(n+1)x^n+n x^{n+1}}{1-2x+x^2}.$$

This formula will not apply in the caſe of $x=1$, becauſe then the numerator and denominator are each $=0$: but in ſuch caſes as this we may find the value of the function which expreſſes the ſum by what is delivered at § 90, FLUXIONS.

(19.) The proceſs by which we have determined the value of *n* terms of the ſeries $T_{(1)}+T_{(2)}+T_{(3)}+$, &c. will alſo apply to the finding the rational fraction from which the ſeries may be deduced, which is alſo the ſum of the ſeries continued *ad infinitum*. For in this caſe the equation from which we have deduced the ſum being

$$\left.\begin{matrix} p(T_{(1)}+T_{(2)}+T_{(3)}+, \&c.) \\ +q(T_{(2)}+T_{(3)}+T_{(4)}+, \&c.) \\ +r(T_{(3)}+T_{(4)}+T_{(5)}+, \&c.) \end{matrix}\right\} =0,$$

that is,

$$ps+q(s-T_{(1)})+r(s-T_{(1)}-T_{(2)})=0,$$

we have

$$s=\frac{(q+r)T_{(1)}+rT_{(2)}}{p+q+r}.$$

For example, let it be required to find the fraction, which being developed produces the ſeries

$$1+2x+3x^2+4x^3+, \&c.$$

the ſcale of relation of which is

$$x^2T_{(n-2)}-2xT_{(n-1)}+T_{(n)}+0.$$

Here $p=x^2$, $q=-2x$, $r=1$, $T_{(1)}=1$, $T_{(2)}=2x$; therefore, ſubſtituting in the formula, we get

$$\frac{1}{1-2x+x^2}=\frac{1}{(1-x)^2}$$

for the fraction required, or for the ſum of the ſeries continued *ad infinitum.*

(20). We come now to the laſt branch of the theory of recurring ſeries which we propoſed to conſider, namely, how to find in any caſe the *general term.*

We ſhall begin with the moſt ſimple, and ſuppoſe the fraction to be $\frac{a}{1-px}$, which being expounded into a ſeries by diviſion, is

$$a+apx+ap^2x^2+ap^3x^3+, \&c.$$

here it is immediately manifeſt that the general term is $ap^{n-1}x^{n-1}$.

Next let us ſuppoſe the fraction to be $\frac{a+bx}{1-\alpha x-\beta x^2}$. Let the two roots of the quadratic equation $1-\alpha x-\beta x^2=0$ be $x=\frac{1}{p}$, $x=\frac{1}{q}$, ſo that $1-px=0$, and $1-qx=0$; therefore, $1-\alpha x-\beta x^2=(1-px)(1-qx)$, thus, we have

$$\frac{a+bx}{1-\alpha x-\beta x^2}=\frac{a+bx}{(1-px)(1-qx)}.$$

Let us aſſume this expreſſion equal to

$$\frac{P}{1-px}+\frac{Q}{1-qx},$$

where P and Q denote quantities which are to be independent of x, then, reducing to a common denominator, we have

$$\frac{a+bx}{(1-px)(1-qx)}=\frac{P+Q-(qP+pQ)x}{(1-px)(1-qx)}.$$

Hence, that x may remain indeterminate, we muſt make

$$P+Q=a,\ qP+pQ=-b,$$

and from theſe equations we get

$$P=\frac{ap+b}{p-q},\ Q=-\frac{aq+b}{p-q}.$$

Now, by the operation of diviſion, we find

$$\frac{P}{1-px}=P+Ppx+Pp^2x^2+, \&c.$$

$$\frac{Q}{1-qx}=Q+Qqx+Qq^2x^2+, \&c.$$

therefore, ſince $\frac{a+bx}{1-\alpha x-\beta x^2}=\frac{P}{1-px}+\frac{Q}{1-qx}$, it follows that the developement of the fraction $\frac{a+bx}{1-\alpha x-\beta x^2}$ which proceeds according to the powers of x, is

$$(P+Q)Pp+Qq)x+(Pp^2+Qq^2)x^2$$
$$+(Pp^3+Qq^3)x^3+, \&c.$$

And here it is evident that the general term is $(Pp^{n-1}+Qq^{n-1})x^{n-1}$.

Let us take as a particular example the fraction $\frac{1-x}{1-x-2x^2}$, which when expanded into a ſeries, becomes

$$1+0x+2x^2+2x^3+6x^4+10x^5$$
$$+22x^6+42x^7+86x^8+, \&c.$$

Here, from the equation $1-x-2x^2=0$, we get $x=\frac{1}{2}$ and $x=-1$, ſo that $1-2x$ and $1+x$ are diviſors of the function $1-x-2x^2$, that is, $1-x-2x^2=(1+x)(1-2x)$; hence $p=-1$, $q=2$, and ſince $a=1$, $b=-1$; therefore $P=\frac{2}{3}$, $Q=\frac{1}{3}$, and the general term $(Pp^{n-1}+Qq^{n-1})x^{n-1}$ becomes by ſubſtituting

$$\left\{\frac{2}{3}(-1)^{n-1}+\frac{1}{3}2^{n-1}\right\}x^{n-1}=\frac{2^{n-1}\pm2}{3}x^{n-1}.$$

where the ſign + is to be taken when n is an odd number; but the ſign — when n is even.

Sometimes the values of p and q will come out imaginary quantities; theſe, however, will be found always to deſtroy one another when ſubſtituted in the general term.

Let us next ſuppoſe the fraction which produces a recurring ſeries to be

$$\frac{a+bx+cx^2}{1-\alpha x-\beta x^2-\gamma x^3}.$$

Let $x=\frac{1}{p}$, $x=\frac{1}{q}$, $x=\frac{1}{r}$ be the three roots of the cubic equation $1-\alpha x-\beta x^2-\gamma x^3=0$, then the denominator of the fraction will be the product of the three factors

$$1-px,\ 1-qx,\ 1-rx.$$

We muſt now aſſume the fraction equal to the expreſſion

$$\frac{P}{1-px}+\frac{Q}{1-qx}+\frac{R}{1-rx};$$

in which P, Q, R denote quantities which are independent of x.

The three terms of this expreſſion are next to be reduced to a common denominator and collected into one, and the coefficients of the powers of x in the numerator of the reſult are to be put equal to the like powers of x in the propoſed fraction, we ſhall then have

$$P+Q+R=a,$$
$$(q+r)P+(p+r)Q+(p+q)R=-b,$$
$$qrP+prQ+pqR=c,$$

and by theſe equations the values of P, Q, R may be found.

Let $\frac{P}{1-px}$, $\frac{Q}{1-qx}$, $\frac{R}{1-rx}$ be now reſolved into ſeries by diviſion; then, adding the like powers of x in each we have

$$(P+Q+R)+(Pp+Qq+Rr)x+(Pp^2+Qq^2 +Rr^2)x^2+, \&c.$$

for the ſeries which is the developement of the fraction

$$\frac{a+bx+cx^2}{1-\alpha x-\beta x^2-\gamma x^3}$$

and here the general term is evidently

$$(Pp^{n-1}+Qq^{n-1}+Rr^{n-1})x^{n-1};$$

and in the very ſame manner may the general term be found in every caſe in which the denominator of the fraction admits of being reſolved into unequal factors.

(21.) Let us now ſuppoſe the fraction to have the form $\frac{a+bx}{(1-px)^2}$, the denominator being the product of two equal factors; this fraction cannot be decompoſed into other fractions, the denominators of which are the ſimple factors of its denominator. We may, however, transform it into two, which ſhall have their numerators conſtant quantities by proceeding as follows: Aſſume the numerator $a+bx=P+Q(1-px)$, then, that x may remain indeterminate, we muſt have $P+Q=a$, $-pQ=b$, therefore

$$Q=-\frac{b}{p}, \quad P=a+\frac{b}{p}.$$

The aſſumption of $a+bx=P+Q(1-px)$ gives us therefore

$$\frac{a+bx}{(1-px)^2}=\frac{P}{(1-px)^2}+\frac{Q}{1-px}.$$

Now, putting the firſt term of the latter ſide of this equation under the form $P(1-px)^{-2}$, it is reſolved by the binomial theorem into the ſeries

$$P(1+2px+3p^2x^2+4p^3x^3+, \&c.);$$

the other fraction $\frac{Q}{1-px}$ being expanded into a ſeries is

$$Q+Qpx+Qp^2x^2+, \&c.$$

Therefore, the complete developement of $\frac{a+bx}{(1-px)^2}$ is

$$P+Q+(2P+Q)px+(3P+Q)p^2x^2+, \&c.$$

and here the general term is manifeſtly
$(nP+Q)p^{n-1}x^{n-1}$, or, ſubſtituting for P and Q their values,

$$\left\{npa+(n-1)b\right\}p^{n-2}x^{n-1}.$$

(22.) In general, whatever be the form of the fraction from which a recurring ſeries is derived, to determine the general term we muſt decompoſe the fraction into others which may be as ſimple as poſſible; and provided it be rational, and the higheſt power of x in the numerator at leaſt one degree leſs than the higheſt power in the denominator, it may be always decompoſed into others having one or other of theſe two forms

$$\frac{P}{1-px}, \frac{Q}{(1-qx)^n},$$

in which expreſſions P, Q, p, and q, denote quantities independent of x. Each partial fraction gives a recurring ſeries, the general term of which will be ſufficiently obvious; and as the ſeries belonging to the original fraction, is the ſum of theſe ſeries, ſo alſo its general term will be the ſum of all their general terms.

We have now treated of ſome of the more general methods of ſumming ſeries which admit of being explained by the common principles of algebra; but the ſubject is of great extent, and to treat of it ſo as to give a tolerable notion of its various branches, would require more room than could with propriety be ſpared in ſuch a work as ours.

(23.) The fluxionary calculus affords a method, almoſt the only general one we poſſeſs, of ſumming ſeries. The general principles upon which it is applied may be ſtated briefly as follows. Since the fluent of any fluxion containing one variable quantity may always be expreſſed by a ſeries, on the contrary every ſeries may be regarded as the expreſſion of a fluent: when any ſeries then is propoſed, we muſt endeavour to find the fluxional expreſſion of which that ſeries is the fluent; and as we can always find the fluent of a fluxion, at leaſt by approximation, within given limits; we may thence determine, if not the exact, at leaſt the approximate value of any infinite ſeries. We ſhall now ſhew how this principle may be applied in ſome particular caſes.

Problem I. It is propoſed to find the ſum of n terms of the ſeries

$$x+2x^2+3x^3+4x^4 \cdots\cdots +nx^n.$$

Let the ſum be denoted by s. Then, multiplying all the terms by $\frac{\dot{x}}{x}$ we have

$$\frac{s\dot{x}}{x}=\dot{x}+2x\dot{x}+3x^2\dot{x}+4x^3\dot{x}\cdots+nx^{n-1}\dot{x}$$

Let the fluent of both ſides be now taken, and the reſult is

$$\int\frac{s\dot{x}}{x}=x+x^2+x^3+x^4\cdots+x^n.$$

Now the ſeries on the right-hand ſide of this equation is a geometrical progreſſion, the ſum of which is known to be $\frac{x-x^{n+1}}{1-x}$, (Algebra, § 106.). Therefore

$$\int\frac{s\dot{x}}{x}=\frac{x-x^{n+1}}{1-x},$$

and

and, taking the fluxions,

$$\frac{s\dot{x}}{x}=\frac{\dot{x}-(n+1)x^{n}\dot{x}+n\,x^{n+1}\dot{x}}{(1-x)^{2}}.$$

Hence we find

$$s=\frac{x-(n+1)x^{n+1}+n\,x^{u+2}}{(1-x)^{2}}.$$

This reſult agrees with that formerly found (17.) of this article.

Problem II. It is propoſed to ſum the infinite ſeries

$$1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\frac{1}{11}+,\ \&c.$$

We may conſider this ſeries as a particular caſe of the more general ſeries,

$$x-\frac{x^{3}}{3}+\frac{x^{5}}{5}-\frac{x^{7}}{7}+,\ \&c.$$

namely, that in which $x=1$. Putting, therefore, the ſum $=s$, and taking the fluxions, we have

$$\dot{s}=\dot{x}(1-x^{2}+x^{4}-x^{6}+,\ \&c.).$$

Now the ſeries in the parentheſis is obviouſly the developement of the rational fraction $\frac{1}{1+x^{2}}$; therefore, $\dot{s}=\frac{\dot{x}}{1+x^{2}}$, and taking the fluent $s=\text{arc (tan.} =x)$ $+c$, radius being unity. (Fluxions, § 60.). Now when $x=0$, all the terms of the ſeries vaniſh, ſo that in this caſe $s=0$; and as when $x=0$, arc. (tan. $=x$)$=0$; therefore c, the conſtant quantity added to complete the fluent is 0, and we have ſimply $s=$arc. (tan. $=x$), and when $x=1$, then $s=\frac{1}{2}$ a quadrant $=.7853982$.

Problem III. Required the ſum of the infinite ſeries

$$\frac{x}{1\cdot 2}+\frac{x^{2}}{2\cdot 3}+\frac{x^{3}}{3\cdot 4}+\frac{x^{4}}{4\cdot 5}+,\ \&c.$$

Putting s for the ſum, and taking the fluxions, we get

$$\dot{s}=\frac{\dot{x}}{x^{2}}\left(\frac{x^{2}}{2}+\frac{x^{3}}{3}+\frac{x^{4}}{4}+\frac{x^{5}}{5}+,\ \&c.\right).$$

Now the ſeries in the parentheſis is evidently equal to $-x-$ Nap. log. $(1-x)$, (ſee Logarithms, page 76. column 1.) ; therefore

$$\dot{s}=-\frac{\dot{x}}{x}-\frac{\dot{x}}{x^{2}}\times\text{Nap. log. }(1-x).$$

To find the fluent, let us put v for the function $\frac{1}{x}$ log. $(1-x)$, then, taking its fluxion, we have

$$\dot{v}=-\frac{\dot{x}}{x^{2}}\times\text{log. }(1-x)-\frac{\dot{x}}{x(1-x)},$$

and $-\frac{\dot{x}}{x^{2}}\times\text{log. }(1-x)=\dot{v}+\frac{\dot{x}}{x(1-x)}$,

therefore, ſubſtituting, we get

$$\dot{s}=\dot{v}+\frac{\dot{x}}{x(1-x)}-\frac{\dot{x}}{x}$$

$$=\dot{v}+\frac{\dot{x}}{1-x};$$

and taking the fluents,

$$s=v-\text{log. }(1-x)+c$$

$$=\frac{\text{log. }(1-x)}{x}-\text{log. }(1-x)+c.$$

To determine the conſtant quantity c, let us take $x=0$, then, in this caſe all the terms of the ſeries vaniſh ſo that $s=0$, alſo log. $(1-x)=$log. $1=0$; and ſince in general $\frac{\text{log. }(1-x)}{x}=\frac{1}{x}\left(-x-\frac{x^{2}}{2}-\frac{x^{3}}{3}-,\ \&c.\right)=-1-\frac{x}{2}-\frac{x^{2}}{3}-,\ \&c.$ when $x=0$, then $\frac{\text{log. }(1-x)}{x}=-1$: therefore $0=-1+c$, and $c=1$;

hence it appears that

$$s=\frac{\text{log. }(1-x)}{x}-\text{log. }(1-x)+1$$

$$=\frac{(1-x)\,\text{log. }(1-x)}{x}+1.$$

Example. Let $x=\frac{1}{2}$, then our formula gives

$$\frac{1}{1\cdot 2\cdot 2}+\frac{1}{2\cdot 3\cdot 2^{2}}+\frac{1}{3\cdot 4\cdot 2^{3}}+\frac{1}{4\cdot 5\cdot 2^{4}}+,\ \&c.$$

$=1-$ Nap. log. $2=.3068528$.

Problem IV. Let the ſeries to be ſummed be

$$1+\frac{m}{n}x+\frac{m+1}{n+1}x^{2}+\frac{m+2}{n+2}x^{3}+,\ \&c.$$

Putting s for this ſeries, let all its terms be multiplied by x^{n-1} ſo that the exponent of x in each may be identical with its denominator, the reſult is

$$s\,x^{n-1}=x^{n-1}+\frac{m}{n}x^{n}+\frac{m+1}{n+1}x^{n+1}+\frac{m+2}{n+2}x^{n+2}+,\ \&c.$$

and hence taking the fluxions

$$\dot{s}\,x^{n-1}+(n-1)\,s\,\dot{x}\,x^{n-2}=(n-1)\,\dot{x}\,x^{n-2}+m\dot{x}\,x^{n-1}$$
$$+(m+1)\dot{x}\,x^{n}+(m+2)\,\dot{x}\,x^{n+1}+,\ \&c.$$

Let both ſides of this equation be now multiplied by x^{m-n}, and it becomes

$$\dot{s}\,x^{m-1}+(n-1)\,s\,\dot{x}\,x^{m-2}=(n-1)\dot{x}\,x^{m-2}+m\,\dot{x}\,x^{m-1}$$
$$+(m+1)\dot{x}\,x^{m}+(m+2)\dot{x}\,x^{m+1}+,\ \&c.$$

Putting now the ſingle character $\dot{p}$ for the fluxional expreſſion which forms the firſt member of this equation, we get by taking the fluents of both ſides,

$$p=\frac{n-1}{m-1}x^{m-1}+x^{m}+x^{m+1}+x^{m+2}+,\ \&c.$$

$$=\frac{n-1}{m-1}x^{m-1}+x^{m}(1+x+x^{2}+x^{3}+,\ \&c.);$$

but the ſeries in the parentheſis is the developement of $\frac{1}{1-x}$, therefore

$$p=\frac{n-1}{m-1}x^{m-1}+\frac{x^{m}}{1-x};$$

taking

taking now the fluxions, and ſubſtituting inſtead of $\dot{p}$ the expreſſion it was put to repreſent, we get

$$\dot{s}x^{m-1}+(n-1)s\dot{x}x^{m-2}$$

$$=(n-1)\dot{x}x^{m-2}+\frac{m\dot{x}x^{m-1}}{1-x}+\frac{\dot{x}x^{m}}{(1-x)^{2}},$$

and this, after reduction, becomes

$$\dot{s}+\frac{n-1}{x}s\dot{x}=\frac{(n-1)\dot{x}}{x}+\frac{m\dot{x}}{1-x}+\frac{x\dot{x}}{(1-x)^{2}}.$$

This fluxional equation being of the firſt degree, and firſt order, its primitive equation may be found (from the general formula given in FLUXIONS, § 182.) to be

$$s=\frac{1}{x^{n-1}}\times\int\left\{(n-1)\dot{x}x^{n-2}+\frac{m\dot{x}x^{n-1}}{1-x}+\frac{\dot{x}x^{n}}{(1-x)^{2}}\right\};$$

and this again, by remarking that $\int(n-1)\dot{x}x^{n-2}=x^{n-1}$, and that

$$\int\frac{m\dot{x}x^{n-1}}{1-x}=\frac{mx^{n}}{n(1-x)}-\int\frac{m\dot{x}x^{n}}{n(1-x)^{2}},$$

may be reduced to

$$s=1+\frac{mx}{n(1-x)}+\frac{n-m}{nx^{n-1}}\int\frac{x^{n}\dot{x}}{(1-x)^{2}}.$$

The remaining fluent $\int\frac{x^{n}\dot{x}}{(1-x)^{2}}$ may be found by § 109. FLUXIONS, and it muſt be ſo taken, that after being multiplied by $\frac{n-m}{nx^{n-1}}$, it ſhall vaniſh when $x=0$; for then this hypotheſis will make the whole function which expreſſes the value of s vaniſh, except its firſt term 1, as it ought to do.

Example. Let us ſuppoſe $n=2$, then

$$\int\frac{x^{2}\dot{x}}{(1-x)^{2}}=x+\frac{x}{1-x}+2\text{ log. }(1-x),$$

and

$$\frac{2-m}{2x}\int\frac{x^{2}\dot{x}}{(1-x)^{2}}=\frac{(2-m)x}{2(1-x)}$$

$$+\frac{2-m}{x}\text{log. }(1-x),$$

the fluent being here taken as directed. In this caſe then, after collecting the terms, we get s, or

$$1+\frac{m}{2}x+\frac{m+1}{3}x^{2}+\frac{m+2}{4}x^{3}+,\ \&c.$$

$$=\frac{1}{1-x}+\frac{(2-m)}{x}\text{ log. }(1-x).$$

(24). There is a branch of the doctrine of ſeries which is of conſiderable importance in pure mathematics as well as in many phyſical inquiries, and in the ſcience of aſtronomy; it is called the *Interpolation* of ſeries.

To interpolate a ſeries is to interpoſe among its terms others which ſhall be ſubject to the ſame law, or which ſhall be formed in the ſame manner as the original terms of the ſeries; or in other words, it is to find the value of one or more terms by means of others which are given, and which may be either at equal or unequal intervals from one another, the places of the given terms as well as of thoſe ſought being ſuppoſed known.

It is eaſy to ſee that this problem may be applied to the conſtruction of logarithmic tables; for we may regard the logarithms of the natural numbers 1, 2, 3, 4, &c. *ad infinitum* as the terms of a particular ſeries of which the numbers themſelves are then the indices. Having given the logarithms of ſome numbers, we may by interpolating deduce from them the logarithms of others.

Again, in aſtronomy we may conſider the numbers which expreſs the ſucceſſive obſerved poſitions of a celeſtial body as the terms of a ſeries, their indices being the intervals of time between the obſervations, and ſome aſſumed epoch, and the problem we are conſidering will enable us to determine the poſition at any inſtant different from the times of actual obſervation, provided the intervals between the obſervations be ſmall, and the inſtant for which the poſition is ſought not very remote from thoſe at which the obſervations were made.

(25.) With a view to illuſtrate the nature of the problem to be reſolved, let us conſider ſome particular caſe, as for example the arithmetical ſeries

$$a,\ a+d,\ a+2d,\ a+3d,\ a+4d,\ \&c.$$

Let t and t' be two given terms of the ſeries, which are at any diſtance from one another, and let n and n' be their indices, or numbers which denote their places in the ſeries. Alſo let y be any term whatever, and x its index. Then by the nature of an arithmetical ſeries,

$$t=a+(n-1)d,\ t'=a+(n'-1)d,$$
$$y=a+(x-1)d,$$

Now, as there are here three equations, each involving the quantities a and d, we may eliminate both theſe quantities by the common rules (ALGEBRA, Sect. VII.), and this being done, we get

$$(x-n')(t'-t)=(n'-n)(y-t');$$

and hence we find this expreſſion,

$$y=\frac{x-n'}{n-n'}t+\frac{x-n}{n'-n}t',$$

which is a general formula for interpolating any arithmetical ſeries, and it is obſervable, that it is entirely independent both of the firſt term and common difference.

Example. The 7th term of an arithmetical ſeries is 15, and the 12th term is 25: It is required to find the 10th term.

Here $n=7,\ n'=12,\ x=10;$
$t=15,\ t'=25,\ y$ is ſought.

Therefore by the formula,

$$y=\frac{2}{5}\times 15+\frac{3}{5}\times 25=21,\text{ the anſwer.}$$

(26.) The mode of inveſtigation by which we have found a formula for the interpolation of an arithmetical ſeries will apply alſo to others, if the law according to which the terms are formed be known; in general, however, the law of a ſeries to be interpolated is either not

not known, or it is not taken into account, and we only conſider the abſolute magnitudes of certain terms, and the numbers expreſſing their places in the ſeries. To reſolve the problem generally with theſe *data*, it is uſual to proceed as follows: Let a ſtraight line, AB, and a point A in it, be aſſumed as given in poſition, and let there be taken the ſegments AD, AD', AD'', AD''', &c. proportional to the numbers denoting the places of the terms of a ſeries reckoned from any term aſſumed as a fixed origin, and at the points D, D'. D'', let there be erected perpendiculars proportional to the terms themſelves. Let us now ſuppoſe a curve to paſs through C, C', C'', C''', &c. then, if it be ſo choſen that its curvature may vary gradually in its progreſs from point to point, without any very abrupt changes of inflection, and moreover, if the terms (which we may ſuppoſe to be either at equal or unequal diſtances) are pretty near to one another, it is eaſy to conceive, that if AP be taken equal to the number expreſſing the place of a term between $C''D''$, $C'''D'''$ any two others, the term itſelf will, if not exactly, at leaſt be nearly expreſſed by PQ, the ordinate to the curve.

Plate [illegible]viii.

As an infinite variety of curves may be found that ſhall paſs through the ſame given points; in this reſpect the problem is unlimited; it is, however, convenient to aſſume ſuch as are ſimple and tractable. The parabolic claſs poſſeſs theſe properties, and accordingly they are commonly employed.

Let us then expreſs the ordinates CD, $C'D'$, $C''D''$, $C'''D'''$, &c. which are the given terms of the ſeries by

$$t,\ t',\ t'',\ t''',\ \&c.$$

and the abſciſſæ AD, AD', AD'', AD''', or the numbers denoting the order of the terms by

$$n,\ n'\ n'',\ n''',\ \&c.$$

Put y for PQ, a term to be interpolated, and x for AP its place. Then, conſidering x and y as indefinite co-ordinates, a parabolic curve that ſhall paſs through the points C, C', C'', C''', &c. will have for its equation

$$y=A+Bx+Cx^2+Dx^3,\ \&c.$$

the number of terms on the right-hand ſide being ſuppoſed equal to that of the given points, and A, B, C, &c. being put to denote conſtant quantities. To determine theſe we muſt conſider that when $x=n$, then $y=t$, and that when $x=n'$, then $y=t'$ and ſo on, therefore, ſubſtituting the ſucceſſive correſponding values of x and y we get

$$\begin{array}{l} t\ =A+B\,n\ +C\,n^2\ +D\,n^3\ +,\ \&c. \\ t'\ =A+B\,n'\ +C\,n'^2\ +D\,n'^3\ +,\ \&c. \\ t''=A+B\,n''\ +C\,n''^2\ +D\,n''^3\ +,\ \&c. \\ t'''=A+B\,n'''+C\,n'''^2+D\,n'''^3+,\ \&c. \\ \qquad \&c. \qquad\qquad \&c. \end{array}$$

this ſeries of equations muſt be continued until their number be the ſame as that of the coefficient, A, B, C, D, &c. If we now conſider t, t', t'', &c. and n, n', n'', &c. as known, and A, B, C, &c. as unknown quantities, we may determine theſe laſt by eliminating them one after another from the above equations, as is taught in ALGEBRA, Sect. XVII. And the values of A, B, C, &c. being thus determined and ſubſtituted in the general equation, we ſhall have a general expreſſion for y in terms of x the number denoting its place and known quantities; and this is in ſubſtance the ſolution originally given of the problem by Sir Iſaac Newton, who propoſed it in the third book of his *Principia* with a view to its application in aſtronomy.

A celebrated foreign mathematician (Lagrange) has, in the *Cahiers de l'Ecole Normale*, given a different form to the expreſſion for y. He has obſerved that ſince, when x becomes n, n', n'', n''', &c. ſucceſſively, then y becomes t, t', t'', t''', &c. It follows that the expreſſion for y muſt have this form.

$$y=\alpha\,t+\beta\,t'+\gamma\,t''+\partial\,t'''+,\ \&c.$$

where the quantities α, β, γ, &c. muſt be ſuch functions of x, that if we put $x=n$, then $\alpha=1$ and $\beta=0$, $\gamma=0$, &c. and if we put $x=n'$, then $\alpha=0$, $\beta=1$, $\gamma=0$, &c.; and again, if we make $x=n''$, then $x=0$, $\beta=0$, $\gamma=1$, &c. and ſo on. Hence it is eaſy to conclude that the values of α, β, γ, &c. muſt have the form

$$\alpha=\frac{(x-n')(x-n'')(x-n''')}{(n-n')(n-n'')(n-n''')},\ \&c.$$

$$\beta=\frac{(x-n)(x-n'')(x-n''')}{(n'-n)(n'-n'')(n'-n''')},\ \&c.$$

$$\gamma=\frac{(x-n)(x-n')(x-n''')}{(n''-n)(n''-n')(n''-n''')},\ \&c.$$

$$\partial=\frac{(x-n)(x-n')(x-n''')}{(n'''-n)(n'''-n')(n'''-n'')},\ \&c.$$

$$\&c.$$

and here the number of factors in the numerator and denominator muſt be each equal to the number of given points in the curve. This formula would be found to be identical with that which may be obtained by the method indicated in laſt article, if we were to take the actual product of the factors and arrange the whole expreſſion according to powers of x. It poſſeſſes however one advantage over the other, viz. that of admitting of the application of logarithms.

We ſhall now ſhew the application of this formula.

Ex. 1. Having given the logarithms of 101, 102, 104, and 105, it is required to find the logarithm of 103.

In this caſe we may reckon the terms of the ſeries forward from the firſt given term, viz. log. 101, ſo that we have

$$\begin{array}{ll} t\ =\text{log. }101=2.0043214, & n\ =0, \\ t'\ =\text{log. }102=2.0086002, & n'\ =1, \\ y\ =\text{log. }103=\text{term ſought}, & x\ =2, \\ t''=\text{log. }104=2.0170333, & n''\ =3, \\ t'''=\text{log. }105=2.0211893, & n'''=4. \end{array}$$

Subſtituting now in the general formula we get

$$\alpha=\frac{1\times-1\times-2}{-1\times-3\times-4}=-\frac{1}{6},\quad \gamma=\frac{2\times1\times-2}{3\times2\times-1}=\ \frac{2}{3},$$

$$\beta=\frac{2\times-1\times-2}{1\times-2\times-3}\ =\ \frac{2}{3},\quad \partial=\frac{2\times1\times-1}{4\times3\times1}=-\frac{1}{6},$$

$$\text{Therefore } y=-\frac{t}{6}+\frac{2t'}{3}+\frac{2\,t''}{3}-\frac{t'''}{6}$$

$$=\tfrac{2}{3}(t'+t'')-\tfrac{1}{6}(t+t''')$$

$$=2.0128372 \text{ the anſwer.}$$

Ex.

Ex. 2. Given a comet's diſtance from the ſun on the following days at 12 at night, to find its diſtance December 20th.

December 12. diſtance 301, Dec. 24. diſtance 715,
21. 629, 26. 772.

Here we ſhall eſtimate the places of the terms from the time of the firſt poſition, viz. December 12. Therefore

$$\begin{array}{ll} t = 301, & n = 0, \\ y \text{ is ſought}, & x = 8, \\ t' = 620, & n' = 9, \\ t'' = 715, & n'' = 12, \\ t''' = 772, & n''' = 14. \end{array}$$

In this caſe the general formula gives us

$$\alpha = \frac{1}{63}, \beta = \frac{6}{45}, \gamma = -\frac{2}{3}, \delta = \frac{8}{35},$$

therefore

$$y = \frac{t}{63} + \frac{64t'}{45} - \frac{2t''}{3} + \frac{8t'''}{35}.$$

$$= 586.3 \text{ the anſwer.}$$

We ſhall conclude this article with a brief enumeration of the beſt works on the ſubject which we have been treating of.

Ars Conjectandi, (Jac. Bernoulli). *Methodus Differentialis*, (Newton). *Methodus Incrementorum*, (Taylor). *Methodus Differentialis, ſive Tractatus de Summatione et Interpolatione Serierum*, (Stirling). *Inſtitutiones Calcul. Diff.* (Euler). *Emerſon's Method of Increments*. The differential method, (ſame author). *Miſcellanea Analytica*, (De Moivre). The various writings of Landen and Simpſon. *Theorie des Fonctions Analytiques*, (Lagrange). *Du Calcul des Derivation*, (Arbogart). *Traité des differences et des Series*, (a ſequel to Lacroix's work on the *Calcul Differential*, &c.). Dr Hutton's Mathematical and Philoſophical Tracts. An Eſſay on the Theory of the various orders of Logarithmic Tranſcendents, with an Inquiry into their applications to the Integral Calculus, and the Summation of Series, by W. Spence, &c. &c.

SERINGAPATAM, the capital of Myſore, formerly the dominions of Tippoo Sultan, is ſituated in an iſland of the Cavery river, about 290 or 300 miles from Madras, and in N. Lat. 12° 32′ and E. Long. 96° 47′, about four miles in length, by one and a half in breadth, acroſs the middle, where it is likewiſe higheſt, whence it gradually falls and narrows towards the extremities. The weſt end of the iſland, on which there is a fort of conſiderable ſtrength, ſlopes more, eſpecially towards the north; and the ground riſing on the oppoſite ſide of the river commands a diſtinct view of every part of the fort. The fort and outworks occupy about a mile of the weſt end of the iſland, and are diſtinguiſhed by magnificent buildings, and ancient Hindoo pagodas, contraſted with the more lofty and ſplendid monuments lately raiſed in honour of the Mahometan faith. The great garden, called the *Laul Baug*, covers about as much of the eaſt end of the iſland as the fort and outworks do of the weſt; and the whole intermediate ſpace, except a ſmall incloſure on the north bank near the fort, was, before the laſt war, filled with houſes, and formed an extenſive ſuburb, of which the greateſt part was deſtroyed by Tippoo to make room for batteries to defend the iſland, when attacked by the combined forces of Earl Cornwallis and the Mahratta chiefs in February 1792. This ſuburb, or town of modern ſtructure, is about half a mile ſquare, divided into regular croſs ſtreets, all wide, and ſhaded on each ſide by trees. It is ſurrounded by a ſtrong mud wall, contains many good houſes, and ſeems to have been preſerved by the Sultan for the accommodation of merchants, and for the convenience of troops ſtationed on that part of the iſland for its defence. A little to the eaſtward of the town is the entrance to the great garden, which was laid out in regular ſhady walks of large cypreſs trees, and abounding with fruit-trees, flowers, and vegetables of every deſcription. It poſſeſſed all the beauty and elegance of a country retirement, and was dignified by the mauſoleum of Hyder, and a ſuperb new palace built by his ſon. This noble garden was devoted to deſtruction; and the trees which had ſhaded their proud maſter, and contributed to his pleaſures, were formed into the means of protecting his enemies in ſubverting his empire. "Before that event, ſo glorious to the arms of England, this inſulated metropolis (ſays Major Dirom) muſt have been the richeſt, moſt convenient, and beautiful ſpot poſſeſſed in the preſent age by any native prince in India; but when the allies left it, the Sultan's fort and city only remained in repair amidſt all the wrecks of his former grandeur, the iſland preſenting nothing but the appearance of wretched barrenneſs. Tippoo is a man of talents, enterpriſe, and great wealth; but, in the opinion of our author, the remaining years of his ill-fated life will be unequal to renew the beauties of his terreſtrial paradiſe." This prediction was more than verified in the fate of Tippoo; for he loſt his life in bravely defending his capital, which was taken by aſſault in 1799 by the Britiſh troops under General Baird. See INDIA, N° 183.

SERINGHAM, an iſland of Indoſtan, formed about ſix miles north-weſt of Trinchinopoly by the river Cavery, which divides itſelf into two branches: that to the northward takes the name of *Coleroon*, but the ſouthern branch preſerves its old name the *Cavery*. Each of theſe rivers, after a courſe of about 90 miles, empty themſelves into the ſea; the Coleroon at Devicottah, and the Cavery near Tranquebar, at about 20 miles diſtance from one another. In this iſland, facing Trinchinopoly, ſtood a famous pagoda ſurrounded by ſeven ſquare walls of ſtone, 25 feet high and four feet thick. The ſpace between the outward and ſecond walls meaſured 310 feet, and ſo proportionably of the reſt. Each incloſure had four large gates, with a high tower; which were placed, one in the middle of each ſide of the incloſure, and oppoſite to the four cardinal points. The outward wall was about four miles in circumference, and its gateway to the ſouth was ornamented with pillars, ſome of which were ſingle ſtones 33 feet in length and five in diameter; while thoſe that formed the roof were ſtill larger; and in the inmoſt incloſure were the chapels.—About half a mile to the eaſt was another large pagoda called *Jumbikiſtna*, which had but one incloſure.

The pagoda of Seringham was held in great veneration, from a belief that it contained the identical image of of the god Wiſtnou worſhipped by Brama; and pilgrims came here from all parts of India with offerings of money to procure abſolution. A large part of the revenue of the iſland was allotted for the maintenance of the Bramins who inhabited the pagoda; and theſe, with their families, formerly amounted to no fewer than 40,000 perſons, all maintained by the ſuperſtitious liberality of the adjacent country.

SERIOLA, a genus of plants belonging to the claſs ſyngeneſia, and in the natural ſyſtem ranged under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SERIPHIUM, a genus of plants belonging to the claſs ſyngeneſia. See BOTANY *Index*.

SERIPHUS, in *Ancient Geography*, one of the Cyclades or iſlands in the Ægean ſea, called *Saxum Seriphium* by Tacitus, as if all a rock; one of the uſual places of baniſhment among the Romans. The people, *Seriphii;* who, together with the Siphnii, joined Greece againſt Xerxes, were almoſt the only iſlanders who refuſed to give him earth and water in token of ſubmiſſion, (Herodotus). *Seriphia Rana*, a proverbial ſaying concerning a perſon who can neither ſing nor ſay; frogs in this iſland being ſaid to be dumb, (Pliny).

SERMON, a diſcourſe delivered in public, for the purpoſe of religious inſtruction and improvement.

Funeral SERMON. See *FUNERAL Orations.*

SERON OF ALMONDS, is the quantity of two hundred weight; of aniſe ſeed, it is from three to four hundred; of Caſtile ſoap, from two hundred and a half to three hundred and three quarters.

SEROSITY, in *Medicine*, the watery part of the blood.

SERPENS, in *Aſtronomy*, a conſtellation in the northern hemiſphere, called more particularly *Serpens Ophiuchi*. The ſtars in the conſtellation Serpens, in Ptolemy's catalogue, are 18; in Tycho's, 13; in Hevelius's, 22; and in the Britannic catalogue, 64.

SERPENS Biceps, or *Double-headed Snake;* a monſter of the ſerpent kind, of which ſome individuals are deſcribed by naturaliſts.

SERPENTES, *Serpents*, in the Linnæan ſyſtem of zoology, an order of animals belonging to the claſs of *amphibia*. See OPHIOLOGY.

The ſerpent has been always conſidered the enemy of man; and it has hitherto continued to terrify and annoy him, notwithſtanding all the arts which have been practiſed to deſtroy it. Formidable in itſelf, it deters the invader from the purſuit; and from its figure, capable of finding ſhelter in a little ſpace, it is not eaſily diſcovered by thoſe who would venture to encounter it. Thus poſſeſſed at once of potent arms, and inacceſſible or ſecure retreats, it baffles all the arts of man, though ever ſo earneſtly bent upon its deſtruction. For this reaſon, there is ſcarcely a country in the world that does not ſtill give birth to this poiſonous brood, that ſeems formed to quell human pride, and repreſs the boaſts of ſecurity. Mankind have driven the lion, the tiger, and the wolf, from their vicinity; but the ſnake and the viper ſtill defy their power.

Their numbers, however, are thinned by human aſſiduity; and it is poſſible ſome of the kinds are wholly deſtroyed. In none of the countries of Europe are they ſufficiently numerous to be truly terrible. The various malignity that has been aſcribed to European ſerpents of old is now utterly unknown; there are not above three or four kinds that are dangerous, and their poiſon operates in all in the ſame manner. The drowſy death, the ſtarting of the blood from every pore, the inſatiable and burning thirſt, the melting down the ſolid maſs of the whole form into one heap of putrefaction, ſaid to be occaſioned by the bites of African ſerpents, are horrors with which we are entirely unacquainted, and are perhaps only the creatures of fancy.

But though we have thus reduced theſe dangers, having been incapable of wholly removing them, in other parts of the world they ſtill rage with all their ancient malignity. In the warm countries that lie within the tropics, as well as in the cold regions of the north, where the inhabitants are few, the ſerpents propagate in equal proportion. But of all countries thoſe regions have them in the greateſt abundance where the fields are unpeopled and fertile, and where the climate ſupplies warmth and humidity. All along the ſwampy banks of the river Niger or Oroonoko, where the ſun is hot, the foreſts thick, and the men but few, the ſerpents cling among the branches of the trees in infinite numbers, and carry on an unceaſing war againſt all other animals in their vicinity. Travellers have aſſured us, that they have often ſeen large ſnakes twining round the trunk of a tall tree, encompaſſing it like a wreath, and thus riſing and deſcending at pleaſure.— We are not, therefore, to reject as wholly fabulous the accounts left us by the ancients of the terrible devaſtations committed by a ſingle ſerpent. It is probable, in early times, when the arts were little known, and mankind were but thinly ſcattered over the earth, that ſerpents, continuing undiſturbed poſſeſſors of the foreſt, grew to an amazing magnitude; and every other tribe of animals fell before them. It then might have happened, that ſerpents reigned the tyrants of a diſtrict for centuries together. To animals of this kind, grown by time and rapacity to 100 or 150 feet in length, the lion, the tiger, and even the elephant itſelf, were but feeble opponents. That horrible fœtor, which even the commoneſt and the moſt harmleſs ſnakes are ſtill found to diffuſe, might, in theſe larger ones, become too powerful for any living being to withſtand; and while they preyed without diſtinction, they might thus alſo have poiſoned the atmoſphere around them. In this manner, having for ages lived in the hidden and unpeopled foreſt, and finding, as their appetites were more powerful, the quantity of their prey decreaſing, it is poſſible they might venture boldly from their retreats into the more cultivated parts of the country, and carry conſternation among mankind, as they had before deſolation among the lower ranks of nature. We have many hiſtories of antiquity, preſenting us ſuch a picture, and exhibiting a whole nation ſinking under the ravages of a ſingle ſerpent. At that time man had not learned the art of uniting the efforts of many to effect one great purpoſe. Oppoſing multitudes only added new victims to the general calamity, and increaſed mutual embarraſſment and terror. The animal was therefore to be ſingly oppoſed by him who had the greateſt ſtrength, the beſt armour, and the moſt undaunted courage. In ſuch an encounter, hundreds muſt have fallen; till one, more lucky than the reſt, by a fortunate blow, or by taking the monſter in its torpid interval, and ſurcharged with ſpoil, might kill, and thus rid his country

country of the deſtroyer. Such was the original occupation of heroes; and thoſe who firſt obtained that name, from their deſtroying the ravagers of the earth, gained it much more deſervedly than their ſucceſſors, who acquired their reputation only for their ſkill in deſtroying each other. But as we deſcend into more enlightened antiquity, we find theſe animals leſs formidable, as being attacked in a more ſucceſsful manner. We are told, that while Regulus led his army along the banks of the river Bagrada in Africa, an enormous ſerpent diſputed his paſſage over. We are aſſured by Pliny, that it was 120 feet long, and that it had deſtroyed many of the army. At laſt, however, the battering engines were brought out againſt it; and theſe aſſailing it at a diſtance, it was ſoon deſtroyed. Its ſpoils were carried to Rome, and the general was decreed an ovation for his ſucceſs. There are, perhaps, few facts better aſcertained in hiſtory than this: an ovation was a remarkable honour; and was given only for ſome ſignal exploit that did not deſerve a triumph: no hiſtorian would offer to invent that part of the ſtory at leaſt, without being ſubject to the moſt ſhameful detection. The ſkin was kept for ſeveral years after in the Capitol; and Pliny ſays he ſaw it there. At preſent, indeed, ſuch ravages from ſerpents are ſcarcely ſeen in any part of the world; not but that, in Africa and America, ſome of them are powerful enough to brave the aſſaults of men to this day.

> *—Nequeunt expleri corda tuendo*
> *Terribiles oculos, vultum villoſaque ſetis*
> *Pectora.—* VIRGIL.

We have given a place to the preceding remarks, not ſo much for their accuracy, as to ſhow what were formerly the ſentiments of mankind concerning this tribe of animals.

SERPENT, a muſical inſtrument, ſerving as a baſs to the cornet, or *ſmall ſhawm*, to ſuſtain a chorus of ſingers in a large edifice. It has its name *ſerpent* from its figure, as conſiſting of ſeveral folds or wreaths, which ſerve to reduce its length, which would otherwiſe be ſix or ſeven feet.

It is uſually covered with leather, and conſiſts of three parts, a mouth-piece, a neck, and a tail. It has ſix holes, by means whereof it takes in the compaſs of two octaves.

Merſennus, who has particularly deſcribed this inſtrument, mentions ſome peculiar properties of it, e. gr. that the ſound of it is ſtrong enough to drown 20 robuſt voices, being animated merely by the breath of a boy, and yet the ſound of it may be attempered to the ſoftneſs of the ſweeteſt voice. Another peculiarity of this inſtrument is, that great as the diſtance between the third and fourth hole appears, yet whether the third hole be open or ſhut, the difference is but a tone.

SERPENT, in *Mythology*, was a very common ſymbol of the ſun, and he is repreſented biting his tail, and with his body formed into a circle, in order to indicate the ordinary courſe of this luminary, and under this form it was an emblem of time and eternity. The ſerpent was alſo the ſymbol of medicine, and of the gods which preſided over it, as of Apollo and Æſculapius: and this animal was the object of very ancient and general worſhip, under various appellations and characters.

In moſt of the ancient rites we find ſome alluſion to the ſerpent, under the ſeveral titles of Ob, Ops, Python, &c. This idolatry is alluded to by Moſes, (Lev. xx. 27.). The woman at Endor who had a familiar ſpirit is called Oub, or Ob, and it is interpreted Pythoniſſa. The place where ſhe reſided, ſays the learned Mr Bryant, ſeems to have been named from the worſhip then inſtituted; for Endor is compounded of *En ador*, and ſignifies *fons Pythonis*, " the fountain of light, the oracle of the god Ador, which oracle was probably founded by the Canaanites, and had never been totally ſuppreſſed. His pillar was alſo called *Abbadir*, or *Abadir*, compounded of *ab* and *adir*, and meaning the ſerpent deity Addir, the ſame as Adorus.

In the orgies of Bacchus, the perſons who partook of the ceremony uſed to carry ſerpents in their hands, and with horrid ſcreams call upon Eva! Eva! Eva! being, according to the writer juſt mentioned, the ſame as epha, or opha, which the Greeks rendered *ophis*, and by it denoted a ſerpent. Theſe ceremonies and this ſymbolic worſhip began among the Magi, who were the ſons of Chus; and by them they were propagated in various parts. Wherever the Ammonians founded any places of worſhip, and introduced their rites, there was generally ſome ſtory of a ſerpent. There was a legend about a ſerpent at Colchis, at Thebes, and at Delphi; and likewiſe in other places. The Greeks called Apollo himſelf Python, which is the ſame as Opis, Oupis, and Oub.

In Egypt there was a ſerpent named Thermuthis, which was looked upon as very ſacred; and the natives are ſaid to have made uſe of it as a royal tiara, with which they ornamented the ſtatues of Iſis. The kings of Egypt wore high bonnets, terminating in a round ball, and ſurrounded with figures of aſps; and the prieſts likewiſe had the repreſentation of ſerpents upon their bonnets.

Abadon, or Abaddon, mentioned in the Revelations xx. 2. is ſuppoſed by Mr Bryant to have been the name of the Ophite god, with whoſe worſhip the world had been ſo long infected. This worſhip began among the people of Chaldea, who built the city of Ophis upon the Tigris, and were greatly addicted to divination, and to the worſhip of the ſerpent. From Chaldea the worſhip paſſed into Egypt, where the ſerpent deity was called Canoph, Can-eph, and C'neph. It had alſo the name of Ob or Oub, and was the ſame as the Baſiliſcus or royal ſerpent, the ſame as the Thermuthis, and made uſe of by way of ornament to the ſtatues of their gods. The chief deity of Egypt is ſaid to have been Vulcan, who was ſtyled Opas. He was the ſame as Oſiris, the Sun, and hence was often called Ob-el, or Pytho-ſol; and there were pillars ſacred to him, with curious hieroglyphical inſcriptions bearing the ſame name; whence among the Greeks, who copied from the Egyptians, every thing gradually tapering to a point was ſtyled obelos, or obeliſcus.

As the worſhip of the ſerpent began among the ſons of Chus, Mr Bryant conjectures, that from thence they were denominated Ethiopians and Aithiopians, from Ath-ope, or Ath-opes, the god whom they worſhipped, and not from their complexion: the Ethiopes brought theſe rites into Greece, and called the iſland where they firſt eſtabliſhed them, *Ellopia, Solis Serpentis inſula*, the ſame with *Eubœa*, or *Oubaia*, i. e. " the ſerpent iſland."

The ſame learned writer diſcovers traces of the ſerpent worſhip among the Hyperboreans, at Rhodes, named Ophiuſa, in Phrygia, and upon the Helleſpont, in the iſland Cyprus, in Crete, among the Athenians, in the name of Cecrops, among the natives of Thebes in Bœotia, among the Lacedæmonians, in Italy, in Syria, &c. and in the names of many places, as well as of the people where the Ophites ſettled. One of the moſt early hereſies introduced into the Chriſtian church was that of the Ophitæ. Bryant's Analyſis of Ancient Mythology, vol. i. p. 43, &c. p. 473, &c.

SERPENT Stones. See *CORNU Ammonis*, and *SNAKE-Stones.*

Sea-SERPENT. See *SEA-Serpent.*

SERPENTARIA, SNAKE-ROOT; a ſpecies of ARISTOLOCHIA. See BOTANY and MATERIA MEDICA *Index.*

SERPENTARIUS, in *Aſtronomy*, a conſtellation of the northern hemiſphere, called alſo Ophiuchus, and anciently Æſculapius. The ſtars in the conſtellation Serpentarius, in Ptolemy's catalogue, are 29; in Tycho's 15; in Hevelius's 40; in the Britannic catalogue they are 74.

SERPENTINE, in general, denotes any thing that reſembles a ſerpent; hence the worm or pipe of a ſtill, twiſted in a ſpiral manner, is termed a *ſerpentine worm.*

SERPENTINE-Stone, a ſpecies of mineral belonging to the magneſian genus. See MINERALOGY *Index.*

SERPENTINE *verſes*, are ſuch as begin and end with the ſame word. As,

Ambo florentes ætatibus, Arcades ambo.

SERPENTINE, in the *Manege.* A horſe is ſaid to have a ſerpentine tongue, if it is always friſking and moving, and ſometimes paſſing over the bit, inſtead of keeping in the void ſpace, called the liberty of the tongue.

SERPICULA, a genus of plants belonging to the claſs monœcia. See BOTANY *Index.*

SERPIGO, in *Surgery*, a kind of herpes, popularly called a *tetter* or ringworm. See SURGERY.

SERPULA, a genus belonging to the claſs of vermes, and to the order of teſtacea. See CONCHOLOGY *Index.*

SERRANUS, JOANNES, or John de Serres, a learned French Proteſtant, was born about the middle of the 16th century. He acquired the Greek and Latin languages at Lauſanne, and devoted himſelf to the ſtudy of the philoſophy of Ariſtotle and Plato. On his return to France he ſtudied divinity. He began to diſtinguiſh himſelf in 1572 by his writings, but was obliged to forſake his country after the dreadful maſſacre of St Bartholomew. He became miniſter of Niſmes in 1582, but was never regarded as a very zealous Calviniſt: he has even been ſuſpected, though without reaſon, of having actually abjured the Proteſtant religion. He was one of the four clergymen whom Henry IV. conſulted about the Romiſh religion, and who returned for anſwer, *that Catholics might be ſaved.* He wrote afterwards a treatiſe in order to reconcile the two communions, entitled *De fide Catholica, ſive de principiis religionis Chriſtianæ, communi omnium Chriſtianorum conſenſu, ſemper et ubique ratis.* This work was diſliked by the Catholics, and received with ſuch indignation by the Calviniſts of Geneva, that many writers have affirmed that they poiſoned the author. It is certain at leaſt that he died at Geneva in 1598, at the age of 50. His principal works are, 1. A Latin tranſlation of Plato, publiſhed by Henry Stephens, which owes much of its reputation to the elegance of the Greek copy which accompanies it. 2. A Treatiſe on the Immortality of the Soul. 3. *De ſtatu religionis et reipublicæ in Francia.* 4. *Memoire de la 3me guerre civile et derniers troubles de France ſous Charles IX. &c.* 5. *Inventaire general de l'Hiſtoire de France, illuſtré par la conference de l'Egliſe et de l'Empire, &c.* 6. *Recueil de choſe memorable avenue en France ſous Henri II. François II. Charles IX. Henri III.* Theſe three hiſtorical treatiſes have been juſtly accuſed of partiality and paſſion; faults which it is next to impoſſible for a contemporary writer to avoid, eſpecially if he bore any part in the tranſactions which he deſcribes. His ſtyle is exceedingly incorrect and inelegant; his miſtakes too and miſſtatements of facts are very numerous.

SERRATED, in general, ſomething indented or notched in the manner of a ſaw; a term much uſed in the deſcription of the leaves of plants. See BOTANY *Index.*

SERRATULA, SAW-WORT, a genus of plants belonging to the ſyngeneſia claſs, and in the natural ſyſtem ranged under the 49th order, *Compoſitæ.* See BOTANY *Index.*

SERRATUS, in *Anatomy*, a name given to ſeveral muſcles, from their reſemblance to a ſaw. See ANATOMY, *Table of the Muſcles.*

SERRISHTEHDAR, in Bengal, keeper of records or accounts.

SERTORIUS, QUINTUS, an eminent Roman general; (ſee SPAIN), under the hiſtory of which his exploits are related.

SERTULARIA, a genus belonging to the claſs of vermes, and to the order of zoophyta. See HELMINTHOLOGY *Index.*

SERVAL, MOUNTAIN CAT. See FELIS, MAMMALIA *Index.*

SERVANDONI, JOHN NICOLAS, a celebrated architect, was born at Florence in 1695. He rendered himſelf famous by his exquiſite taſte in architecture, and by his genius for decorations, fetes, and building. He was employed and rewarded by moſt of the princes in Europe. He was honoured in Portugal with the order of Chriſt: In France he was architect and painter to the king, and member of the different academies eſtabliſhed for the advancement of theſe arts. He received the ſame titles from the kings of Britain, Spain, Poland, and from the duke of Wirtemberg. Notwithſtanding theſe advantages, his want of economy was ſo great, that he left nothing behind him. He died at Paris in 1766. Paris is indebted to him for many of its ornaments. He made decorations for the theatres of London and Dreſden. The French king's theatre, called *la ſalle des Machines*, was under his management for ſome time. He was permitted to exhibit ſome ſhows conſiſting of ſimple decorations: Some of theſe were aſtoniſhingly ſublime; his "Deſcent of Æneas into Hell" in particular, and his "Enchanted Foreſt," are well known. He built and embelliſhed a theatre at Chambor for Mareſchal Saxe; and furniſhed the plan and the model of the theatre royal at Dreſden. His genius for fetes was remarkable; he had the management of a great number in Paris, and even in London. He conducted one at Liſbon given on account of a victory gained by the duke of Cumberland. He was employed frequently by the king of Portugal, to whom he preſented ſeveral elegant plans and models. The prince of Wales, too, father to the preſent king, engaged him in his ſervice; but the death of that prince prevented the execution of the deſigns which had been projected. He preſided at the magnificent *fete* given at Vienna on account of the marriage of the archduke Joſeph and the Infanta of Parma. But it would be endleſs to attempt an enumeration of all his performances and exhibitions.

SERVANT, a term of relation, ſignifying a perſon who owes and pays obedience for a certain time to another in quality of a maſter.

As to the ſeveral ſorts of ſervants: It was obſerved, under the article LIBERTY, that pure and proper ſlavery does not, nay cannot, ſubſiſt in Britain: ſuch we mean whereby an abſolute and unlimited power is given to the maſter over the life and fortune of the ſlave. And indeed it is repugnant to reaſon, and the principles of natural law, that ſuch a ſtate ſhould ſubſiſt anywhere. See SLAVERY.

The law of England therefore abhors, and will not endure, the exiſtence of ſlavery within this nation: ſo that when an attempt was made to introduce it, by ſtatute 1 Edw. VI. c. 3. which ordained, that all idle vagabonds ſhould be made ſlaves, and fed upon bread, water, or ſmall drink, and refuſe-meat; ſhould wear a ring of iron round their necks, arms, or legs; and ſhould be compelled, by beating, chaining, or otherwiſe, to perform the work aſſigned them, were it ever ſo vile; the ſpirit of the nation could not brook this condition, even in the moſt abandoned rogues; and therefore this ſtatute was repealed in two years afterwards. And now it is laid down, that a ſlave or negro, the inſtant he lands in Britain, becomes a freeman; that is, the law will protect him in the enjoyment of his perſon and his property. Yet, with regard to any right which the maſter may have lawfully acquired to the perpetual ſervice of John or Thomas, this will remain exactly in the ſame ſtate as before: for this is no more than the ſame ſtate of ſubjection for life which every apprentice ſubmits to for the ſpace of ſeven years, or ſometimes for a longer term. Hence, too, it follows, that the infamous and unchriſtian practice of withholding baptiſm from negro-ſervants, leſt they ſhould thereby gain their liberty, is totally without foundation, as well as without excuſe. The law of England acts upon general and extenſive principles: it gives liberty, rightly underſtood, that is, protection, to a Jew, a Turk, or a Heathen, as well as to thoſe who profeſs the true religion of Chriſt; and it will not diſſolve a civil obligation between maſter and ſervant, on account of the alteration of faith in either of the parties; but the ſlave is entitled to the ſame protection in England before as after baptiſm; and, whatever ſervice the Heathen negro owed of right to his American maſter, by general, not by local law, the ſame (whatever it be) is he bound to render when brought to England and made a Chriſtian.

1. The firſt ſort of ſervants, therefore, acknowledged by the laws of England, are *menial ſervants*; ſo called from being *intra mœnia*, or domeſtics. The contract between them and their maſters ariſes upon the hiring. If the hiring be general, without any particular time limited, the law conſtrues it to be a hiring for a year; upon a principle of natural equity, that the ſervant ſhall ſerve and the maſter maintain him, throughout all the revolutions of the reſpective ſeaſons; as well when there is work to be done, as when there is not: but the contract may be made for any larger or ſmaller term. All ſingle men between 12 years old and 60, and married ones under 30 years of age, and all ſingle women between 12 and 40, not having any viſible livelihood, are compellable by two juſtices to go out to ſervice in huſbandry or certain ſpecific trades, for the promotion of honeſt induſtry; and no maſter can put away his ſervant, or ſervant leave his maſter, after being ſo retained, either before or at the end of his term, without a quarter's warning; unleſs upon reaſonable cauſe, to be allowed by a juſtice of the peace: but they may part by conſent, or make a ſpecial bargain.

2. Another ſpecies of ſervants are called *apprentices*, (from *apprendre*, to learn); and are uſually bound for a term of years, by deed indented or indentures, to ſerve their maſters, and be maintained and inſtructed by them. This is uſually done to perſons of trade, in order to learn their art and myſtery; and ſometimes very large ſums are given with them as a premium for ſuch their inſtruction: but it may be done to huſbandmen, nay, to gentlemen and others. And children of poor perſons may be apprenticed out by the overſeers, with conſent of two juſtices, till 24 years of age, to ſuch perſons as are thought fitting; who are alſo compellable to take them: and it is held, that gentlemen of fortune, and clergymen, are equally liable with others to ſuch compulſion: for which purpoſes our ſtatutes have made the indentures obligatory, even though ſuch pariſh-apprentice be a minor. Apprentices to trades may be diſcharged on reaſonable cauſe, either at the requeſt of themſelves or maſters, at the quarter-ſeſſions, or by one juſtice, with appeal to the ſeſſions; who may, by the equity of the ſtatute, if they think it reaſonable, direct reſtitution of a rateable ſhare of the money given with the apprentice: and pariſh-apprentices may be diſcharged in the ſame manner by two juſtices. But if an apprentice, with whom leſs than 10 pounds hath been given, runs away from his maſter, he is compellable to ſerve out his time of abſence, or make ſatisfaction for the ſame, at any time within ſeven years after the expiration of his original contract. See APPRENTICE and APPRENTICESHIP.

3. A third ſpecies of ſervants are *labourers*, who are only hired by the day or the week, and do not live *intra mœnia*, as part of the family; concerning whom the ſtatutes before cited have made many very good regulations; 1. Directing that all perſons who have no viſible effects may be compelled to work; 2. Defining how long they muſt continue at work in ſummer and in winter: 3. Puniſhing ſuch as leave or deſert their work: 4. Empowering the juſtices at ſeſſions, or the ſheriff of the county, to ſettle their wages: and, 5. Inflicting penalties on ſuch as either give or exact more wages than are ſo ſettled.

4. There is yet a fourth ſpecies of ſervants, if they may be ſo called, being rather in a ſuperior, a miniſterial, capacity; ſuch as *ſtewards*, *factors*, and *bailiffs*; whom, however, the law conſiders as ſervants *pro tempore*, with regard to ſuch of their acts as affect their maſter's or employer's property.

As to the manner in which this relation affects the maſter, the ſervant himſelf, or third parties, ſee the article *MASTER and Servant*.

For the condition of ſervants by the law of Scotland, ſee LAW.

SERVETISTS, a name given to the modern Antitrinitarians, from their being ſuppoſed to be the followers of Michael Servetus; who, in the year 1553, was burnt at Geneva, together with his books.

SERVETUS, MICHAEL, a learned Spaniſh phyſician, was born at Villanueva, in Arragon, in 1509. He was ſent to the univerſity of Toulouſe to ſtudy the civil law. The Reformation, which had awakened the moſt poliſhed nations of Europe, directed the attention of thinking men to the errors of the Romiſh church and to the ſtudy of the Scriptures. Among the reſt Servetus applied to this ſtudy. From the love of novelty, or the love of truth, he carried his inquiries far beyond the other reformers, and not only renounced the falſe opinions of the Roman Catholics, but went ſo far as to queſtion the doctrine of the Trinity. Accordingly, after ſpending two or three years at Toulouſe, he determined to go into Germany to propagate his new opinions, where he could do it with moſt ſafety. At Baſil he had ſome conferences with Oecolampadius. He went next to Straſburg to viſit Bucer and Capito, two eminent reformers of that town. From Straſburg he went to Hugenau, where he printed a book, intitled *De Trinitatis Erroribus*, in 1531. The enſuing year he publiſhed two other treatiſes on the ſame ſubject: in an advertiſement to which, he informs the reader that it was not his intention to retract any of his former ſentiments, but only to ſtate them in a more diſtinct and accurate manner. To theſe two publications he had the courage to put his name, not ſuſpecting that in an age when liberty of opinion was granted, the exerciſe of that liberty would be attended with danger. After publiſhing theſe books, he left Germany, probably finding his doctrines not ſo cordially received as he expected. He went firſt to Baſil, and thence to Lyons, where he lived two or three years. He then removed to Paris, where he ſtudied medicine under Sylvius, Fernelius, and other profeſſors, and obtained the degree of maſter of arts and doctor of medicine. His love of controverſy involved him in a ſerious diſpute with the phyſicians of Paris; and he wrote an Apology, which was ſuppreſſed by an edict of the Parliament. The miſunderſtanding which this diſpute produced with his colleagues, and the chagrin which ſo unfavourable a termination occaſioned, made him leave Paris in diſguſt. He ſettled two or three years in Lyons, and engaged with the Frellons, eminent printers of that age, as a corrector to their preſs. At Lyons he met with Pierre Palmier, the archbiſhop of Vienne, with whom he had been acquainted at Paris. That prelate, who was a great encourager of learned men, preſſed him to accompany him to Vienne, offering him at the ſame time an apartment in his palace. Servetus accepted the offer, and might have lived a tranquil and happy life at Vienne, if he could have confined his attention to medicine and literature. But the love of controverſy, and an eagerneſs to eſtabliſh his opinions, always poſſeſſed him. At this time Calvin was at the head of the reformed church at Geneva. With Servetus he had been acquainted at Paris, and had there oppoſed his opinions. For 16 years Calvin kept up a correſpondence with him, endeavouring to reclaim him from his errors. Servetus had read the works of Calvin, but did not think they merited the high eulogies of the reformers, nor were they ſufficient to convince him of his errors. He continued, however, to conſult him; and for this purpoſe ſent from Lyons to Geneva three queſtions, which reſpected the divinity of Jeſus Chriſt, regeneration, and the neceſſity of baptiſm. To theſe Calvin returned a civil anſwer. Servetus treated the anſwer with contempt, and Calvin replied with warmth. From reaſoning he had recourſe to abuſive language; and this produced a polemical hatred, the moſt implacable diſpoſition in the world. Calvin having obtained ſome of Servetus's papers, by means, it is ſaid, not very honourable, ſent them to Vienne along with the private letters which he had received in the courſe of their correſpondence. The conſequence was, that Servetus was arreſted; but having eſcaped from priſon, he reſolved to retire to Naples, where he hoped to practiſe medicine with the ſame reputation which he had ſo long enjoyed at Vienne. He imprudently took his route through Geneva, though he could not but know that Calvin was his mortal enemy. Calvin informed the magiſtrates of his arrival; Servetus was apprehended, and appointed to ſtand trial for hereſy and blaſphemy. It was a law at Geneva, that every accuſer ſhould ſurrender himſelf a priſoner, that if the charge ſhould be found falſe, the accuſer ſhould ſuffer the puniſhment in which he meant to involve the accuſed. Calvin not chooſing to go to priſon himſelf, ſent one of his domeſtics to preſent the impeachment againſt Servetus. The articles brought againſt him were collected from his writings with great care; an employment which took up three days. One of theſe articles was, "that Servetus had denied that Judæa was a beautiful, rich, and fertile country; and affirmed, on the authority of travellers, that it was poor, barren, and diſagreeable." He was alſo charged with "corrupting the Latin Bible, which he was employed to correct at Lyons, by introducing impertinent, trifling, whimſical, and impious notes of his own through every page." But the main article, which was certainly fatal to him, was, "that in the perſon of Mr Calvin, miniſter of the word of God in the church of Geneva, he had defamed the doctrine that is preached, uttering all imaginable injurious, blaſphemous words againſt it."

Calvin viſited Servetus in priſon, and had frequent conferences with him: but finding that, in oppoſition to all the arguments he could employ, the priſoner remained inflexible in his opinions, he left him to his fate. Before ſentence was paſſed, the magiſtrates of Geneva conſulted the miniſters of Bale, of Bern, and Zurich; and, as another account informs us, the magiſtrates of the Proteſtant Cantons of Switzerland. And to enable them to form a judgment of the criminality of Servetus, they tranſmitted the writings of Calvin, with his anſwers. The general opinion was, that Servetus ought to be condemned to death for blaſphemy. He was accordingly ſentenced to be burnt alive on the 27th of October 1553. As he continued alive in the midſt of the flames more than two hours, it is ſaid, finding his torment thus protracted, he exclaimed, "Unhappy wretch that I am! Will the flames be inſufficient to terminate my miſery! What then! Will the hundred pieces of gold, and the rich collar which they took from me, me, not purchaſe wood enough to conſume me more quickly!” “Though the ſentence of death was paſſed againſt Servetus by the magiſtrates of Geneva, with the approbation of a great number of the magiſtrates and miniſters of Switzerland, yet it is the opinion of moſt hiſtorians that this dreadful ſentence was impoſed at the inſtigation of Calvin. This act of ſeverity for holding a ſpeculative opinion, however erroneous and abſurd, has left a ſtain on the character of this illuſtrious reformer, which will attend the name of Calvin as long as hiſtory ſhall preſerve it from oblivion. The addreſs and art which he uſed in apprehending Servetus, his inhumanity to him during his trial, his diſſimulation and malevolence after his condemnation, prove that he was as much influenced by perſonal hatred as by a deſire to ſupport the intereſt of religion, though probably, during the trial, Calvin believed he was performing a very pious action. This intolerant ſpirit of Calvin and the magiſtrates of Geneva gave the Roman Catholics a favourable opportunity to accuſe the Proteſtants of inconſiſtency in their principles, which they did not fail to embrace. “How could the magiſtrates (ſays the author of the *Dictionnaire des Hereſies*), who acknowledged no infallible interpretation of the Scriptures, condemn Servetus to death becauſe he explained them differently from Calvin; ſince every man has the privilege to expound the Scripture, according to his own judgment, without having recourſe to the church? It is a great injuſtice to condemn a man becauſe he will not ſubmit to the judgment of an enthuſiaſt, who may be wrong as well as himſelf.”

Servetus was a man of great acuteneſs and learning, and well verſed in the arts and ſciences. In his own profeſſion his genius exerted itſelf with ſucceſs. In his tract intitled *Chriſtianiſmi Reſtitutio*, publiſhed in 1553, he remarks, that the whole maſs of blood paſſes through the lungs by the pulmonary artery and vein, in oppoſition to the opinion which was then univerſally entertained, that the blood paſſes through the partition which divides the two ventricles. This was an important ſtep towards the diſcovery of the circulation of the blood.

His works conſiſt of Controverſial Writings concerning the Trinity; an edition of Pagninus's Verſion of the Bible, with a preface and notes, publiſhed under the name of Michael Villanevanus; an Apology to the Phyſicians of Paris; and a book intitled *Ratio Syruporum*. Moſheim has written in Latin a Hiſtory of the Hereſy and Misfortunes of Servetus, which was publiſhed at Helmſtadt, in 4to, in 1728. From the curious details which it gives it is extremely intereſting.

SERVIA, a province of Turkey in Europe, bounded on the north by the rivers Danube and Save, which ſeparate it from Hungary; on the eaſt, by Bulgaria; on the weſt, by Boſnia: and on the ſouth, by Albania and Macedonia. It is about 190 miles in length from eaſt to weſt; 95 in breadth from north to ſouth; and is divided into four ſangiacates. Two of theſe were ceded to the Chriſtians in 1718, who united them into one. This continued till 1739, when the Turks were victorious; and then they were abandoned to the Turks by the treaty of Belgrade. Belgrade is the capital town.

SERVICE, in *Law*, is a duty which a tenant, on account of his fee, owes to his lord.

There are many diviſions of ſervices; as, 1. Into perſonal, where ſomething is to be done by the tenant in perſon, as homage and fealty. 2. Real, ſuch as wards, marriages, &c. 3. Accidental, including heriots, reliefs, and the like. 4. Entire, where, on the alienation of any part of the lands by a tenant, the ſervices become multiplied. 5. Frank-ſervice, which was performed by freemen, who were not obliged to perform any baſe ſervice, but only to find a man and horſe to attend the lord into the army or to court. 6. Knight's ſervice, by which lands were anciently held of the king, on paying homage, ſervice in war, &c.

As in every free and well regulated ſociety there muſt be a diverſity of ranks, there muſt be a great number of perſons employed in ſervice, both in agriculture and domeſtic affairs. In this country, ſervice is a contract into which the ſervant voluntarily enters; and the maſter's authority extends no farther than to the performance of that ſpecies of labour for which the agreement was made.

Paley's Moral and Political Philoſophy, p. 139.

“The treatment of ſervants (ſays that reſpectable moraliſt Mr Paley), as to diet, diſcipline, and accommodation, the kind and quantity of work to be required of them, the intermiſſion, liberty, and indulgence to be allowed them, muſt be determined in a great meaſure by cuſtom; for where the contract involves ſo many particulars, the contracting parties expreſs a few perhaps of the principal, and by mutual underſtanding refer the reſt to the known cuſtom of the country in like caſes.

“A ſervant is not bound to obey the unlawful commands of his maſter; to miniſter, for inſtance, to his unlawful pleaſures; or to aſſiſt him in unlawful practices in his profeſſion; as in ſmuggling or adulterating the articles which he deals in. For the ſervant is bound by nothing but his own promiſe; and the obligation of a promiſe extends not to things unlawful.

“For the ſame reaſon, the maſter's authority does not juſtify the ſervant in doing wrong; for the ſervant's own promiſe, upon which that authority is founded, would be none.

“Clerks and apprentices ought to be employed entirely in the profeſſion or trade which they are intended to learn. Inſtruction is their wages; and to deprive them of the opportunities of inſtruction, by taking up their time with occupations foreign to their buſineſs, is to defraud them of their wages.

“The maſter is reſponſible for what a ſervant does in the ordinary courſe of his employment; for it is done under a general authority committed to him, which is in juſtice equivalent to a ſpecific direction. Thus, if I pay money to a banker's clerk, the banker is accountable: but not if I had paid it to his butler or his footman, whoſe buſineſs it is not to receive money. Upon the ſame principle, if I once ſend a ſervant to take up goods upon credit, whatever goods he afterwards takes up at the ſame ſhop, ſo long as he continues in my ſervice, are juſtly chargeable to my account.

“The law of this country goes great lengths in intending a kind of concurrence in the maſter, ſo as to charge him with the conſequences of his ſervants conduct. If an innkeeper's ſervant rob his gueſts, the innkeeper muſt make reſtitution; if a farrier's ſervant lame your horſe, the farrier muſt anſwer for the damage;

mage; and ſtill farther, if your coachman or carter drive over a paſſenger on the road, the paſſenger may recover from you a ſatisfaction for the hurt he ſuffers. But theſe determinations ſtand, I think, rather upon the authority of the law, than any principle of natural juſtice."

There is a grievance which has long and juſtly been complained of, the giving of good characters to bad ſervants. This is perhaps owing to careleſſneſs, to a deſire of getting rid of a bad ſervant, or to miſtaken compaſſion. But ſuch careleſſneſs is inexcuſable. When a man gives his ſanction to the character of a bad ſervant, he ought to reflect on the nature and conſequences of what he is doing. He is giving his name to a falſehood; he is deceiving the honeſt man who confides in his veracity; and he is deliberately giving a knave an opportunity of cheating an honeſt man. To endeavour to get quit of a bad ſervant in this way, is ſurely not leſs criminal than concealing the faults and diſadvantages of an eſtate which is advertiſed for ſale, and aſcribing to it advantages which it does not poſſeſs. In this caſe, we know the ſale would be reduced, and the advertiſer diſgraced. Many maſters give characters to ſervants out of compaſſion; but it is to this miſtaken compaſſion that the diſorderly behaviour of ſervants is perhaps principally owing: for if the puniſhment of diſhoneſty be only a change of place (which may be a reward inſtead of a puniſhment), it ceaſes to be a ſervant's intereſt to be true to his truſt.

We have ſaid above that a maſter's authority over his ſervant extends no farther than the terms of contract; by which we meant, that a maſter could give no unreaſonable orders to his ſervant, or ſuch as was inconſiſtent with the terms of contract. But the relation between a maſter and ſervant is certainly cloſer than the mere terms of a contract: it is a moral as well as a legal relation. A maſter of a family ought to ſuperintend the morals of his ſervants, and to reſtrain them from vices. This he may do by his example, by his influence, and authority. Indeed every man poſſeſſed of authority is guilty of criminal negligence if he does not exert his authority for promoting virtue in his inferiors; and no authority is ſo well adapted for this purpoſe as that of maſters of families, becauſe none operates with an influence ſo immediate and conſtant. It is wonderful how much good a nobleman or gentleman of fortune can do to his domeſtics by attending to their morals; and every maſter may be a bleſſing to individuals and to ſociety, by exerting prudently that influence which his ſituation gives him over the conduct of his ſervant.

Choral SERVICE, in church hiſtory, denotes that part of religious worſhip which conſiſts in chanting and ſinging. The advocates for the high antiquity of ſinging, as a part of church-muſic, urge the authority of St Paul in its favour (Epheſ. chap. v. ver. 19. and Coloſ. chap. iii. ver. 16.). On the authority of which paſſages it is aſſerted, that ſongs and hymns were, from the eſtabliſhment of the church, ſung in the aſſemblies of the faithful; and it appears from undoubted teſtimony, that ſinging, which was practiſed as a ſacred rite among the Egyptians and Hebrews, at a very early period, and which likewiſe conſtituted a conſiderable part of the religious ceremonies of the Greeks and Romans, made a part of the religious worſhip of Chriſtians, not only before churches were built, and their religion eſtabliſhed by law, but from the firſt profeſſion of Chriſtianity. However, the era from whence others have dated the introduction of muſic into the ſervice of the church, is that period during which Leontius governed the church of Antioch, *i. e.* between the year of Chriſt 347 and 356. See ANTIPHONY.

From Antioch the practice ſoon ſpread through the other churches of the Eaſt; and in a few ages after its firſt introduction into divine ſervice, it not only received the ſanction of public authority, but thoſe were forbid to join in it who were ignorant of muſic. A canon to this purpoſe was made by the council of Laodicea, which was held about the year 372; and Zonaras informs us, that theſe canonical ſingers were reckoned a part of the clergy. Singing was introduced into the weſtern churches by St Ambroſe about the year 374, who was the inſtitutor of the Ambroſian chant eſtabliſhed at Milan about the year 386; and Euſebius (lib. ii. cap. 17.) tells us, that a regular choir, and method of ſinging the ſervice, were firſt eſtabliſhed, and hymns uſed, in the church at Antioch, during the reign of Conſtantine, and that St Ambroſe, who had long reſided there, had his melodies thence. This was about 230 years afterwards amended by Pope Gregory the Great, who eſtabliſhed the Gregorian chant; a plain, uniſonous kind of melody, which he thought conſiſtent with the gravity and dignity of the ſervice to which it was to be applied. This prevails in the Roman church even at this day: it is known in Italy by the name of *canto fermo;* in France by that of *plain chant;* and in Germany and moſt other countries by that of the *cantus Gregorianus.* Although no ſatisfactory account has been given of the ſpecific difference between the Ambroſian and Gregorian chants, yet all writers on this ſubject agree in ſaying, that St Ambroſe only uſed the four authentic modes, and that the four plagal were afterwards added by St Gregory. Each of theſe had the ſame final, or key-note, as its relative authentic; from which there is no other difference, than that the melodies in the four authentic or principal modes are generally confined within the compaſs of the eight notes above the key-note, and thoſe in the four plagal or relative modes, within the compaſs of eight notes below the fifth of the key. See MODE.

Eccleſiaſtical writers ſeem unanimous in allowing that Pope Gregory, who began his pontificate in 590, collected the muſical fragments of ſuch ancient pſalms and hymns as the firſt fathers of the church had approved and recommended to the firſt Chriſtians; and that he ſelected, methodized, and arranged them in the order which was long continued at Rome, and ſoon adopted by the chief part of the weſtern church. Gregory is alſo ſaid to have baniſhed from the church the *canto figurato,* as too light and diſſolute; and it is added, that his own chant was called *canto fermo,* from its gravity and ſimplicity.

It has been long a received opinion, that the eccleſiaſtical tones were taken from the reformed modes of Ptolemy; but Dr Burney obſerves, that it is difficult to diſcover any connection between them, except in their names; for their number, upon examination, is not the ſame: thoſe of Ptolemy being ſeven, the eccleſiaſtical eight; and indeed the Greek names given to the

the eccleſiaſtical modes do not agree with thoſe of Ptolemy in the ſingle inſtance of key, but with thoſe of higher antiquity. From the time of Gregory to that of Guido, there was no other diſtinction of keys than that of authentic and plagal; nor were any ſemitones uſed but thoſe from E to F, B to C, and occaſionally A to B *b*.

With reſpect to the muſic of the primitive church, it may be obſerved, that though it conſiſted in the ſinging of pſalms and hymns, yet it was performed in many different ways; ſometimes the pſalms were ſung by one perſon alone, whilſt the reſt attended in ſilence; ſometimes they were ſung by the whole aſſembly; ſometimes alternately, the congregation being divided into ſeparate choirs; and ſometimes by one perſon, who repeated the firſt part of the verſe, the reſt joining in the cloſe of it. Of the four different methods of ſinging now recited, the ſecond and third were properly diſtinguiſhed by the names of *ſymphony* and *antiphony*; and the latter was ſometimes called *reſponſaria*, in which women were allowed to join. St Ignatius, who, according to Socrates (lib. vi. cap. 8.), converſed with the apoſtles, is generally ſuppoſed to have been the firſt who ſuggeſted to the primitive Chriſtians in the Eaſt the method of ſinging hymns and pſalms alternately, or in dialogues; and the cuſtom ſoon prevailed in every place where Chriſtianity was eſtabliſhed; though Theodoret in his hiſtory (lib. ii. cap. 24.) tells us, that this manner of ſinging was firſt practiſed at Antioch. It likewiſe appears, that almoſt from the time when muſic was firſt introduced into the ſervice of the church, it was of two kinds, and conſiſted in a gentle inflection of the voice, which they termed plain ſong, and a more elaborate and artificial kind of muſic, adapted to the hymns and ſolemn offices contained in its ritual; and this diſtinction has been maintained even to the preſent day.

Although we find a very early diſtinction made between the manner of ſinging the hymns and chanting the pſalms, it is, however, the opinion of the learned Martini, that the muſic of the firſt five or ſix ages of the church conſiſted chiefly in a plain and ſimple chant of uniſons and octaves, of which many fragments are ſtill remaining in the *canto fermo* of the Romiſh miſſals. For with reſpect to muſic in parts, as it does not appear, in theſe early ages, that either the Greeks or Romans were in poſſeſſion of harmony or counterpoint, which has been generally aſcribed to Guido, a monk of Arezzo in Tuſcany, about the year 1022, though others have traced the origin of it to the eighth century, it is in vain to ſeek it in the church. The choral muſic, which had its riſe in the church of Antioch, and from thence ſpread through Greece, Italy, France, Spain, and Germany, was brought into Britain by the ſingers who accompanied Auſtin the monk, when he came over, in the year 596, charged with a commiſſion to convert the inhabitants of this country to Chriſtianity. Bede tells us, that when Auſtin and the companions of his miſſion had their firſt audience of King Ethelbert, in the iſle of Thanet, they approached him in proceſſion, ſinging litanies; and that afterwards, when they entered the city of Canterbury, they ſung a litany, and at the end of it Allelujah. But though this was the firſt time the Anglo-Saxons had heard the Gregorian chant, yet Bede likewiſe tells us, that our Britiſh anceſtors had been inſtructed in the rites and ceremonies of the Gallican church by St Germanus, and heard him ſing Allelujah many years before the arrival of St Auſtin. In 680, John, præcentor of St Peter's in Rome, was ſent over by Pope Agatho to inſtruct the monks of Weremouth in the art of ſinging; and he was prevailed upon to open ſchools for teaching muſic in other places in Northumberland. Benedict Biſcop, the preceptor of Bede, Adrian the monk, and many others, contributed to diſſeminate the knowledge of the Roman chant. At length the ſucceſſors of St Gregory, and of Auſtin his miſſionary, having eſtabliſhed a ſchool for eccleſiaſtical muſic at Canterbury, the reſt of the iſland was furniſhed with maſters from that ſeminary. The choral ſervice was firſt introduced in the cathedral church of Canterbury; and till the arrival of Theodore, and his ſettlement in that ſee, the practice of it ſeems to have been confined to the churches of Kent; but after that, it ſpread over the whole kingdom; and we meet with records of very ample endowments for the ſupport of this part of public worſhip. This mode of religious worſhip prevailed in all the European churches till the time of the Reformation: the firſt deviation from it is that which followed the Reformation by Luther, who, being himſelf a lover of muſic, formed a liturgy, which was a muſical ſervice, contained in a work entitled *Pſalmodia*, h. e. *Cantica ſacra Veteris Eccleſiæ ſelecta*, printed at Norimberg in 1553, and at Wittemberg in 1561. But Calvin, in his eſtabliſhment of a church at Geneva, reduced the whole of divine ſervice to prayer, preaching, and ſinging; the latter of which he reſtrained. He excluded the offices of the antiphon, hymn, and motet, of the Romiſh ſervice, with that artificial and elaborate muſic to which they were ſung; and adopted only that plain metrical pſalmody, which is now in general uſe among the reformed churches, and in the parochial churches of our own country. For this purpoſe he made uſe of Marot's verſion of the Pſalms, and employed a muſician to ſet them to eaſy tunes only of one part. In 1553, he divided the Pſalms into pauſes or ſmall portions, and appointed them to be ſung in churches. Soon after they were bound up with the Geneva catechiſm; from which time the Catholics, who had been accuſtomed to ſing them, were forbid the uſe of them, under a ſevere penalty. Soon after the Reformation commenced in England, complaints were made by many of the dignified clergy and others, of the intricacy and difficulty of the church-muſic of thoſe times: in conſequence of which it was once propoſed, that organs and curious ſinging ſhould be removed from our churches. Latimer, in his dioceſe of Worceſter, went ſtill farther, and iſſued injunctions to the prior and convent of St Mary, forbidding in their ſervice all manner of ſinging. In the reign of Edward VI. a commiſſion was granted to eight biſhops, eight divines, eight civilians, and eight common lawyers, to compile a body of ſuch eccleſiaſtical laws as ſhould in future be obſerved throughout the realm. The reſult of this compilation was a work firſt publiſhed in 1571 by Fox the martyrologiſt, and afterwards in 1640, under the title of *Reformatio Legum Eccleſiaſticarum*. Theſe 32 commiſſioners, inſtead of reprobating church-muſic, merely condemned figurative and operoſe muſic, or that kind of ſinging which abounded with fugues, reſponſive paſſages, and a commixture of various and intricate proportions; which, whether extemporary or written, is by muſicians termed *deſcant*. However, notwithſtanding the objections againſt choral muſic, and the practice of ſome of the reformed churches, the compilers of the Engliſh liturgy in 1548, and the king himſelf, determined to retain muſical ſervice. Accordingly the ſtatute 2 and 3 Edw. VI. cap. 1. though it contains no formal obligation on the clergy, or others, to uſe or join in either vocal or inſtrumental muſic in the common prayer, does clearly recogniſe the practice of ſinging; and in leſs than two years after the compiling of King Edward's liturgy, a formula was compoſed, which continues, with ſcarce any variation, to be the rule for choral ſervice even at this day. The author of this work was John Marbecke, or Marbeike; and it was printed by Richard Grafton, in 1550 under the title of the Book of Common Prayer, noted. Queen Mary laboured to re-eſtabliſh the Romiſh choral ſervice; but the acceſſion of Elizabeth was followed by the act of uniformity; in conſequence of which, and of the queen's injunctions, the Book of Common Prayer, noted by Marbecke, was conſidered as the general formula of choral ſervice. In 1560, another muſical ſervice, with ſome additions and improvements, was printed by John Day; and in 1565, another collection of offices, with muſical notes. Many objections were urged by Cartwright and other Puritans againſt the form and manner of cathedral ſervice, to which Hooker replied in his Eccleſiaſtical Polity. In 1664, the ſtatutes of Edward VI. and Elizabeth, for uniformity in the Common Prayer, were repealed; and the Directory for Public Worſhip, which allows only of the ſinging of pſalms, eſtabliſhed. But upon the reſtoration of Charles II. choral ſervice was again revived, and has ſince uniformly continued. See on this ſubject Hawkins's Hiſtory of Muſic. vol. i. p. 404. vol. ii. p. 264. vol. iii. p. 58—468, &c. vol. iv. p. 44—347.

SERVICE-Tree. See SORBUS, BOTANY *Index.*

SERVITES, a religious order in the church of Rome, founded about the year 1233, by ſeven Florentine merchants, who, with the approbation of the biſhop of Florence, renounced the world, and lived together in a religious community on Mount Senar, two leagues from that city.

SERVITOR, in the univerſity of Oxford, a ſtudent who attends on another for his maintenance and learning. See SIZAR.

SERVITUDE, the condition of a ſervant, or rather ſlave.

Under the declenſion of the Roman empire, a new kind of ſervitude was introduced, different from that of the ancient Romans: it conſiſted in leaving the lands of ſubjugated nations to the firſt owners, upon condition of certain rents, and ſervile offices, to be paid in acknowledgement. Hence the names of *ſervi cenſiti, aſcriptitii,* and *addicti glebæ;* ſome whereof were taxable at the reaſonable diſcretion of the lord; others at a certain rate agreed on; and others were mainmortable, who, having no legitimate children, could not make a will to above the value of fivepence, the lord being heir of all the reſt; and others were prohibited marrying, or going to live out of the lordſhip. Moſt of theſe ſervices exiſted lately in France; but they were long ago aboliſhed in England. Such, however, was the original of our tenures, &c. See SLAVE.

SERVITUDE, in *Scots Law.* See LAW, Part III. Sect. ix.

SERVIUS, MAURUS HONORATUS, a celebrated grammarian and critic of antiquity, who flouriſhed about the time of Arcadius and Honorius; now chiefly known by his Commentaries on Virgil. There is alſo extant a piece of Servius upon the feet of verſes and the quantity of ſyllables, called *Centimetrum.*

SERUM, a thin, tranſparent, ſaltiſh liquor, which makes a conſiderable part of the maſs of blood. See ANATOMY and CHEMISTRY *Index.*

SESAMOIDEA OSSA, certain ſmall bones ſomewhat reſembling the ſeeds of ſeſamum, whence their name. They are placed at the under part of the bones of the laſt joints of the fingers and toes.

SESAMUM, OILY GRAIN; a genus of plants belonging to the claſs didynamia; and in the natural ſyſtem ranging under the 20th order, *Luridæ.* See BOTANY *Index.*

SESELI, MEADOW SAXIFRAGE; a genus of plants belonging to the claſs pentandria; and in the natural ſyſtem ranging under the 45th order, *Umbellatæ.* See BOTANY *Index.*

SESOSTRIS, king of Egypt. See EGYPT, p. 591.

SESQUI, a Latin particle, ſignifying a whole and a half; which, joined with *altera, terza, quarta,* &c. is much uſed in the Italian muſic to expreſs a kind of ratios, particularly ſeveral ſpecies of triples.

SESQUI-Alterate, in *Geometry* and *Arithmetic,* is a ratio between two lines, two numbers, or the like, where one of them contains the other once, with the addition of a half.

Thus 6 and 9 are in a ſeſqui-alterate ratio; ſince 9 contains 6 once, and 3, which is half of 6, over; and 20 and 30 are in the ſame; as 30 contains 20, and half 20 or 10.

SESQUI-Duplicate ratio, is when of two terms the greater contains the leſs twice, and half the leſs remains; as 15 and 6; 50 and 20.

SESQUI-Tertional proportion, is when any number or quantity contains another once and one third.

SESSILE, among botaniſts. See BOTANY.

SESSION, in general, denotes each ſitting or aſſembly of a council, &c.

SESSION of Parliament, is the ſeaſon or ſpace from its meeting to its prorogation. See PARLIAMENT.

Kirk-SESSION, the name of a petty eccleſiaſtical court in Scotland. See *KIRK-Seſſion.*

SESSIONS for weights and meaſures. In London, four juſtices from among the mayor, recorder, and aldermen (of whom the mayor and recorder is to be one), may hold a ſeſſion to inquire into the offences of ſelling by falſe weights and meaſures, contrary to the ſtatutes; and to receive indictments, puniſh offenders, &c. Char. King Charles I.

Court of SESSION. See LAW, Part III. Sect. ii.

Court of Quarter-SESSIONS, an Engliſh court that muſt be held in every county once in every quarter of a year; which by ſtatute 2 Henry V. c. 4. is appointed to be in the firſt week after Michaelmas-day, the firſt week after the Epiphany, the firſt week after the cloſe of Eaſter, and in the week after the tranſlation of St Thomas the martyr, or the 7th of July. It is held before two or more juſtices of the peace, one of which muſt be of the quorum. The juriſdiction of this court, by 34 Edward III. c. 1. extends to the trying and determining all felonies and treſpaſſes whatſoever: though they ſeldom, if ever, try any greater offence than ſmall felonies within the benefit of clergy; their commiſſion providing, that if any caſe of difficulty ariſes, they ſhall not proceed to judgment, but in the preſence of one of the juſtices of the courts of king's-bench or common-pleas, or one of the judges of aſſize: and therefore murders, and other capital felonies, are uſually remitted for a more ſolemn trial to the aſſizes. They cannot alſo try any new-created offence, without expreſs power given them by the ſtatute which creates it. But there are many offences and particular matters which, by particular ſtatutes, belong properly to this juriſdiction, and ought to be proſecuted in this court; as, the ſmaller miſdemeanors againſt the public or commonwealth, not amounting to felony; and eſpecially offences relating to the game, highways, alehouſes, baſtard children, the ſettlement and proviſion for the poor, vagrants, ſervants wages, and Popiſh recuſants. Some of theſe are proceeded upon by indictment: others in a ſummary way, by motion, and order thereupon; which order may for the moſt part, unleſs guarded againſt by particular ſtatutes, be removed into the court of king's-bench by writ of *certiorari facias*, and be there either quaſhed or confirmed. The records or rolls of the ſeſſions are committed to the cuſtody of a ſpecial officer, denominated *cuſtos rotulorum*, who is always a juſtice of the quorum; and among them of the quorum (ſaith Lambard) a man for the moſt part eſpecially picked out, either for wiſdom, countenance, or credit. The nomination of the *cuſtos rotulorum* (who is the principal officer in the county, as the lord-lieutenant is chief in military command) is by the king's ſign manual: and to him the nomination of the clerk of the peace belongs; which office he is expreſsly forbidden to ſell for money.

In moſt corporation-towns there are quarter-ſeſſions kept before juſtices of their own, within their reſpective limits; which have exactly the ſame authority as the general quarter-ſeſſions of the county, except in a very few inſtances; one of the moſt conſiderable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation-juſtices, muſt be to the ſeſſions of the county, by ſtatute 8 and 9 William III. c. 30. In both corporations and counties at large, there is ſometimes kept a ſpecial or petty ſeſſion, by a few juſtices, for diſpatching ſmaller buſineſs in the neighbourhood between the times of the general ſeſſions; as for licenſing alehouſes, paſſing the account of pariſh-officers, and the like.

SESTERCE, Sestertius, a ſilver coin, in uſe among the ancient Romans, called alſo ſimply *nummus*, and ſometimes *nummus ſeſtertius*. The ſeſtertius was the fourth part of the denarius, and originally contained two aſſes and a half. It was at firſt denoted by LLS; the two L's ſignifying two libræ, and the S half. But the librarii, afterwards converting the two L's into an H, expreſſed the ſeſtertius by HS. The word *ſeſtertius* was firſt introduced by way of abbreviation for *ſemiſtertius*, which ſignifies two, and a half of a third, or, literally, only half a third; for in expreſſing half a third, it was underſtood that there were two before.

Some authors make two kinds of ſeſterces; the leſs called *ſeſtertius*, in the maſculine gender; and the great one, called *ſeſtertium*, in the neuter: the firſt, that we have already deſcribed; the latter containing a thouſand of the other. Others will have any ſuch diſtinction of great and little ſeſterces unknown to the Romans: *ſeſtertius*, ſay they, was an adjective, and ſignified, *as ſeſtertius*, or two aſſes and a half; and when uſed in the plural, as in *quinquaginta ſeſtertium*, or *ſeſtertia*, it was only by way of abbreviation, and there was always underſtood *centena*, *millia*, &c.

This matter has been accurately ſtated by Mr Raper, in the following manner. The ſubſtantive to which ſeſtertius referred is either *as*, or *pondus*; and *ſeſtertius as* is two aſſes and a half; *ſeſtertium pondus*, two pondera and a half, or two hundred and fifty denarii. When the denarius paſſed for ten aſſes, the ſeſtertius of two aſſes and a half was a quarter of it; and the Romans continued to keep their accounts in theſe ſeſterces long after the denarius paſſed for ſixteen aſſes; till, growing rich, they found it more convenient to reckon by quarters of the denarius, which they called *nummi*, and uſed the words *nummus* and *ſeſtertius* indifferently, as ſynonymous terms, and ſometimes both together, as *ſeſtertius nummus*; in which caſe the word *ſeſtertius*, having loſt its original ſignification, was uſed as a ſubſtantive; for *ſeſtertius nummus* was not two nummi and a half, but a ſingle nummus of four aſſes. They called any ſum under two thouſand ſeſterces ſo many *ſeſtertii* in the maſculine gender; two thouſand ſeſterces they called *duo* or *bina ſeſtertia*, in the neuter; ſo many quarters making five hundred denarii, which was twice the ſeſtertium; and they ſaid *dena*, *vicena*, &c. *ſeſtertia*, till the ſum amounted to a thouſand ſeſtertia, which was a million of ſeſterces. But, to avoid ambiguity, they did not uſe the neuter *ſeſtertium* in the ſingular number, when the whole ſum amounted to no more than a thouſand ſeſterces, or one ſeſtertium. They called a million of ſeſterces *decies nummûm*, or *decies ſeſtertiûm*, for *decies centena millia nummorum*, or *ſeſtertiorum* (in the maſculine gender), omitting *centena millia* for the ſake of brevity. They likewiſe called the ſame ſum *decies ſeſtertium* (in the neuter gender) for *decies centies ſeſtertium*, omitting *centies* for the ſame reaſon; or ſimply *decies*, omitting *centena millia ſeſtertiûm*, or *centies ſeſtertium*; and with the numeral adverbs *decies*, *vicies*, *centies*, *millies*, and the like, either *centena millia* or *centies* was always underſtood. Theſe were their moſt uſual forms of expreſſion; though for *bina*, *dena*, *vicena ſeſtertia*, they frequently ſaid *bina*, *dena*, *vicena millia nummûm*. If the conſular denarius contained 60 troy grains of fine ſilver, it was worth ſomething more than eight-pence farthing and a half ſterling; and the as, of 16 to the denarius, a little more than a half-penny. To reduce the ancient ſeſterces of two aſſes and a half, when the denarius paſſed for 16, to pounds ſterling, multiply the given number by 5454, and cut off ſix figures on the right hand for decimals. To reduce *nummi ſeſtertii*, or quarters of the denarius, to pounds ſterling; if the given ſum be conſular money, multiply it by 8727, and cut off ſix figures on the right hand for decimals; but for imperial money diminiſh the ſaid product by one-eighth of itſelf. Phil. Tranſ. vol. lxi. part ii. art. 48.

To be qualified for a Roman knight, an eſtate of 400,000 *ſeſterces* was required; and for a ſenator, of 800,000.

Authors alſo mention a copper *ſeſterce*, worth about one-third of a penny Engliſh.

SESTERCE, or *ſeſtertius*, was alſo uſed by the ancients for a thing containing two wholes and an half of another, as *as* was taken for any whole or integer.

SESTOS, a noted fortreſs of European Turkey, ſituated at the entrance of the Helleſpont or Dardanelles, 24 miles ſouth-weſt of Gallipoli. This place is famous for the loves of HERO and LEANDER, ſung by the poet Muſæus.

SESUVIUM, a genus of plants belonging to the claſs icoſandria. See BOTANY *Index*.

SET, or SETS, a term uſed by the farmers and gardeners to expreſs the young plants of the white thorn and other ſhrubs, with which they uſe to raiſe their quick or quick-ſet hedges. The white thorn is the beſt of all trees for this purpoſe; and, under proper regulations, its ſets ſeldom fail of anſwering the farmer's utmoſt expectations.

SET-off, in *Law*, is an act whereby the defendant acknowledges the juſtice of the plaintiff's demand on the one hand; but, on the other, ſets up a demand of his own, to counterbalance that of the plaintiff, either in the whole, or in part: as, if the plaintiff ſues for 10l. due on a note of hand, the defendant may ſet off 9l. due to himſelf for merchandiſe ſold to the plaintiff; and, in caſe he pleads ſuch ſet-of, muſt pay the remaining balance into court. This anſwers very nearly to the *compenſatio* or ſtoppage of the civil law, and depends upon the ſtatutes 2 Geo. II. cap. 22. and 8 Geo. II. cap. 24.

SETACEOUS WORM, in *Natural Hiſtory*, a name given by Dr Liſter to that long and ſlender water-worm, which ſo much reſembles a horſe-hair, that it has been ſuppoſed by the vulgar to be an animated hair of that creature. Theſe creatures, ſuppoſed to be living hairs, are a peculiar ſort of inſects, which are bred and nouriſhed within the bodies of other inſects, as the worms of the ichneumon flies are in the bodies of the caterpillars.

Aldrovand deſcribes the creature, and tells us it was unknown to the ancients; but called *ſeta aquatica*, and *vermis ſetarius*, by the moderns, either from its figure reſembling that of a hair, or from the ſuppoſition of its once having been the hair of ſome animal. We generally ſuppoſe it, in the imaginary ſtate of the hair, to have belonged to a horſe; but the Germans ſay it was once the hair of a calf, and call it by a name ſignifying *vitulus aquaticus*, or the "water calf."

Albertus, an author much reverenced by the common people, has declared that this animal is generated of a hair; and adds, that any hair thrown into ſtanding water, will, in a very little time, obtain life and motion. Other authors have diſſented from this opinion, and ſuppoſed them generated of the fibrous roots of water-plants; and others, of the parts of graſshoppers fallen into the water. This laſt opinion is rejected by Aldrovand as the moſt improbable of all. Standing and foul waters are moſt plentifully ſtored with them; but they are ſometimes found in the cleareſt and pureſt ſprings, and ſometimes out of the water, on the leaves of trees and plants, as on the fruit-trees in our gardens, and the elms in hedges. They are from three to five inches long, of the thickneſs of a large hair; and are brown upon the back, and white under the belly, and the tail is white on every part.

SETH, the third ſon of Adam, the father of Enos, was born 3874 B. C. and lived 912 years.

SETHIANS, in church hiſtory, Chriſtian heretics; ſo called becauſe they paid divine worſhip to Seth, whom they looked upon to be Jeſus Chriſt the ſon of God, but who was made by a third divinity, and ſubſtituted in the room of the two families of Abel and Cain, which had been deſtroyed by the deluge. Theſe heretics appeared in Egypt in the ſecond century; and as they were addicted to all ſorts of debauchery, they did not want followers; and continued in Egypt above 200 years.

SETIMO, a town of Italy, in the province of Piedmont, ſituated on the river Po, eight miles north of Turin.

SETON, in *Surgery*, a few horſe hairs, ſmall threads, or large packthread, drawn through the ſkin, chiefly the neck, by means of a large needle or probe, with a view to reſtore or preſerve health.

Experience ſhews that ſetons are uſeful in catarrhs, inflammations, and other diſorders, and particularly thoſe of the eyes; to theſe may be added ſevere headachs, with ſtupor, drowſineſs, epilepſies, and even apoplexy itſelf. See SURGERY.

SETTEE, in ſea-language, a veſſel very common in the Mediterranean with one deck and a very long and ſharp prow. They carry ſome two maſts, ſome three, without top-maſts. They have generally two maſts, equipped with triangular ſails, commonly called *lateen ſails*. The leaſt of them are of 60 tons burden. They ſerve to tranſport cannon and proviſions for ſhips of war and the like. Theſe veſſels are peculiar to the Mediterranean ſea, and are uſually navigated by Italians, Greeks, or Mahometans.

SETTING, in *Aſtronomy*, the withdrawing of a ſtar or planet, or its ſinking below the horizon. Aſtronomers and poets make three different kinds of ſetting of the ſtars, viz. the COSMICAL, ACRONYCAL, and HELIACAL. See theſe articles.

SETTING, in the ſea-language. To ſet the land or the ſun by the compaſs, is to obſerve how the land bears on any point of the compaſs, or on what point of the compaſs the ſun is. Alſo when two ſhips ſail in ſight of one another, to mark on what point the chaſed bears, is termed *ſetting the chace by the compaſs*.

SETTING, among ſportſmen, a term uſed to expreſs the manner of taking partridges by means of a dog peculiarly trained to that purpoſe. See SHOOTING.

ACT OF SETTLEMENT, in Britiſh hiſtory, a name given to the ſtatute 12 and 13 Will. III. cap. 2. whereby the crown was limited to his preſent majeſty's illuſtrious houſe; and ſome new proviſions were added, at the ſame fortunate era, for better ſecuring our religion, laws, and liberties: which the ſtatute declares to be the birthright of the people of England, according to the ancient doctrine of the common law.

SEVEN STARS, a common denomination given to the cluſter of ſtars in the neck of the ſign Taurus, the bull; properly called the *Pleiades*. They are ſo called from their number ſeven, which appear to the naked eye, though ſome eyes can diſcover only ſix of them; but by the aid of teleſcopes there appears to be a great multitude of them.

SEVENTH, in *Muſic*, an interval called by the Greeks *heptachordon*. See INTERVAL.

SEVERANCE, in *Law*, the ſingling or ſevering two or more that join or are joined in the ſame writ or action.

tion. As if two join in a writ *de libertate probanda*, and the one be afterwards nonſuited; here ſeverance is permitted, ſo as notwithſtanding the nonſuit of the one, the other may ſeverally proceed.

There is alſo ſeverance of the tenants in aſſize; when one, two, or more diſſeiſees appear upon the writ, and not the other. And ſeverance in debt, where two executors are named plaintiffs, and the one refuſes to proſecute. We alſo meet with ſeverance of ſummons, ſeverance in attaints, &c. An eſtate in joint tenancy may be ſevered and deſtroyed by deſtroying any of its unities. 1. That of time, which reſpects only the original commencement of the joint eſtate, cannot indeed (being now part) be affected by any ſubſequent tranſaction. But, 2. The joint-tenants eſtate may be deſtroyed without any alienation, by merely diſuniting their poſſeſſion. 3. The jointure may be deſtroyed, by deſtroying the unity of title. And, 4. By deſtroying the unity of intereſt.

SEVERIA, a province of the Ruſſian empire, with the title of a duchy, bounded on the north by Smolenſko and Muſcovy, on the eaſt by Vorotinſbi and the country of the Coſſacks, on the ſouth by the ſame, and on the weſt by Zernegovia. It is a country overrun with woods, and on the ſouth part is a foreſt of great length. Novogrodec, or Novogorod, is the capital town.

ST SEVERINA, a town of Italy, in the kingdom of Naples, in the Lower Calabria, with an archbiſhop's ſee. It is very well fortified, and ſeated on a craggy rock, on the river Neeto; in E. Long. 17. 14. N. Lat. 39. 15.

SEVERINO, a town of Italy, in the territory of the church, and in the Marche of Ancona, with a biſhop's ſee. It has fine vineyards, and is ſeated between two hills on the river Petenza, in E. Long. 13. 6. N. Lat. 43. 16.

SEVERN, a river of England which riſes near Plimlimmon Hill in Montgomeryſhire, and before it enters Shropſhire receives about 30 ſtreams, and paſſes down to Laudring, where it receives the Morda, that flows from Oſweſtry. When it arrives at Monford, it receives the river Mon, paſſing on to Shrewſbury, which it almoſt ſurrounds, then to Bridgeworth; afterwards it runs through the ſkirts of Staffordſhire, enters Worceſterſhire, and paſſes by Worceſter; then it runs to Tewkeſbury, where it joins the Avon, and from thence to Glouceſter, keeping a north weſterly courſe, till it falls into the Briſtol Channel. It begins to be navigable for boats at Welchpool, in Montgomeryſhire, and takes in ſeveral other rivers in its courſe, beſides thoſe already mentioned, and *is the ſecond in England*. By means of inland navigation, it has communication with the rivers Merſey, Dee, Ribble, Ouſe, Trent, Derwent, Humber, Thames, Avon, &c.; which navigation, including its windings, extends above 500 miles in the counties of Lincoln, Nottingham, York, Lancaſter, Weſtmoreland, Cheſter, Stafford, Warwick, Leiceſter, Oxford, Worceſter, &c. A canal from Stroud-Water, a branch of the Severn, to join the Thames, was projected and executed for the purpoſe of conveying a tunnel 16 feet high and 16 feet wide, under Sapperton Hill and Hayley-Wood (very high ground), for two miles and a quarter in length, through a very hard rock, which was lined and arched with brick. This ſtupendous undertaking was completed, and boats paſſed through it the 21ſt of May 1789. By this opening, a communication is made between the river Severn at Framiload and the Thames near Lechlade, and is continued over the Thames near Ingleſham, into deep water in the Thames below St John-Bridge, and ſo to Oxford, &c. and London, for conveyance of coals, goods, &c.

ucombe's nghſh azetteer.

SEVERNDROOG, a ſea-port town and fortreſs of Hindoſtan, which was taken by the Engliſh in 1756. It is 68 miles ſouth from Bombay, and in N. Lat. 17. 55. E. Long. 72. 50.

SEVERUS, CORNELIUS, an ancient Latin poet of the Auguſtan age; whoſe *Ætna*, together with a fragment *De morte Ciceronis*, were publiſhed, with notes and a proſe interpretation, by Le Clerc, 12mo, Amſterdam, 1703. They were before inſerted among the *Catalecta Virgilii* publiſhed by Scaliger; whoſe notes, with others, Le Clerc has received among his own.

SEVERUS, *Septimius*, a Roman emperor, who has been ſo much admired for his military talents, that ſome have called him the moſt warlike of the Roman emperors. As a monarch he was cruel, and it has been obſerved that he never did an act of humanity or forgave a fault. In his diet he was temperate, and he always ſhowed himſelf an open enemy to pomp and ſplendour. He loved the appellation of a man of letters, and he even compoſed an hiſtory of his own reign, which ſome have praiſed for its correctneſs and veracity. However cruel Severus may appear in his puniſhments and in his revenge, many have endeavoured to exculpate him, and obſerved that there was need of ſeverity in an empire where the morals were ſo corrupted, and where no leſs than 3000 perſons were accuſed of adultery during the ſpace of 17 years. Of him, as of Auguſtus, ſome were diſpoſed to ſay, that it would have been better for the world if he had never been born, or had never died. See ROME, Nº 372.

SEVERUS's Wall, in Britiſh topography, the fourth and laſt barrier erected by the Romans againſt the incurſions of the North Britons. See the articles ADRIAN, and *ANTONINUS's Wall*.

We learn from ſeveral hints in the Roman hiſtorians, that the country between the walls of Hadrian and Antoninus continued to be a ſcene of perpetual war and ſubject of contention between the Romans and Britons, from the beginning of the reign of Commodus to the arrival of the emperor Septimius Severus in Britain, A. D. 206. This laſt emperor having ſubdued the Mæatæ, and repulſed the Caledonians, determined to erect a ſtronger and more impenetrable barrier than any of the former, againſt their future incurſions.

Though neither Dio nor Herodian make any mention of a wall built by Severus in Britain for the protection of the Roman province, yet we have abundant evidence from other writers of equal authority, that he really built ſuch a wall. "He fortified Britain (ſays Spartian) with a wall drawn croſs the iſland from ſea to ſea; which is the greateſt glory of his reign. After the wall was finiſhed, he retired to the next ſtation (York), not only a conqueror, but the founder of an eternal peace." To the ſame purpoſe, Aurelius Victor and Oroſius, to ſay nothing of Eutropius and Caſſiodorus: "Having repelled the enemy in Britain, he fortified the country, which was ſuited to that purpoſe, with a wall drawn croſs the iſland from ſea to ſea."—"Severus drew a great ditch, and built a ſtrong wall, fortified

fortified with ſeveral turrets, from ſea to ſea, to protect that part of the iſland which he had recovered from the yet unconquered nations." As the reſidence of the emperor Severus in Britain was not quite four years, it is probable that the two laſt of them were employed in building this wall; according to which account, it was begun A. D. 209, and finiſhed A. D. 211.

This wall of Severus was built nearly on the ſame tract with Hadrian's rampart, at the diſtance only of a few paces north. The length of this wall, from Couſin's houſe near the mouth of the river Tyne on the eaſt, to Boulneſs on the Solway frith on the weſt, has been found, from two actual menſurations, to be a little more than 68 Engliſh miles, and a little leſs than 74 Roman miles. To the north of the wall was a broad and deep ditch, the original dimenſions of which cannot now be aſcertained, only it ſeems to have been larger than that of Hadrian. The wall itſelf, which ſtood on the ſouth brink of the ditch, was built of freeſtone, and where the foundation was not good, it is built on piles of oak; the interſtices between the two faces of this wall is filled with broad thin ſtones, placed not perpendicularly, but obliquely on their edges; the running mortar or cement was then poured upon them, which, by its great ſtrength and tenacity, bound the whole together, and made it firm as a rock. But though theſe materials are ſufficiently known, it is not eaſy to gueſs where they were procured, for many parts of the wall are at a great diſtance from any quarry of freeſtone; and, though ſtone of another kind was within reach, yet it does not appear to have been anywhere uſed. The height of this wall was 12 feet beſides the parapet, and its breadth 8 feet, according to Bede, who lived only at a ſmall diſtance from the eaſt end of it, and in whoſe time it was in many places almoſt quite entire. Such was the wall erected by the command and under the direction of the emperor Severus in the north of England; and, conſidering the length, breadth, height, and ſolidity, it was certainly a work of great magnificence and prodigious labour. But the wall itſelf was but a part, and not the moſt extraordinary part, of this work. The great number and different kinds of fortreſſes which were built along the line of it for its defence, and the military ways with which it was attended, are ſtill more worthy of our admiration, and come now to be deſcribed.

The fortreſſes which were erected along the line of Severus's wall for its defence, were of three different kinds, and three different degrees of ſtrength; and were called by three different Latin words, which may be tranſlated *ſtations*, *caſtles*, and *turrets*. Of each of theſe in their order.

The *ſtationes*, ſtations, were ſo called from their ſtability and the ſtated reſidence of garriſons. They were alſo called *caſtra*, which hath been converted into *cheſtres*, a name which many of them ſtill bear. Theſe were by far the largeſt, ſtrongeſt, and moſt magnificent of the fortreſſes which were built upon the wall, and were deſigned for the head-quarters of the cohorts of troops which were placed there in garriſon, and from whence detachments were ſent into the adjoining caſtles and turrets. Theſe ſtations, as appears from the veſtiges of them which are ſtill viſible, were not all exactly of the ſame figure nor of the ſame dimenſions; ſome of them being exactly ſquares, and others oblong, and ſome of them a little larger than others. Theſe variations were no doubt occaſioned by the difference of ſituation and other circumſtances. The ſtations were fortified with deep ditches and ſtrong walls, the wall itſelf coinciding with and forming the north wall of each ſtation. Within the ſtations were lodgings for the officers and ſoldiers in garriſon; the ſmalleſt of them being ſufficient to contain a cohort, or 600 men. Without the walls of each ſtation was a town, inhabited by labourers, artificers, and others, both Romans and Britons, who choſe to dwell under the protection of theſe fortreſſes. The number of the ſtations upon the wall was exactly 18; and if they had been placed at equal diſtances, the interval between every two of them would have been four miles and a few paces: but the intervention of rivers, marſhes, and mountains; the conveniency of ſituations for ſtrength, proſpect, and water; and many other circumſtances to us unknown, determined them to place theſe ſtations at unequal diſtances. The ſituation which was always choſen by the Romans, both here and everywhere elſe in Britain where they could obtain it, was the gentle declivity of a hill, near a river, and facing the meridian ſun. Such was the ſituation of the far greateſt part of the ſtations on this wall. In general, we may obſerve, that the ſtations ſtood thickeſt near the two ends and in the middle, probably becauſe the danger of invaſion was greateſt in theſe places. But the reader will form a clearer idea of the number of theſe ſtations, their Latin and Engliſh names, their ſituation and diſtance from one another, by inſpecting the following table, than we can give him with equal brevity in any other way. The firſt column contains the number of the ſtation, reckoning from eaſt to weſt; the ſecond contains its Latin, and the third its Engliſh name; and the three laſt its diſtance from the next ſtation to the weſt of it, in miles, furlongs, and chains.

N°	Latin Name.	Engliſh Name.	M.	F.	C.
1	Segedunum	Couſin's-houſe	3	5	1½
2	Pons Ælii	Newcaſtle	2	0	9
3	Condercum	Benwell hill	6	6	5
4	Vindobala	Rutcheſter	7	0	3½
5	Hunnum	Halton-cheſters	5	1	7
6	Cilurnum	Walwick-cheſters	3	1	8
7	Procolitia	Carrawbrugh	4	5	3½
8	Borcovicus	Houſeſteeds	1	3	8
9	Vindolana	Little-cheſters	3	6	4
10	Æſica	Great-cheſters	2	1	6½
11	Magna	Carrvoran	2	6	0
12	Amboglana	Burdoſwald	6	2	8
13	Petriana	Cambeck	2	6	6
14	Aballaba	Watchcroſs	5	1	9
15	Congavata	Stanwix	3	3	4
16	Axelodunum	Brugh	4	0	9
17	Gabroſentum	Brumbrugh	3	4	1
18	Tunnocelum	Boulneſs	0	0	0
		Length of the wall	68	3	3

The *caſtella*, or caſtles, were the ſecond kind of fortifications which were built along the line of this wall for its defence. Theſe caſtles were neither ſo large nor ſtrong as the ſtations, but much more numerous, being no fewer than 81. The ſhape and dimenſions of the caſtles, as appears from the foundations of many of them which are ſtill viſible, were exact ſquares of 66 feet every way. They were fortified on every ſide with thick and lofty walls, but without any ditch, except on the north ſide; on which the wall itſelf, raiſed much above its uſual height, with the ditch attending it, formed the fortification. The caſtles were ſituated in the intervals between the ſtations, at the diſtance of about ſeven furlongs from each other; though particular circumſtances ſometimes occaſioned a little variation. In theſe caſtles, guards were conſtantly kept by a competent number of men detached from the neareſt ſtations.

The *turres*, or turrets, were the third and laſt kind of fortifications on the wall. Theſe were ſtill much ſmaller than the caſtles, and formed only a ſquare of about 12 feet, ſtanding out of the wall on its ſouth ſide. Being ſo ſmall, they are more entirely ruined than the ſtations and caſtles, which makes it difficult to diſcover their exact number. They ſtood in the intervals between the caſtles; and from the faint veſtiges of a few of them, it is conjectured that there were four of them between every two caſtles, at the diſtance of about 300 yards from one another. According to this conjecture the number of the turrets amounted to 324. They were deſigned for watch-towers and places for ſentinels, who, being within hearing of one another, could convey an alarm or piece of intelligence to all parts of the wall in a very little time.

Such were the ſtations, caſtles, and turrets, on the wall of Severus; and a very conſiderable body of troops was conſtantly quartered in them for its defence. The uſual complement allowed for this ſervice was as follows:

1. Twelve cohorts of foot, conſiſting of 600 men each, - - -	7200
2. One cohort of mariners in the ſtation at Boulneſs, - - - - -	600
3. One detachment of Moors, probably equal to a cohort, - - - -	600
4. Four alæ or wings of horſe, conſiſting, at the loweſt computation, of 400 each, -	1600
	10,000

For the conveniency of marching theſe troops from one part of the wall to another, with the greater eaſe and expedition, on any ſervice, it was attended with two military ways, paved with ſquare ſtones, in the moſt ſolid and beautiful manner. One of theſe ways was ſmaller, and the other larger. The ſmaller military way run cloſe along the ſouth ſide of the wall, from turret to turret, and caſtle to caſtle, for the uſe of the ſoldiers in relieving their guards and ſentinels, and ſuch ſervices. The larger way did not keep ſo near the wall, nor touch at the turrets or caſtles, but purſued the moſt direct courſe from one ſtation to another, and was deſigned for the conveniency of marching larger bodies of troops.

It is to be regretted, that we cannot gratify the reader's curioſity, by informing him by what particular bodies of Roman troops the ſeveral parts of this great work were executed; as we were enabled to do with regard to the wall of Antoninus Pius from inſcriptions. For though it is probable that there were ſtones with inſcriptions of the ſame kind, mentioning the ſeveral bodies of troops, and the quantity of work performed by each of them, originally inſerted in the face of this wall, yet none of them are now to be found. There have indeed been diſcovered, in or near the ruins of this wall, a great number of ſmall ſquare ſtones, with very ſhort, and generally imperfect, inſcriptions upon them; mentioning particular legions, cohorts, and centuries; but without directly aſſerting that they had built any part of the wall, or naming any number of paces. Of theſe inſcriptions, the reader may ſee no fewer than twenty-nine among the Northumberland and Cumberland inſcriptions in Mr Horſley's Britannia Romana. As the ſtones on which theſe inſcriptions are cut are of the ſame ſhape and ſize with the other facing-ſtones of this wall, it is almoſt certain that they have been originally placed in the face of it. It is equally certain, from the uniformity of theſe inſcriptions, that they were all intended to intimate ſome one thing, and nothing ſo probable as that the adjacent wall was built by the troops mentioned in them. This was, perhaps, ſo well underſtood, that it was not thought neceſſary to be expreſſed; and the diſtance of theſe inſcriptions from one another ſhowed the quantity of work performed. If this was really the caſe, we know in general, that this great work was executed by the ſecond and ſixth legions, theſe being the only legions mentioned in theſe inſcriptions. Now, if this prodigious wall, with all its appendages of ditches, ſtations, caſtles, turrets, and military ways, was executed in the ſpace of two years by two legions only, which, when moſt complete, made no more than 12,000 men, how greatly muſt we admire the ſkill, the induſtry, and excellent diſcipline of the Roman ſoldiers, who were not only the valiant guardians of the empire in times of war, but its moſt active and uſeful members in times of peace?

This wall of Severus, and its fortreſſes, proved an impenetrable barrier to the Roman territories for near 200 years. But about the beginning of the 5th century, the Roman empire being aſſaulted on all ſides, and the bulk of their forces withdrawn from Britain, the Mæatæ and Caledonians, now called *Scots* and *Picts*, became more daring; and ſome of them breaking through the wall, and others ſailing round the ends of it, they carried their ravages into the very heart of Provincial Britain. Theſe invaders were indeed ſeveral times repulſed after this by the Roman legions ſent to the relief of the Britons. The laſt of theſe legions, under the command of Gallio of Ravenna, having, with the aſſiſtance of the Britons, thoroughly repaired the breaches of Severus's wall and its fortreſſes, and exhorted the Britons to make a brave defence, took their final farewell of Britain. It ſoon appeared, that the ſtrongeſt walls and ramparts are no ſecurity to an undiſciplined and daſtardly rabble, as the unhappy Britons then were. The Scots and Picts met with little reſiſtance in breaking through the wall, while the towns and caſtles were tamely abandoned to their deſtructive rage. In many places they levelled it with the ground, that it might prove no obſtruction to their future inroads.—From this time no attempts were ever made to repair this noble work. Its beauty and grandeur procured it no reſpect in the dark and taſteleſs ages which ſucceeded. It became the common quarry for more than a thouſand years, out of which all the towns and villages around were built; and is now ſo entirely ruined, that the penetrating eyes of the moſt poring and patient antiquarian can hardly trace its vaniſhing foundations.

SEVIGNE', Marie de Rabutin, Marquise de, a French lady, was born in 1626. When only a year old ſhe loſt her father, who was killed in the deſcent of the Engliſh on the iſle of Rhé, where he commanded a company of volunteers. In 1644 ſhe married the marquis of Sevigné, who was ſlain in a duel by the chevalier d'Albret, in 1651. She had by him a ſon and a daughter, to the education of whom ſhe afterwards religiouſly devoted herſelf. Her daughter was married in 1669 to the count of Grignan, who conducted her to Provence. Madame de Sevigné conſoled herſelf by writing frequent letters to her daughter. She fell at laſt the victim to her maternal tenderneſs. In one of her viſits to Grignan, ſhe fatigued herſelf ſo much during the ſickneſs of her daughter, that ſhe was ſeized with a fever, which carried her off on the 14th of January 1696. We have two portraits of Madame de Sevigné; the one by the compte de Buſſi, the other by Madame de la Fayette. The firſt exhibits her defects; the ſecond her excellencies. Buſſi deſcribes her as a lively gay coquette, a lover of flattery, fond of titles, honour, and diſtinction: M. de la Fayette as a woman of wit and good ſenſe, as poſſeſſed of a noble ſoul, formed for diſpenſing benefits, incapable of debaſing herſelf by avarice, and bleſſed with a generous, obliging, and faithful heart. Both theſe portraits are in ſome meaſure juſt. That ſhe was vain-glorious, appears evident from her own letters, which, on the other hand, exhibit undoubted proofs of her virtue and goodneſs of heart.

This illuſtrious lady was acquainted with all the wits of her age. It is ſaid that ſhe decided the famous diſpute between Perrault and Boileau concerning the preference of the ancients to the moderns, thus, "The ancients are the fineſt, and we are the prettieſt." She left behind her a moſt valuable collection of letters, the beſt edition of which is that of 1775, in 8 vols 12mo. "Theſe letters (ſays Voltaire) are filled with anecdotes, written with freedom, and in a natural and animated ſtyle; are an excellent criticiſm on ſtudied letters of wit, and ſtill more on thoſe fictitious letters which aim at the epiſtolary ſtyle, by a recital of falſe ſentiments and feigned adventures to an imaginary correſpondent." It were to be wiſhed that a proper ſelection had been made of theſe letters. It is difficult to read eight volumes of letters, which, though inimitably written, preſent frequent repetitions, and are often filled with trifles. What makes them in general perhaps ſo intereſting is, that they are in part hiſtorical. They may be looked on as a relation of the manners, the ton, the genius, the faſhions, the etiquette, which reigned in the court of Louis XIV. They contain many curious anecdotes nowhere elſe to be found: But theſe excellencies would be ſtill more ſtriking, were they ſometimes ſtripped of that multitude of domeſtic affairs and minute incidents which ought naturally to have died with the mother and the daughter. A volume entitled *Sevigniana* was publiſhed at Paris in 1756, which is nothing more than a collection of the fine ſentiments, literary and hiſtorical anecdotes, and moral apophthegms, ſcattered throughout theſe letters.

Siecle de Louis XIV. tom. ii.

SEVILLE, a large and populous city of Spain, ſtands on the banks of the Guadalquiver, in the midſt of a rich, and to the eye a boundleſs, plain; in W. Long. 5° 5', N. Lat. 37° 20'. This city is ſuppoſed to have been founded by the Phœnicians, who gave it the name of *Hiſpalis*. When it fell under the power of the Romans, it was called *Julia;* and at laſt, after a variety of corruptions, was called *Sebilla* or *Sevilla;* both of which names are retained by the Spaniards. The Romans embelliſhed it with many magnificent edifices; of which ſcarce any veſtige now remains. The Gothic kings for ſome time made it their reſidence: but in proceſs of time they removed their court to Toledo; and Seville was taken by ſtorm ſoon after the victory obtained at Xeres over the Gothic king Rodrigo.—In 1027, Seville became an independent monarchy; but was conquered 70 years afterwards by Yuſef Almoravides, an African prince. At laſt it was taken by Ferdinand III. after a year's ſiege; and 300,000 Moors were then obliged to leave the place. Notwithſtanding this prodigious emigration, Seville continued to be a great and populous city, and ſoon after it was enlarged and adorned with many magnificent buildings, the chief of which is the cathedral. Seville arrived at its utmoſt pitch of grandeur a little after the diſcovery of America, the reaſon of which was, that all the valuable productions of the Weſt Indies were carried thither. Its court was then the moſt ſplendid in Europe; but in the courſe of a few years all this grandeur diſappeared, owing to the impediments in navigating the Guadalquiver. The ſuperior excellence of the port of Cadiz induced government to order the galeons to be ſtationed there in time to come.

Seville is of a circular form, and is ſurrounded by a wall about five miles and a half in circumference, containing 176 towers. The ditch in many places is filled up. The ſtreets of Seville are crooked and dirty, and moſt of them ſo narrow that two carriages can ſcarcely paſs one another abreaſt.

Seville is ſaid to contain 80,268 ſouls, and is divided into 30 pariſhes. It has 84 convents, with 24 hoſpitals.

Of the public edifices of this city the cathedral is the moſt magnificent. Its dimenſions are 420 feet in length, 263 in breadth within the walls, and 126 feet in height. It has nine doors, 80 altars, at which 500 maſſes are daily celebrated, and 80 windows of painted glaſs, each of which coſt 1000 ducats. At one angle ſtands a tower of Mooriſh workmanſhip 350 feet high. On the top of it is the giralda, or large brazen image, which, with its palm branch, weighs near one ton and a half, yet turns as a weather cock with the ſlighteſt variation of the wind. The whole work is brick and mortar. The paſſage to the top is an inclined plane, which winds about in the inſide in the manner of a ſpiral ſtaircaſe, ſo eaſy of aſcent that a horſe might trot from the bottom to the top; at the ſame time it is ſo wide that two horſemen may ride abreaſt. What appears very unaccountable, the ſolid maſonry in the upper half is juſt as thick again as that in the lower, though on the outſide the tower is all the way of the ſame dimenſions. In the opinion of Mr Swinburne, this cathedral is inferior to York

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York minſter. Its treaſures are ineſtimable; one altar with all its ornaments is ſolid ſilver; of the ſame metal are the images of St Iſidore and St Leander, which are as large as the life; and a tabernacle for the hoſt more than four yards high, adorned with 48 columns. Before the choir of the cathedral is the tomb of the celebrated Chriſtopher Columbus, the diſcoverer of America. His monument conſiſts of one ſtone only, on which theſe words are inſcribed, *A Caſtella y Arragon otro mundo dio Colon*; that is, "To Caſtile and Arragon Columbus gave another world:" an inſcription ſimple and expreſſive, the juſtneſs of which will be acknowledged by thoſe who have read the adventures of this illuſtrious but unfortunate man. The cathedral was begun by Don Sancho the Brave, about the cloſe of the 13th century, and finiſhed by John II. about an hundred years after. To the cathedral belongs a library of 20,000 volumes, collected by Hernando the ſon of Columbus; but, to the diſgrace of the Spaniards, it has ſcarcely received any addition ſince the death of the founder. The organ in this cathedral is a very ingenious piece of mechaniſm *. "I was much pleaſed (ſays Mr Townſend in his intereſting travels) with the conſtruction of a new organ, containing 5300 pipes, with 110 ſtops, which latter, as the builder told me, is 50 more than are in the famous one of Haerlem; yet, ſo ample are the bellows, that when ſtretched they ſupply the full organ 15 minutes. The mode of filling them with air is ſingular; for, inſtead of working with his hands, a man walks backwards and forwards along an inclined plane of about 15 feet in length, which is balanced in the middle on its axis; under each end is a pair of bellows, of about ſix feet by three and a half. Theſe communicate with five other pairs united by a bar; and the latter are ſo contrived, that when they are in danger of being overſtrained, a valve is lifted up, and gives them relief. Paſſing 10 times along the inclined plane fills all theſe veſſels."

Bourgoanne's Travels, vol. ii.

The Canos de Carmone, or great aqueduct of Seville, is reckoned by the hiſtorians of this city one of the moſt wonderful works of antiquity. Mr Swinburne, however, remarks, that it is ugly, crooked, the arches unequal, and the architecture neglected. The conduit is ſo leaky, that a rivulet is formed by the waſte water. Nevertheleſs, it ſtill conveys to the city an ample ſupply of water, ſufficient to turn ſeveral mills, and to give almoſt every houſe in town the benefit of it.

Swinburne's Travels, p. 283.

Many of the convents are remarkable for the beauty of their architecture; but in Seville the eye covets only pictures, of which there is a wonderful profuſion. Among theſe are the works of the famous painter Murillo, with many others univerſally admired.

The convent of the Franciſcans contains 15 cloiſters, with apartments for 200 monks, though, when Mr Townſend viſited them, they amounted only to 140. The annual expenditure of theſe, who are all fed on charity, is about 4000l. ſterling. "In the principal cloiſter (ſays the ſame intelligent traveller), which is entirely incloſed by a multitude of little chapels, are repreſented, in 14 pictures, each called a *ſtation*, all the ſufferings of the Redeemer. Theſe are ſo arranged as to mark given diſtances by walking round the cloiſter from the firſt to the ſecond, and ſo in order to the reſt. Over them is mentioned the number of ſteps taken by our Lord between the ſeveral incidents of his paſſion in his way to Calvary; and theſe preciſely are the paces meaſured for the penitents in their progreſs from one ſtation to another. Over one is the following inſcription: 'This ſtation conſiſts of 1087 ſteps. Here the bleſſed Redeemer fell a ſecond time under the weight of his croſs, and here is to be gained the indulgence of ſeven years and forty quarantines. Mental prayer, the Paternoſter, and the Ave Maria.' This may ſerve as an example for the reſt."

Townſend's Travels, vol. ii. p. 326.

The principal manufacture of Seville is ſnuff. Mr Townſend, who paid particular attention to it, informs us, that the building in which it is carried on is elegant and ſimple in its form, and is about 600 feet by 480, and not leſs than 60 feet in height, with four regular fronts, incloſing 28 quadrangles. It coſt 37,000,000 of reals, or about 370,000l. At preſent (1787), no more than 1700 workmen are employed, and 100 horſes or mules; but formerly 3000 men were engaged, and near 400 horſes. This falling off is attributed by Mr Swinburne to a practice which the directors followed, of adulterating the tobacco with the red earth of Almazarron. When Mr Townſend viſited this manufacture, they had changed their ſyſtem. From the year 1780, he informs us, the annual ſale of tobacco from Brazil has been 1,500,000 pounds, purchaſed from the Portugueſe at three reals a pound; and of ſnuff from the produce of their own colonies 1,600,000 pounds, beſide *cigars* (A) to a very conſiderable amount. They have lying by them more than 5,000,000 pounds of ſnuff unſold; but as it will not ſuffer by age, they are not uneaſy at this accumulation. Beſides the peculiar kind of ſnuff with which Spain was accuſtomed to ſupply the market, they have lately introduced the manufacture of rappee. In this branch alone are employed 220 perſons, old and young, with 16 mules.

"All the workmen (continues Mr Townſend) depoſit their cloaks at the door; and when they go out are ſo ſtrictly examined, that they have little chance of being able to conceal tobacco; yet they ſometimes venture to hide it about their perſons. An officer and a guard is always attending to take delinquents into cuſtody; and that they may prevent reſiſtance, no workman is permitted to enter with a knife. Were it not for this precaution, the conſequence of a detection might be fatal. The whole buſineſs is conducted by a director, with a ſalary of 40,000 reals a-year, and 54 ſuperior officers, aſſiſted by as many ſubordinate to them. For grinding their ſnuff, they have 40 mills, each conſiſting of a ſtone roller, moved by a large horſe or mule, with the traces faſtened to a beam of eight feet in length, in the angle of 45 degrees, conſequently loſing preciſely half his force."

Before Mr Townſend left Seville, according to his uſual practice, which was truly laudable, he enquired into the prices of labour and proviſions. As a piece of

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* Vol. ii. p. 318.

(A) Theſe are little rolls of tobacco which the Spaniards ſmoke without a pipe.

curious and uſeful information, and as an example to other travellers, we preſent them to our readers. They are as follows :

Day-labourers $4\frac{1}{2}$ reals, about L.	0	0	$10\frac{3}{4}$
Carpenters from 7 to 11 ——			
Joiners, if good workmen, 24 —— or	0	4	9
Weavers, if good workmen, 15 reals, about	0	3	0
Bread, for 3 lb. of 16 oz. 16 quartos, or	0	0	$4\frac{1}{2}$
—— ſometimes 28 quartos, or	0	0	$7\frac{7}{8}$
Beef, 30 quartos for 32 oz. per lb. about	0	0	$4\frac{1}{2}$
Mutton, 38 do. do.	0	0	$5\frac{11}{12}$
Kid, 24 do.	0	0	$3\frac{3}{8}$
Pork from 36 to 42 quartos, do. { or	0	0	$5\frac{1}{16}$
to	0	0	$5\frac{39}{31}$

The price of wheat has at different periods been very remarkable. In 1652, it ſold at the rate of 15s. $3\frac{1}{2}$d. the buſhel ; and in 1657, it fell ſo low as 1s. $4\frac{1}{2}$d. per buſhel, reckoning the fanega at $109\frac{1}{2}$ lb. and the buſhel at 70.

SEVUM MINERALE, mineral tallow ; a ſubſtance ſomewhat reſembling tallow, found on the ſea coaſts of Finland in the year 1736. It burns with a blue flame, and ſmell of greaſe, leaving a black viſcid matter which cannot eaſily be conſumed. It is extremely light ; being only of the ſpecific gravity of 0.770 ; whereas tallow is not leſs than 0.969. It is partly ſoluble in highly rectified ſpirit of wine ; but entirely ſo in expreſſed oils when boiling. It is met with in ſome of the rocky parts of Perſia, but there it appears to be mixed with petrolæum. Dr Herman of Straſburg mentions a ſpring in the neighbourhood of that city which contains a ſubſtance of this ſort diffuſed through it, ſeparating, and capable of being collected on ebullition.—A fat mineral matter reſembling butter or tallow has lately been extracted from peat in Lancaſhire. See PEAT.

SEWAURY, a Hindoo word uſed in Bengal, and ſignifying the train of attendants that accompany a nabob or great man.

SEWER, *in the Houſehold*, an officer who arranged on the table the diſhes of a king or nobleman.

SEWER is alſo a paſſage or gutter made to carry water into the ſea or a river, whereby to preſerve the land, &c. from inundations and other annoyances.

Court of Commiſſioners of SEWERS *in England*, a temporary tribunal, erected by virtue of a commiſſion under the great ſeal ; which formerly uſed to be granted *pro re nata* at the pleaſure of the crown, but now at the diſcretion and nomination of the lord chancellor, lord treaſurer, and chief juſtices, purſuant to the ſtatute 23 Hen. VIII. c. 5. Their juriſdiction is to overlook the repairs of ſea-banks and ſea-walls, and the cleanſing of rivers, public ſtreams, ditches, and other conduits, whereby any waters are carried off ; and is confined to ſuch county or particular diſtrict as the commiſſion ſhall expreſsly name. The commiſſioners are a court of record, and may fine and impriſon for contempts ; and in the execution of their duty may proceed by jury, or upon their own view, and may take order for the removal of any annoyances, or the ſafeguard and conſervation of the ſewers within their commiſſion, either according to the laws and cuſtoms of Romney-marſh, or otherwiſe at their own diſcretion. They may alſo aſſeſs ſuch rates or ſcots upon the owners of lands within their diſtrict as they ſhall judge neceſſary : and if any perſon refuſes to pay them, the commiſſioners may levy the ſame by diſtreſs of his goods and chattels ; or they may, by ſtatute 23 Hen. VIII. c. 5. ſell his freehold lands (and by the 7 Ann. c. 10. his copyhold alſo), in order to pay ſuch ſcots or aſſeſſments. But their conduct is under the controul of the court of King's-bench, which will prevent or puniſh any illegal or tyrannical proceedings. And yet in the reign of King James I. (8th Nov. 1616), the privy-council took upon them to order, that no action or complaint ſhould be proſecuted againſt the commiſſioners unleſs before that board ; and committed ſeveral to priſon who had brought ſuch actions at common law, till they ſhould releaſe the ſame : and one of the reaſons for diſcharging Sir Edward Coke from his office of lord chief-juſtice, was for countenancing thoſe legal proceedings. The pretence for theſe arbitrary meaſures was no other than the tyrant's plea of the *neceſſity* of unlimited powers in works of evident utility to the public, "the ſupreme reaſon above all reaſons, which is the ſalvation of the king's lands and people." But now it is clearly held, that this (as well as all other inferior juriſdiction) is ſubject to the diſcretionary coercion of his majeſty's court of King's-bench.

Ferguſon's Roman Hiſtory.

Common SEWERS, in Rome, were executed at a great expence. It was propoſed that they ſhould be of ſufficient dimenſions to admit a waggon loaded with hay. When theſe common ſewers came to be obſtructed, or out of repair, under the republic, the cenſors contracted to pay a thouſand talents, or about 193,000l. for clearing and repairing them. They were again in diſrepair at the acceſſion of Auguſtus Cæſar, and the reinſtating them is mentioned among the great works of Agrippa. He is ſaid to have turned the courſe of ſeven rivers into theſe ſubterraneous paſſages, to have made them navigable, and to have actually paſſed in barges under the ſtreets and buildings of Rome. Theſe works are ſtill ſuppoſed to remain ; but as they exceed the power and reſources of the preſent city to keep them in repair, they are quite concealed, except at one or two places. They were in the midſt of the Roman greatneſs, and ſtill are, reckoned among the wonders of the world ; and yet they are ſaid to have been works of the elder Tarquin, a prince whoſe territory did not extend, in any direction, above 16 miles ; and, on this ſuppoſition, they muſt have been made to accommodate a city that was calculated chiefly for the reception of cattle, herdſmen, and banditti. Rude nations ſometimes execute works of great magnificence, as fortreſſes and temples, for the purpoſes of war and ſuperſtition ; but ſeldom palaces, and ſtill more ſeldom works of mere convenience and cleanlineſs, in which for the moſt part they are long defective. It is not unreaſonable, therefore, to queſtion the authority of tradition in reſpect to this ſingular monument of antiquity, which ſo greatly exceeds what the beſt accommodated city of modern Europe could undertake for its own conveniency. And as thoſe works are ſtill entire, and may continue ſo for thouſands of years, it may be ſuſpected that they were even prior to the ſettlement of Romulus, and may have been the remains of a more ancient city, on the ruins of which the followers of Romulus ſettled, as the Arabs now hut or encamp on the ruins of Palmyra and Balbeck. Livy owns, that the common ſewers were not accommodated to the plan of Rome, as it was laid out in his time; they were carried in directions acroſs the ſtreets, and paſſed under buildings of the greateſt antiquity. This derangement indeed he imputes to the haſty rebuilding of the city after its deſtruction by the Gauls; but haſte, it is probable, would have determined the people to build on their old foundations, or at leaſt not to change them ſo much as to croſs the direction of former ſtreets.

SEX, the property by which any animal is male or female.

Lavater has drawn the following characteriſtic diſtinctions between the male and female of the human ſpecies.

“ The primary matter of which women are conſtituted appears to be more flexible, irritable, and elaſtic, than that of man. They are formed to maternal mildneſs and affection; all their organs are tender, yielding, eaſily wounded, ſenſible, and receptible. Among a thouſand females there is ſcarcely one without the generic feminine ſigns; the flexible, the circular, and the irritable.

“ They are the counterpart of man, taken out of man, to be ſubject to man; to comfort him like angels, and to lighten his cares. ‘ She ſhall be ſaved in childbearing, if they continue in faith, and charity, and holineſs, with ſobriety’ (1 Tim. ii. 15.). This tenderneſs, this ſenſibility, this light texture of their fibres and organs, this volatility of feeling, render them ſo eaſy to conduct and to tempt; ſo ready of ſubmiſſion to the enterpriſe and power of the man; but more powerful through the aid of their charms than man with all his ſtrength. The man was not firſt tempted, but the woman, afterward the man by the woman. And, not only eaſy to be tempted, ſhe is capable of being formed to the pureſt, nobleſt, moſt ſeraphic virtue; to every thing which can deſerve praiſe or affection. Highly ſenſible of purity, beauty, and ſymmetry, ſhe does not always take time to reflect on internal life, internal death, internal corruption. ‘ The woman ſaw that the tree was good for food, and that it was pleaſant to the eyes, and a tree to be deſired to make one wiſe, and ſhe took of the fruit thereof.’ (Gen. iii. 6.).

“The female thinks not profoundly; profound thought is the power of the man. Women feel more. Senſibility is the power of woman. They often rule more effectually, more ſovereignly, than man. They rule with tender looks, tears, and ſighs: but not with paſſion and threats; for if, or when, they ſo rule, they are no longer women, but abortions. They are capable of the ſweeteſt ſenſibility, the moſt profound emotion, the utmoſt humility, and the exceſs of enthuſiaſm. In their countenance are the ſigns of ſanctity and inviolability, which every feeling man honours, and the effects of which are often miraculous. Therefore, by the irritability of their nerves, their incapacity for deep inquiry and firm deciſion, they may eaſily from their extreme ſenſibility become the moſt irreclaimable, the moſt rapturous enthuſiaſts. Their love, ſtrong and rooted as it is, is very changeable; their hatred almoſt incurable, and only to be effaced by continued and artful flattery. Men are moſt profound; women are more ſublime.

“ Men moſt embrace the whole; women remark individually, and take more delight in ſelecting the minutiæ which form the whole. Man hears the burſting thunder, views the deſtructive bolt with ſerene aſpect, and ſtands erect amidſt the fearful majeſty of the ſtreaming clouds. Woman trembles at the lightning, and the voice of diſtant thunder; and ſhrinks into herſelf, or ſinks into the arms of man. Man receives a ray of light ſingle, woman delights to view it through a priſm in all its dazzling colours. She contemplates the rainbow as the promiſe of peace; he extends his inquiring eye over the whole horizon. Woman laughs, man ſmiles; woman weeps, man remains ſilent. Woman is in anguiſh when man weeps, and in deſpair when man is in anguiſh; yet has ſhe often more faith than man. Man without religion, is a diſeaſed creature, who would perſuade himſelf he is well, and needs not a phyſician; but woman without religion, is raging and monſtrous. A woman with a beard is not ſo diſguſting as a woman who acts the freethinker; her ſex is formed to piety and religion; to them Chriſt firſt appeared; but he was obliged to prevent them from too ardently, and too haſtily, embracing him: ‘ Touch me not.’ They are prompt to receive and ſeize novelty, and become its enthuſiaſts. The whole world is forgotten in the emotion cauſed by the preſence and proximity of him they love. They ſink into the moſt incurable melancholy, as they alſo riſe to the moſt enraptured heights.

“ Male ſenſation is more imagination, female more heart. When communicative, they are more communicative than man; when ſecret, more ſecret. In general they are more patient, long-ſuffering, credulous, benevolent, and modeſt. Woman is not a foundation on which to build. She is the gold, ſilver, precious ſtones, wood, hay, ſtubble (1 Cor. iii. 12.); the materials for building on the male foundation. She is the leaven, or more expreſſively the oil to the vinegar of man: the ſecond part of the book of man.

“ Man ſingly is but half man; at leaſt but half human; a king without a kingdom. Woman, who feels properly what ſhe is, whether ſtill or in motion, reſts upon the man; nor is man what he may and ought to be, but in conjunction with woman; therefore, ‘ it is not good that man ſhould be alone, but that he ſhould leave father and mother, and cleave to his wife, and they two ſhall be one fleſh.”

They differ alſo in their exterior form and appearance.

“ Man is the moſt firm; woman the moſt flexible. Man is the ſtraighteſt; woman the moſt bending. Man ſtands ſtedfaſt; woman gently retreats. Man ſurveys and obſerves; woman glances and feels. Man is ſerious; woman is gay. Man is the talleſt and broadeſt; woman the ſmalleſt and weakeſt. Man is rough and hard; woman ſmooth and ſoft. Man is brown; woman is fair. Man is wrinkly; woman is not. The hair of man is more ſtrong and ſhort; of woman more long and pliant. The eyebrows of man are compreſſed; of woman leſs frowning. Man has moſt convex lines; woman moſt concave. Man has moſt ſtraight lines; woman moſt curved. The countenance of man taken in profile is more ſeldom perpendicular than that of the woman. Man is moſt angular; woman moſt round.”

Fitzoſborne's Letters.

In determining the comparative merit of the two ſexes, it is no derogation from female excellency that it differs in kind from that which diſtinguiſhes the male part of our ſpecies: and if, in general, it ſhould be found (what upon an impartial inquiry will moſt certainly be found) that women fill up their appointed circle of action with greater regularity than men, the claim of preference cannot juſtly be decided in our favour. In the prudential and economical parts of life, it is undeniable that they riſe far above us: and if true fortitude of mind is beſt diſcovered by a cheerful reſignation to the meaſures of Providence, we ſhall not find reaſon, perhaps, to claim that moſt ſingular of the human virtues as our peculiar privilege. There are numbers of the other ſex who, from the natural delicacy of their conſtitution, paſs through one continued ſcene of ſuffering from their cradles to their graves, with a firmneſs of reſolution that would deſerve ſo many ſtatues to be erected to their memories, if heroiſm were not eſteemed more by the ſplendour than the merit of actions.

But whatever real difference there may be between the moral or intellectual powers of the male and female mind, Nature does not ſeem to have marked the diſtinction ſo ſtrongly as our vanity is willing to imagine; and after all, perhaps, education will be found to conſtitute the principal ſuperiority. It muſt be acknowledged, at leaſt, that in this article we have every advantage over the ſofter ſex that art and induſtry can poſſibly ſecure to us. The moſt animating examples of Greece and Rome are ſet before us, as early as we are capable of any obſervation; and the nobleſt compoſitions of the ancients are given into our hands almoſt as ſoon as we have ſtrength to hold them; while the employments of the other ſex, at the ſame period of life, are generally the reverſe of every thing that can open and enlarge their minds, or fill them with juſt and rational notions. The truth of it is, female education is ſo much worſe than none, as it is better to leave the mind to its natural and uninſtructed ſuggeſtions, than to lead it into falſe purſuits, and contract its views, by turning them upon the loweſt and moſt trifling objects. We ſeem, indeed, by the manner in which we ſuffer the youth of that ſex to be trained, to conſider women agreeably to the opinion of certain Mahometan doctors, and treat them as if we believed they had no ſouls: why elſe are they

> Bred only, and completed to the taſte
> Of luſtful appetence, to ſing, to dance,
> To dreſs, and troul the tongue, and roll the eye.
> MILTON.

This ſtrange neglect of cultivating the female mind can hardly be allowed as good policy, when it is conſidered how much the intereſt of ſociety is concerned in the rectitude of their underſtandings. That ſeaſon of every man's life which is moſt ſuſceptible of the ſtrongeſt impreſſions, is neceſſarily under female direction; as there are few inſtances, perhaps, in which that ſex is not one of the ſecret ſprings which regulates the moſt important movements of private or public tranſactions. What Cato obſerves of his countrymen is in one reſpect true of every nation under the ſun: "The Romans (ſaid he) govern the world, but it is the women that govern the Romans."

If it be true then (as true beyond all peradventure it is) that female influence is thus extenſive, nothing certainly can be of more importance than to give it a proper tendency, by the aſſiſtance of a well-directed education. Far are we from recommending any attempts to render women learned; yet ſurely it is neceſſary they ſhould be raiſed above ignorance. Such a general tincture of the moſt uſeful ſciences as may ſerve to free the mind from vulgar prejudices, and give it a reliſh for the rational exerciſe of its powers, might very juſtly enter into a plan of female erudition. That ſex might be taught to turn the courſe of their reflections into a proper and advantageous channel, without any danger of rendering them too elevated for the feminine duties of life. In a word, they ought to be conſidered as deſigned by Providence for uſe as well as ſhow, and trained up, not only as women, but as rational creatures.'

SEX of Bees. See BEE.

SEX of Plants. See BOTANY *Index*.

SEXAGENARY, ſomething relating to the number ſixty: thus ſexagenary or ſexageſimal arithmetic is a method of computation proceeding by ſixties; ſuch is that uſed in the diviſion of a degree into ſixty minutes, of the minute into ſixty ſeconds, of the ſecond into ſixty thirds, &c. Alſo ſexagenary tables are tables of proportional parts, ſhowing the product of two ſexagenaries that are to be multiplied, or the quotient of the two that are to be divided.

SEXAGESIMA, the ſecond Sunday before Lent, or the next to Shrove-Sunday; ſo called as being about the 60th day before Eaſter.

SEXAGESIMALS, or *SEXAGESIMAL Fractions*, fractions whoſe denominators proceed in a ſexagecuple ratio; that is, a prime, or the firſt minute $=\frac{1}{60}$; a ſecond $=\frac{1}{3600}$; a third $=\frac{1}{216000}$. Anciently, there were no other than ſexageſimals uſed in aſtronomy; and they are ſtill retained in many caſes, though decimal arithmetic begins to grow in uſe now in aſtronomical calculations. In theſe fractions, which ſome call *aſtronomical fractions*, the denominator being always 60, or a multiple thereof, is uſually omitted, and the numerator only written down: thus 4^{o}, $59'$, $32''$, $50'''$, $16''''$, is to be read, 4 degrees, 59 minutes, 32 ſeconds, 50 thirds, 16 fourths, &c.

SEXTANS, SEXTANT, a ſixth part of certain things. The Romans having divided their *as* into 12 ounces or uncia, the ſixth part of that, or two ounces, was the ſextans.—*Sextans* was alſo a meaſure which contained two ounces of liquor, or two cyathi.

SEXTANS, in *Aſtronomy*, a conſtellation of the ſouthern hemiſphere, made by Hevelius out of unformed ſtars. In Hevelius's catalogue it contains 11, but in the Britannic catalogue 41 ſtars.

SEXTANT, in *Mathematics*, denotes the ſixth part of a circle, or an arch comprehending 60 degrees.

The word *ſextant* is more particularly uſed for an aſtronomical inſtrument made like a quadrant, excepting that its limb only comprehends 60 degrees. The uſe and application of the ſextant is the ſame with that of the quadrant. See QUADRANT; and NAVIGATION, p. 699, &c.

SEXTILE, SEXTILIS, the poſition or aſpect of two planets when at 60 degrees diſtance, or at the diſtance of two ſigns from one another. It is marked thus (*). See ASPECT.

SEXTIUS, QUINTUS, a Pythagorean philoſopher, flouriſhed in the time of Auguſtus. He ſeemed formed to riſe in the republic; but he ſhrunk from civil honours, and declined accepting the rank of ſenator when it was offered him by Julius Cæſar, that he might have time

time to apply to philoſophy. It appears that he wiſhed to eſtabliſh a ſchool at Rome, and that his tenets, though chiefly drawn from the doctrines of Pythagoras, in ſome particulars reſembled thoſe of the Stoics.

He ſoon found himſelf involved in many difficulties. His laws were tinctured with great ſeverity; and in an early period of this eſtabliſhment, he found his mind ſo haraſſed, and the harſhneſs of the doctrines which he wiſhed to eſtabliſh ſo repulſive to his feelings, that he had nearly worked himſelf up to ſuch an height of deſperation as to reſolve on putting a period to his exiſtence.

Of the ſchool of Sextius were Fabianus, Sotion, Flavianus, Craſſitius, and Celſus. Of his works only a few fragments remain; and whether any of them formed a part of the work which Seneca admired ſo much, cannot now be determined. Some of his maxims are valuable. He recommended an examination of the actions of the day to his ſcholars when they retired to reſt; he taught, that the road to heaven (*ad aſtra*) was by frugality, temperance, and fortitude. He uſed to recommend holding a looking-glaſs before perſons diſordered with paſſion. He enjoined his ſcholars to abſtain from animal food.

SEXTON, a church-officer, thus called by corruption of the Latin *ſacriſta*, or Saxon *ſegerſtone*, which denotes the ſame. His office is to take care of the veſſels, veſtments, &c. belonging to the church; and to attend the miniſter, church-warden, &c. at church. He is uſually choſen by the parſon only. Sextons, as well as pariſh clerks, are regarded by the common law as perſons who have freehold in their offices; and, therefore, though they may be puniſhed, yet they cannot be deprived by eccleſiaſtical cenſures.

The office of ſexton in the pope's chapel is appropriated to the order of the hermits of St Auguſtine. He is generally a biſhop, though ſometimes the pope only gives a biſhopric, *in partibus*, to him on whom he confers the poſt. He takes the title of *Prefect of the Pope's Sacriſty*, and has the keeping the veſſels of gold and ſilver, the relics, &c. When the pope ſays maſs, the ſexton always taſtes the bread and wine firſt. If it be in private he ſays maſs, his holineſs, of two wafers, gives him one to eat; and, if in public, the cardinal, who aſſiſts the pope in quality of deacon, of three wafers, gives him one to eat. When the pope is deſperately ſick, he adminiſters to him the ſacrament of extreme unction, &c. and enters the conclave in quality of firſt conclaviſt.

The office of a ſexton in Sweden is ſometimes ſingular. During M. Outhier's ſtay at Stockholm in 1736 he viſited the church of St Clara, and during divine ſervice he obſerved a ſexton going about with a long rod, waking thoſe perſons who had fallen aſleep.

SEXTUPLE, in *Muſic*, denotes a mixed ſort of triple, which is beaten in double time.

SEXTUS EMPIRICUS, a famous Pyrrhonian philoſopher, lived in the ſecond century, under the reign of Antoninus the Debonair. He was a phyſician of the ſect of the Empirics, and is ſaid to have been one of the preceptors of Antoninus the philoſopher. There are ſtill extant his Pyrrhonian Inſtitutions, and a large work againſt the mathematicians, &c. The beſt edition of Sextus Empiricus is that of Fabricius in Greek and Latin, printed at Leipſic in 1718, folio.

SEXUALISTÆ, among botanical writers, thoſe who have eſtabliſhed the claſſes of plants upon the differences of the ſexes and parts of fructification in plants, according to the modern method; as Linnæus, &c.

SEZAWUL, a Hindoo word, uſed in Bengal to expreſs an officer employed at a monthly ſalary to collect the revenues.

SFORZA, JAMES, was the founder of the illuſtrious houſe of Sforza, which acted ſo conſpicuous a part in Italy during the 15th and 16th centuries, which gave ſix dukes to Milan, and contracted alliances with almoſt every ſovereign in Europe. James Sforza was born on the 28th of May 1369, at Catignola, a ſmall town in Italy, lying between Imola and Faënza. His father was a day labourer, or, according to Commines, a ſhoemaker. A company of ſoldiers happening one day to paſs through Catignola, he was ſeized with the deſire of accompanying them to the wars. "I will go (ſaid he to himſelf), and dart my hatchet againſt that tree, and if it ſtick faſt in the wood, I will immediately become a ſoldier." The hatchet accordingly ſtuck faſt, and our adventurer enliſted; and becauſe, ſays the Abbé de Choiſi, he had thrown the axe with all his force, he aſſumed the name of Sforza; for his true name was Giacomuzzo, or James Attendulo. He roſe rapidly in the army, and ſoon became commander of 7000 men. He defended the cauſe of Jane II. queen of Naples for many years, and was made conſtable of her kingdom. He was created Count of Catignola by Pope John XXII. by way of paying a debt of 14,000 ducats which the church of Rome owed him. His exploits became every day more illuſtrious: He obliged Alphonſo king of Arragon to raiſe the ſiege of Naples; and reduced ſeveral places that had revolted in Abruzzo and Le Labour; but while in purſuit of his enemies he was unfortunately drowned in the river Aterno on the 3d January 1424, at the age of 54 years. His heroic qualities, and the continual wars in which he was engaged, did not prevent him from forming an attachment to the fair ſex. In his youth he fell in love with a woman called *Lucia Trezana*, whom he married after ſhe had born him ſeveral children. He married afterwards Antoinette Salembini, who brought him ſeveral excellent eſtates; ſhe bore him Boſio Sforza, compte of Santa-Flor, a warrior and governor of Orvietta for Pope Martin V. His third wife was Catharine Alopo, ſiſter of Rodolpho, grand chamberlain to the ſovereign of Naples. His laſt wife, for he was four times married, was Mary Marzana, daughter to the duke of Seſſa. She bore him Charles Sforza, who was general of the order of Auguſtines, and archbiſhop of Milan.

SFORZA, *Francis*, the ſon of James Sforza by Lucia Trezana, was born in 1401, and trained up by his father to the profeſſion of arms. At the age of 23 he defeated the troops of Braccio, who diſputed with him the paſſage of the Aterno. In this action his father was drowned, and Francis, though illegitimate, ſucceeded him. He fought ſucceſsfully againſt the Spaniards, and contributed a great deal both towards raiſing the ſiege of Naples, and to the victory which was gained over the troops of Braccio near Aquila in 1425, where that general was killed. After the death of Queen Jane, in 1435, he eſpouſed the intereſts of the duke of Anjou, to whom ſhe had left her crown, and by his courage and abilities ably ſupported that un-

fortunate

fortunate prince. He made himſelf maſter of ſeveral places in Ancona, from which he was driven by Pope Eugenius IV. who defeated and excommunicated him; but he ſoon re-eſtabliſhed his affairs by a victory. His reputation was now ſo great, that the pope, the Venetians, and the Florentines, choſe him for their general againſt the duke of Milan. Sforza had already conducted Venetian armies againſt that prince, though he had eſpouſed his daughter. The duke dying in 1447, the inhabitants of Milan invited Sforza, his ſon-in-law, to lead them againſt that duke. But, after ſome exertions in their favour, he turned his arms againſt themſelves, laid ſiege to Milan, and obliged them to receive him as duke, notwithſtanding the rights of Charles duke of Orleans, the ſon of Valentine of Milan. In 1464, Louis XI. who hated Orleans, gave up to Sforza the rights which the crown of France had over Genoa, and even put into his hands Savona, a town belonging to that republic. The duke of Milan ſoon after made himſelf maſter of Genoa. He died in 1466, with the reputation of a man who was willing to ſell his blood to the beſt purchaſer, and who was not too ſcrupulous an obſerver of his word. His ſecond wife was Blanche Marie, natural daughter of Philip Marie duke of Milan. She bore him Galeas Marie, and Ludovic Marie, dukes of Milan, Philip Marie count of Pavia, Sforza Marie duke of Bari, Aſcagne Marie biſhop of Pavia and Cremona, and a cardinal. He was taken priſoner by the troops of Louis XII. and confined for ſome time in the tower of Bourges. He was a cunning man, and deceived Cardinal d'Amboiſe when that prelate aſpired at the papacy. His daughters were Hyppolita, married to Alphonſo of Arragon, afterwards king of Naples; and Elizabeth, married to William marquis of Montferrat. He had beſides ſeveral natural children.

SHACK, in ancient cuſtoms, a liberty of winter-paſturage. In the counties of Norfolk and Suffolk, the lord of the manor has ſhack, i. e. a liberty of feeding his ſheep at pleaſure in his tenants lands during the ſix winter months. In Norfolk, ſhack alſo extends to the common for hogs, in all men's grounds, from the end of harveſt till ſeed-time. Whence to go *a-ſhack*, is to feed at large.

SHACKLES, aboard a ſhip, are thoſe oblong iron rings, bigger at one end than at the other, with which the ports are ſhut faſt, by thruſting the wooden bar of the port through them. There is alſo a ſort of ſhackles to lift the hatches up with, of a like figure, but ſmaller. They are faſtened at the corners of the hatches.

SHAD, a ſpecies of CLUPEA. See ICHTHYOLOGY *Index*.

SHADDOCK, a ſpecies of CITRUS, the fruit of which is of a very large ſize, and of a very grateful taſte. In the Weſt Indies it is eaten after dinner to give a zeſt to the wine.

SHADOW, in *Optics*, a privation or diminution of light, by the interpoſition of an opaque body; or it is a plane where the light is either altogether obſtructed, or greatly weakened, by the interpoſition of ſome opaque body between it and the luminary.

SHADOW, in *Painting*, an imitation of a real ſhadow, effected by gradually heightening and darkening the colours of ſuch figures as by their diſpoſitions cannot receive any direct rays from the luminary that is ſuppoſed to enlighten the piece.

SHADOW, in *Perſpective*. The appearance of an opaque body, and a luminous one, whoſe rays diverge (*e. gr.* a candle, lamp, &c.), being given; to find the juſt appearance of the ſhadow, according to the laws of perſpective. The method is this: From the luminous body, which is here conſidered as a point, let fall a perpendicular to the perſpective plane or table; i. e. find the appearance of a point upon which a perpendicular, drawn from the middle of the luminary, falls on the perſpective plane; and from the ſeveral angles, or raiſed points of the body, let fall perpendiculars to the plane. Theſe points, whereon the perpendiculars fall, connect by right lines, with the point upon which the perpendicular let fall from the luminary falls; and continue the lines to the ſide oppoſite to the luminary. Laſtly, through the raiſed points draw lines through the centre of the luminary, interſecting the former; the points of interſection are the terms or bounds of the ſhadow.

SHADOWS, COLOURED, a curious phenomenon in optics, which was obſerved by Profeſſor Scherffer of Vienna, and afterwards by Count Rumford, who made the diſcovery while proſecuting his experiments on light.

"Deſirous," ſays the count, "of comparing the intenſity of the light of a clear blue ſky by day with that of a common wax candle, I darkened my room, and letting the day-light from the north, coming through a hole near the top of the window-ſhutter, fall at an angle of about 70° upon a ſheet of very fine white paper, I placed a burning wax candle in ſuch a poſition that its rays fell upon the ſame paper, and, as near as I could gueſs, in the line of reflection of the rays of day-light from without; when, interpoſing a cylinder of wood, about half an inch in diameter, before the centre of the paper, and at the diſtance of about two inches from its ſurface, I was much ſurpriſed to find that the two ſhadows projected by the cylinder upon the paper, inſtead of being merely ſhades without colour, as I expected; the one of them, that which, correſponding with the beam of day-light, was illuminated by the candle, was yellow; while the other, correſponding to the light of the candle, and conſequently illuminated by the light of the heavens, was of the moſt beautiful blue that it is poſſible to imagine. This appearance, which was not only unexpected, but was really in itſelf in the higheſt degree ſtriking and beautiful, I found upon repeated trials, and after varying the experiment in every way I could think of, to be ſo perfectly permanent, that it is abſolutely impoſſible to produce two ſhadows at the ſame time from the ſame body, the one anſwering to a beam of day-light, and the other to the light of a candle or lamp, without thoſe ſhadows being coloured, the one yellow, and the other blue.

"If the candle be brought nearer to the paper, the blue ſhadow will become of a deeper hue, and the yellow ſhadow will gradually grow fainter; but if it be removed farther off, the yellow ſhade will become of a deeper colour, and the blue ſhade will become fainter; and the candle remaining ſtationary in the ſame place, the ſame varieties in the ſtrength of the tints of the coloured ſhadows may be produced merely by opening the window-ſhutter a little more or leſs, and rendering the illumination of the paper, by the light from without, ſtronger or weaker. By either of theſe means, the coloured ſhadows may be made to paſs through all the gradations of ſhade, from the deepeſt to the lighteſt, and *vice verſa*; and it is not a little amuſing to ſee ſhadows thus glowing with all the brilliancy of the pureſt and moſt intenſe priſmatic colours, then paſſing ſuddenly through all the varieties of ſhade, preſerving in all the moſt perfect purity of tint, growing ſtronger and fainter, and vaniſhing and returning, at command *."

The count is clearly of opinion, that the cauſes of the colours of theſe ſhadows ariſe from the different qualities of the light by which they are illuminated; but he does not think it ſo evident how they are produced. Perhaps it may be ſaid, however, that all the phenomena of coloured ſhadows which the count enumerates may be accounted for by the theory of Profeſſor Scherffer.

SHADWELL, Thomas, deſcended of an ancient family in Staffordſhire, was born in 1640, and educated at Caius college, Cambridge. He then was placed in the Middle Temple to ſtudy the laws; where having ſpent ſome time, he travelled abroad. Upon his return home, he became acquainted with the moſt celebrated perſons of wit in that age. He applied himſelf chiefly to dramatic writing, in which he had great ſucceſs; and upon the revolution, was made poet laureat and hiſtoriographer to King William and Queen Mary, in the room of Mr Dryden. Theſe employments he enjoyed till his death, which happened in 1692. Beſide his dramatic writings, he compoſed ſeveral other pieces of poetry; the chief of which are his congratulatory poem on the prince of Orange's coming to England: another on Queen Mary; his tranſlation of Juvenal's 10th ſatire, &c. Mr Dryden treats him with great contempt, in his ſatire called *Mac-Flecno*. The beſt judges of that age, however, gave their teſtimony in favour of his comedies; which have in them fine ſtrokes of humour; the characters are often original, ſtrongly marked, and well ſuſtained. An edition of his works, with ſome account of his life and writings prefixed, was publiſhed in 1720, in 4 vols 8vo.

SHAFRAS, or Suffras, Gregory Savarof, an Armenian merchant, remarkable only as the perſon who ſold the large and celebrated diamond which is now ſet in the imperial ſceptre of Ruſſia. Shah Nadir, an Indian prince, had two principal diamonds in his throne, one of them denominated the *Sun of the Sea*, and the other the *Moon of the Mountain*. When that prince was aſſaſſinated, many precious ornaments belonging to the crown were pillaged, and privately diſpoſed of by the ſoldiers who ſhared the plunder. See DIAMOND, under MINERALOGY, where the account given of this diamond is ſomewhat different.

Shafras, who was called *Millionſhik* at Aſtracan, then had his reſidence at Baſſora, with two of his brothers. A chief of the Avganians one day applied to him, and propoſed to ſell the diamond already mentioned for a very moderate ſum (probably the Moon of the Mountain), together with a very large emerald, a ruby of conſiderable ſize, and other precious ſtones of leſs value. Shafras was aſtoniſhed at the offer; and giving out that he had not a ſufficient ſum to purchaſe them, he requeſted time to conſult with his brothers on the ſubject. The vender did not again make his appearance, probably from ſuſpicious motives. Shafras, with the approbation of his brothers, went directly in ſearch of the ſtranger with the jewels, but by that time he had left Baſſora. Shafras, however, accidentally met him at Bagdad, and paid him 50,000 piaſtres (8958l. 6s. 8d.) for all his jewels. Shafras and his brothers being well aware that the moſt profound ſecrecy was abſolutely neceſſary, reſolved to remain at Baſſora.

At the expiration of 12 years, Shafras ſet off with the largeſt of the jewels, directing his route through Sham and Conſtantinople, and afterwards through Hungary and Sileſia to the city of Amſterdam by land, where he publicly offered them for ſale.

It is reported that the Britiſh government was among the bidders. The Ruſſian court ſent for the large diamond, with an offer to reimburſe all reaſonable expences, if the price could not be agreed on. When the diamond arrived, Count Panin, the Ruſſian miniſter, made the following offer to Shafras. Beſides the patent of hereditary nobility, which the vender demanded, he was to receive an annual penſion of 6000 rubles during life, 500,000 rubles in caſh (112,500l. Sterling), one-fifth of which was to be payable on demand, and the remainder by inſtalments in the courſe of ten years. He alſo claimed the order of nobility for his brothers, perſiſting ſo obſtinately in his demands, that the diamond was returned.

Shafras was now very much perplexed. He had involved himſelf in expences, was forced to pay intereſt for conſiderable ſums of borrowed money, and he ſaw no proſpect of ſelling the jewel to advantage. The negociation was recommenced with Ruſſia by Count Gregory Grigorievitſh Orlof, afterwards created a prince of the empire; and the diamond was purchaſed for 450,000 rubles (105,250l.) ready money, together with a grant of Ruſſian nobility. We are informed that 120,000 rubles (27,000l.), fell to the ſhare of the negociators for commiſſion, intereſt, and ſimilar expences. Shafras ſettled at Aſtracan; and his riches, which by inheritance devolved to his daughters, have been in a great meaſure diſſipated by the extravagance of his ſons-in-law.

SHAFT *of a* Column, in *Building*, is the body thereof between the baſe and capital; ſo called from its ſtraightneſs. See ARCHITECTURE.

Shaft, in mining, is the pit or hollow entrance into the mine. In the tin-mines, after this is ſunk about a fathom, they leave a little, long, ſquare place, which is called a *ſhamble*.

Shafts are ſunk ſome ten, ſome twenty fathoms deep into the earth, more or leſs. Of theſe ſhafts, there is the landing or working ſhaft, where they bring up the work or ore to the ſurface; but if it be worked by a horſe engine or whim, it is called a *whim ſhaft*; and where the water is drawn out of the mine, it is indifferently named an *engine-ſhaft*, or the *rod-ſhaft*. See MINE.

Shaft. See TROCHILUS, ORNITHOLOGY *Index*.

SHAFTESBURY, a town of Dorſetſhire in England, in W. Long. 2. 20. N. Lat. 51. 0. It ſtands on a high hill, and is built in the form of a bow. It enjoys a ſerene wholeſome air, and has a fine proſpect. It is a good thoroughfare, is governed by a mayor, and ſends two members to parliament. This town is ſuppoſed to have been built in the 8th century, and to have been enlarged by King Alfred; and had 12 churches, beſides a Benedictine monaſtery in the time of the Saxons, but has now only three. St Edward the martyr was buried here. It had three mints before the conqueſt, and, in the reign of Henry VIII. was the ſee of a ſuf-

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* Phil. Tranſ. 1794.

fragan biſhop. It was incorporated by Queen Elizabeth and Charles II. and is governed by a mayor, recorder, twelve aldermen, bailiffs, and a common-council. It contains about 320 houſes, many of which are of freeſtone. Water is ſo ſcarce, that it uſed to be ſupplied from Motcomb; but it was obtained more commodiouſly in 1718, by means of engines, which raiſed the water above 300 feet perpendicular, and conveyed it to a large ciſtern in the middle of the town, from the diſtance of two miles. Yet even this is laid aſide, and they have dug ſeveral pits, in which they preſerve the rain-water; and the poor get their living to this day by fetching it in pails or on horſes. It gives the title of earl to the noble family of Cooper.

SHAFTESBURY, *Earl of*. See COOPER.

SHAG. See PELICANUS, ORNITHOLOGY *Index*.

SHAGREEN, or CHAGREEN, in *Commerce*, a kind of grained leather prepared of the ſkin of a ſpecies of SQUALUS, and much uſed in covering caſes, books, &c.

The beſt is that brought from Conſtantinople, of a browniſh colour; the white is the worſt. It is extremely hard; yet, when ſteeped in water, it becomes very ſoft and pliable; whence it is of great uſe among caſe-makers. It takes any colour that is given it, red, green, yellow, or black. It is frequently counterfeited by morocco, formed like ſhagreen; but this laſt is diſtinguiſhed by its peeling off, which the firſt does not.

The following is the method of preparing ſhagreen, as it is deſcribed by Profeſſor Pallas.

“ All kinds of horſes or aſſes ſkins, which have been dreſſed in ſuch a manner as to appear grained, are, by the Tartars, called *ſawyer*, by the Perſians *ſogre*, and by the Turks *ſagri*, from which the Europeans have made *ſhagreen* or *chagreen*. The Tartars who reſide at Aſtracan, with a few of the Armenians of that city, are the only people in the Ruſſian empire acquainted with the art of making ſhagreen. Thoſe who follow this occupation not only gain conſiderable profit by the ſale of their production to the Tartars of Cuban, Aſtracan, and Caſan, who ornament with it their Turkey leather boots, ſlippers, and other articles made of leather, but they derive conſiderable advantage from the great ſale of horſes hides, which have undergone no other proceſs than that of being ſcraped clean, and of which ſeveral thouſands are annually exported, at the rate of from 75 to 85 roubles per hundred, to Perſia, where there is a ſcarcity of ſuch hides, and from which the greater part of the ſhagreen manufactured in that country is prepared. The hind part only of the hide, however, which is cut out in the form of a creſcent about a Ruſſian ell and a half in length acroſs the loins, and a ſhort ell in breadth along the back, can properly be employed for ſhagreen. The remaining part, as is proved by experience, is improper for that purpoſe, and is therefore rejected.

“ The preparation of the ſkins, after being cut into the above form, is as follows:—They are depoſited in a tub filled with pure water, and ſuffered to remain there for ſeveral days, till they are thoroughly ſoaked, and the hair has dropped off. They are then taken from the tub, one by one, extended on boards placed in an oblique direction againſt a wall, the corners of them, which reach beyond the edges of the board, being made faſt, and the hair with the epidermis is then ſcraped off with a blunt iron ſcraper called *urak*. The ſkins thus cleaned are again put in pure water to ſoak. When all the ſkins have undergone this part of the proceſs, they are taken from the water a ſecond time, ſpread out one after the other as before, and the fleſh ſide is ſcraped with the ſame kind of inſtrument. They are carefully cleaned alſo on the hair ſide, ſo that nothing remains but the pure fibrous tiſſue, which ſerves for making parchment, conſiſting of coats of white medullary fibres, and which has a reſemblance to a ſwine's bladder ſoftened in water.

“ After this preparation, the workmen take a certain kind of frames called *pälzi*, made of a ſtraight and a ſemicircular piece of wood, having nearly the ſame form as the ſkins. On theſe the ſkins are extended in as ſmooth and even a manner as poſſible by means of cords; and during the operation of extending them, they are ſeveral times beſprinkled with water, that no part of them may be dry, and occaſion an unequal tenſion. After they have been all extended on the frames, they are again moiſtened, and carried into the houſe, where the frames are depoſited cloſe to each other on the floor with the fleſh ſide of the ſkin next the ground. The upper ſide is then thickly beſtrewed with the black exceedingly ſmooth and hard ſeeds of a kind of gooſe foot (*chenopodium album*), which the Tartars call *alabuta*, and which grows in abundance, to about the height of a man, near the gardens and farms on the ſouth ſide of the Volga; and that they may make a ſtrong impreſſion on the ſkins, a piece of felt is ſpread over them, and the ſeeds are trod down with the feet, by which means they are deeply imprinted into the ſoft ſkins. The frames, without ſhaking the ſeeds, are then carried out into the open air, and placed in a reclining poſition againſt a wall to dry, the ſide covered with the ſeeds being next the wall, in order that it may be ſheltered from the ſun. In this ſtate the ſkins muſt be left ſeveral days to dry in the ſun, until no appearance of moiſture is obſerved in them, when they are fit to be taken from the frames. When the impreſſed ſeeds are beat off from the hair ſide, it appears full of indentations or inequalities, and has acquired that impreſſion which is to produce the grain of the ſhagreen, after the ſkins have been ſubjected to the laſt ſmoothing or ſcraping, and have been dipped in a ley, which will be mentioned hereafter, before they receive the dye.

“ The operation of ſmoothing is performed on an inclined bench or board, which is furniſhed with an iron hook, and is covered with thick felt of ſheep's wool, on which the dry ſkin may gently reſt. The ſkin is ſuſpended in the middle of the bench or board to its iron hook, by means of one of the holes made in the edge of the ſkin for extending it in its frame as before mentioned; and a cord, having at its extremity a ſtone or a weight, is attached to each end of the ſkin, to keep it in its poſition while under the hands of the workman. It is then ſubjected to the operation of ſmoothing and ſcraping by means of two different inſtruments. The firſt uſed for this purpoſe, called by the Tartars *tokar*, is a piece of ſharp iron bent like a hook, with which the ſurface of the ſhagreen is pretty cloſely ſcraped to remove all the projecting inequalities.

This operation, on account of the corneous hardneſs of the dry ſkin, is attended with ſome difficulty; and great caution is at the ſame time required that too much of the impreſſion of the *alabuta* ſeed be not deſtroyed, which might be the caſe if the iron were kept too ſharp. As the iron, however, is pretty blunt, which occaſions inequalities on the ſhagreen, this inconvenience muſt afterwards be remedied by means of a ſharp ſcraping iron or *urak*, by which the ſurface acquires a perfect uniformity, and only faint impreſſions of the *alabuta* ſeed then remain, and ſuch as the workman wiſhes. After all theſe operations, the ſhagreen is again put into water, partly to make it pliable, and partly to raiſe the grain. As the ſeeds occaſion indentations on the ſurface of the ſkin, the intermediate ſpaces, by the operations of ſmoothing and ſcraping, loſe ſome part of their projecting ſubſtance; but the points which have been depreſſed, and which have loſt none of their ſubſtance, now ſwell up above the ſcraped parts, and thus form the grain of the ſhagreen. To produce this effect, the ſkins are left to ſoak in water for 24 hours; after which they are immerſed ſeveral times in a ſtrong warm ley, obtained, by boiling, from a ſtrong alkaline earth named *ſchora*, which is found in great abundance in the neighbourhood of Aſtracan. When the ſkins have been taken from this ley, they are piled up, while warm, on each other, and ſuffered to remain in that ſtate ſeveral hours; by which means they ſwell, and become ſoft. They are then left 24 hours in a moderately ſtrong pickle of common ſalt, which renders them exceedingly white and beautiful, and fit for receiving any colour. The colour moſt uſual for theſe ſkins is a ſea-green; but old experienced workmen can dye them blue, red, or black, and even make white ſhagreen.

“ For the green colour nothing is neceſſary but filings of copper and ſal ammoniac. Sal ammoniac is diſſolved in water till the water is completely ſaturated; and the ſhagreen ſkins, ſtill moiſt, after being taken from the pickle, are waſhed over with the ſolution on the ungrained fleſh ſide, and when well moiſtened a thick layer of copper filings is ſtrewed over them: the ſkins are then folded double, ſo that the ſide covered with the filings is innermoſt. Each ſkin is then rolled up in a piece of felt; the rolls are all ranged together in proper order, and they are preſſed down in an uniform manner by ſome heavy bodies placed over them, under which they remain 24 hours. During that period, the ſolution of ſal ammoniac diſſolves a quantity of the cupreous particles ſufficient to penetrate the ſkin, and to give it a ſea-green colour. If the firſt application be not ſufficient, the proceſs is repeated in the ſame manner; after which the ſkins are ſpread out and dried.

“ For the blue dye, indigo is uſed. About two pounds of it, reduced to a fine powder, are put into a kettle; cold water is poured over it, and the mixture is ſtirred round till the colour begins to be diſſolved. Five pounds of pounded *alakar*, which is a kind of barilla or crude ſoda, prepared by the Armenians and Calmucs, is then diſſolved in it, with two pounds of lime and a pound of pure honey, and the whole is kept ſeveral days in the ſun, and during that time frequently ſtirred round. The ſkins intended to be dyed blue muſt be moiſtened only in the natrous ley *ſchora*, but not in the ſalt brine. When ſtill moiſt, they are folded up and ſewed together at the edge, the fleſh ſide being innermoſt, and the ſhagreened hair ſide outwards; after which they are dipped three times in the remains of an exhauſted kettle of the ſame dye, the ſuperfluous dye being each time expreſſed; and after this proceſs they are dipped in the freſh dye prepared as above, which muſt not be expreſſed. The ſkins are then hung up in the ſhade to dry; after which they are cleaned and pared at the edges.

“ For black ſhagreen, gall nuts and vitriol are employed in the following manner:—The ſkins, moiſt from the pickle, are thickly beſtrewed with finely pulverized gall nuts. They are then folded together, and laid over each other for 24 hours. A new ley, of bitter ſaline earth or *ſchora*, is in the mean time prepared, and poured hot into ſmall troughs. In this ley each ſkin is ſeveral times dipped; after which they are again beſtrewed with pounded gall nuts, and placed in heaps for a certain period, that the galls may thoroughly penetrate them, and they are dried and beat, to free them from the duſt of the galls. When this is done, they are rubbed over, on the ſhagreen ſide, with melted ſheep's tallow, and expoſed a little in the ſun, that they may imbibe the greaſe. The ſhagreen makers are accuſtomed alſo to roll up each ſkin ſeparately, and to preſs or ſqueeze it with their hands againſt ſome hard ſubſtance, in order to promote the abſorption of the tallow. The ſuperfluous particles are removed by means of a blunt wooden ſcraper (*urac*); and when this proceſs is finiſhed, and the ſkins have lain ſome time, a ſufficient quantity of vitriol of iron is diſſolved in water, with which the ſhagreen is moiſtened on both ſides, and by this operation it acquires a beautiful black dye. It is then dreſſed at the edges, and in other places where there are any blemiſhes.

“ To obtain white ſhagreen, the ſkins muſt firſt be moiſtened on the ſhagreen ſide with a ſtrong ſolution of alum. When the ſkin has imbibed this liquor, it is daubed over on both ſides with a paſte made of flour, which is ſuffered to dry. The paſte is then waſhed off with alum water, and the ſkin is placed in the ſun till it is completely dry. As ſoon as it is dry, it is gently beſmeared with pure melted ſheep's tallow, which it is ſuffered to imbibe in the ſun; and to promote the effect, it is preſſed and worked with the hands. The ſkins are then faſtened in ſucceſſion to the before-mentioned bench, where warm water is poured over them, and the ſuperfluous fat is ſcraped off with a blunt wooden inſtrument. In the laſt operation the warm water is of great ſervice. In this manner ſhagreen perfectly white is obtained, and nothing remains but to pare the edges and dreſs it.

“ But this white ſhagreen is not intended ſo much for remaining in that ſtate, as for receiving a dark red dye; becauſe, by the above previous proceſs, the colour becomes much more perfect. The ſkins deſtined for a red colour muſt not be immerſed firſt in ley of bitter ſalt earth (*ſchora*), and then in pickle, but after they have been whitened, muſt be left to ſoak in the pickle for 24 hours. The dye is prepared from cochineal, which the Tartars call *kirmitz*. About a pound of the dried herb *tſchagann*, which grows in great abundance in the neighbourhood of Aſtracan, and is a kind of ſoda plant or kali (*ſalſola ericoides*) (A), is boiled a full hour in a kettle containing about four common pailfuls of water; by which means the water acquires a greeniſh colour. The herb is then taken out, and about half a pound of pounded cochineal is put into the kettle, and the liquor is left to boil a full hour, care being taken to ſtir it that it may not run over. About 15 or 20 drams of a ſubſtance which the dyers call *lüter* (orchilla) is added, and when the liquor has been boiled for ſome time longer, the kettle is removed from the fire. The ſkins taken from the pickle are then placed over each other in troughs, and the dye-liquor is poured over them four different times, and rubbed into them with the hands, that the colour may be equally imbibed and diffuſed. The liquor each time is expreſſed; after which they are fit for being dried. Skins prepared in this manner are ſold at a much dearer rate than any of the other kinds."

SHAIK properly ſignifies an old man. In the eaſt it is uſed to denote a lord or chief, a man of eminence and property. See SCHIECHS.

SHAKE, in ſinging. See TRILL.

SHAKESPEARE, or SHAKSPEARE, *William*, the prince of dramatic writers, was born at Stratford upon Avon in Warwickſhire, on the 23d of April 1564. From the regiſter of that town, it appears that a plague broke out there on the 30th of June following, which raged with great violence; but fortunately it did not reach the houſe in which this infant prodigy lay. His father, John Shakeſpeare, enjoyed a ſmall patrimonial eſtate, and was a conſiderable dealer in wool; his mother was the daughter and heir of Robert Arden of Wellingcote. Our illuſtrious poet being deſigned for the buſineſs of his father, received no better education than the inſtructions which the free-ſchool of Stratford could afford. After applying ſome time to the ſtudy of Latin, he was called home to aſſiſt his father, who ſeems by ſome accident to have been reduced in his circumſtances. Before arriving at the age of 19, he married the daughter of Mr Hathaway, a ſubſtantial yeoman in the neighbourhood of Stratford. This lady was eight years older than her huſband. Having the misfortune to fall into bad company, he was ſeduced into ſome profligate actions, which drew on him a criminal proſecution, and at length forced him to take refuge in the capital. In concert with his aſſociates, he broke into a park belonging to Sir Thomas Lucy of Charlecote, and carried off ſome of his deer. Every admirer of Shakeſpeare will regret that ſuch a blemiſh ſhould have ſtained his character; but, perhaps, if any thing can extenuate his guilt, we might aſcribe it to the opinions of the age, which, perhaps, as was formerly the caſe in Scotland, might not diſtinguiſh the killing of deer by any mark of diſgrace, or any charge of criminality. One thing at leaſt is certain, that Shakeſpeare himſelf thought that the proſecution which Sir Thomas raiſed againſt him was carried on with too great ſeverity; an opinion which he could not have entertained had this action been at that time viewed in the ſame criminal light as it is at preſent. Shakeſpeare teſtified his reſentment againſt Sir Thomas, by writing a ſatirical ballad, which exaſperated him ſo much, that the proceſs was carried on with redoubled violence; and the young poet, in order to avoid the puniſhment of the law, was obliged to make his eſcape. This ballad would be conſidered as a curious relick, on account of its being the firſt production of Shakeſpeare; it would alſo be intereſting to peruſe a poem which could irritate the baronet to ſo high a degree. Tradition has preſerved the firſt ſtanza:

A parliamente member, a juſtice of peace,
At home a poor ſcare-crow, at London an aſſe.
If lowſie is Lucy, as ſome volke miſcalle it,
Then Lucy is lowſie whatever befall it:
    He thinks himſelf greate,
    Yet an aſſe in his ſtate,
We allowe by his ears, but with aſſes to mate.
If Lucy is lowſie, as ſome volke miſcalle it,
Sing lowſie Lucy whatever befall it.

If the reſt of the ballad was of a piece with this ſtanza, it might aſſiſt us to form ſome opinion of the irritability of the baronet, but will enable us to form no idea of the opening genius of Shakeſpeare.

Thus expelled from his native village, he repaired to London, where he was glad to accept a ſubordinate office in the theatre. It has been ſaid that he was firſt engaged, while the play was acting, in holding the horſes of thoſe who rode to the theatre; but this ſtory reſts on a ſlender foundation. As his name is found printed among thoſe of the other players before ſome old plays, it is probable that he was ſome time employed as an actor; but we are not informed what characters he played; we are only told, that the part which he acted beſt was that of the Ghoſt in Hamlet; and that he appeared in the character of Adam in *As you like it*. If the names of the actors prefixed to Ben Jonſon's play of *Every Man in his Humour* were arranged in the ſame order as the perſons repreſented, which is very probable, Shakeſpeare played the part of Old Knowell. We have reaſon therefore to ſuppoſe, as far as we can argue from theſe few facts, that he generally repreſented old men. See Malone's Chronology, in his edition of Shakeſpeare.

But though he was not qualified to ſhine as an actor, he was now in the ſituation which could moſt effectually rouſe thoſe latent ſparks of genius which afterwards burſt forth with ſo reſplendent a flame. Being well acquainted with the mechanical buſineſs of the theatre and the taſte of the times; poſſeſſed of a knowledge of the characters of men reſembling intuition, an imagination that ranged at large through nature, ſelecting the grand, the ſublime, and the beautiful; a judicious caution, that diſpoſed him to prefer thoſe plots which had already been found to pleaſe; an uncommon fluency

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(A) The beautiful red Turkey leather is dyed with cochineal prepared in the ſame manner. Profeſſor Gmelin junior, in the ſecond part of his Travels through Ruſſia, explains the herb *tſchagann* by *artemiſia annua*, having doubtleſs been deceived by the appearance the plant acquires after it has been dried. Beſides, this *artemiſia* is found only in the middle of Siberia, and never on the weſt ſide of the Irtiſch.

Shake-ſpeare.

fluency and force of expreſſion; he was qualified at once to eclipſe all who had gone before him.

Notwithſtanding the unrivalled genius of Shakeſpeare, moſt of his plots were the invention of others; which, however, he certainly much improved, if he did not entirely new-model. We are aſſured, that prior to the theatrical compoſitions of Shakeſpeare, dramatic pieces were written on the following ſubjects, viz. King John, King Richard II. and III. King Henry IV. and V. King Henry VIII. King Lear, Antony and Cleopatra, Meaſure for Meaſure, the Merchant of Venice, the Taming of a Shrew, and the Comedy of Errors.

Among his patrons, the earl of Southampton is particularly honoured by him, in the dedication of two poems, Venus and Adonis, and Lucrece; in the latter eſpecially, he expreſſed himſelf in ſuch terms as gives countenance to what is related of that patron's diſtinguiſhed generoſity to him. In the beginning of King James I.'s reign (if not ſooner) he was one of the principal managers of the playhouſe, and continued in it ſeveral years afterwards; till, having acquired ſuch a fortune as ſatisfied his moderate wiſhes and views in life, he quitted the ſtage, and all other buſineſs, and paſſed the remainder of his time in an honourable eaſe, at his native town of Stratford, where he lived in a handſome houſe of his own purchaſing, to which he gave the name of *New Place;* and he had the good fortune to ſave it from the flames in the dreadful fire that conſumed the greateſt part of the town in 1614.

In the beginning of the year 1616, he made his will, wherein he teſtified his reſpect to his quondam partners in the theatre: he appointed his youngeſt daughter, jointly with her huſband, his executors, and bequeathed to them the beſt part of his eſtate, which they came into the poſſeſſion of not long after. He died on the 23d of April following, being the 53d year of his age; and was interred among his anceſtors on the north ſide of the chancel, in the great church of Stratford, where there is a handſome monument erected for him, inſcribed with the following elegiac diſtich in Latin:

Judicio Pylium, genio Socratem, arte Maronem,
Terra tegit, Populus mœret, Olympus habet.

In the year 1740, another very noble one was raiſed to his memory, at the public expence, in Weſtminſter abbey; an ample contribution for this purpoſe being made upon exhibiting his tragedy of Julius Cæſar, at the theatre-royal in Drury-Lane, April 28th 1738.

Nor muſt we omit mentioning another teſtimony of the veneration paid to his manes by the public in general, which is, that a mulberry-tree planted upon his eſtate by the hands of this revered bard, was cut down not many years ago; and the wood being converted to ſeveral domeſtic uſes, was all eagerly bought at a high price, and each ſingle piece treaſured up by its purchaſer as a precious memorial of the planter.

The character of Shakeſpeare as a dramatic writer has been often drawn, but perhaps never with more accuracy than by the pen of Dr Johnſon: “ Shakeſpeare (ſays he) is above all writers, at leaſt above all modern writers, the poet of nature; the poet that holds up to his readers a faithful mirror of manners and of life. His characters are not modified by the cuſtoms of particular places, unpractiſed by the reſt of the world; by the peculiarities of ſtudies or profeſſions, which can operate but upon ſmall numbers; or by the accidents of tranſient faſhions or temporary opinions: they are the genuine progeny of common humanity, ſuch as the world will always ſupply, and obſervation will always find. His perſons act and ſpeak by the influence of thoſe general paſſions and principles by which all minds are agitated, and the whole ſyſtem of life is continued in motion. In the writings of other poets, a character is too often an individual; in thoſe of Shakeſpeare, it is commonly a ſpecies.

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“ It is from this wide extenſion of deſign that ſo much inſtruction is derived. It is this which fills the plays of Shakeſpeare with practical axioms and domeſtic wiſdom. It was ſaid of Euripides, that every verſe was a precept; and it may be ſaid of Shakeſpeare, that from his works may be collected a ſyſtem of civil and economical prudence. Yet his real power is not ſhown in the ſplendour of particular paſſages, but by the progreſs of his fable, and the tenor of his dialogue; and he that tries to recommend him by ſelect quotations, will ſucceed like the pedant in Hierocles, who, when he offered his houſe to ſale, carried a brick in his pocket as a ſpecimen.

“ Upon every other ſtage the univerſal agent is love, by whoſe power all good and evil is diſtributed, and every action quickened or retarded. But love is only one of many paſſions; and as it has no great influence upon the ſum of life, it has little operation in the dramas of a poet who caught his ideas from the living world, and exhibited only what he ſaw before him. He knew that any other paſſion, as it was regular or exorbitant, was a cauſe of happineſs or calamity.

“ Characters thus ample and general were not eaſily diſcriminated and preſerved; yet perhaps no poet ever kept his perſonages more diſtinct from each other.

“ Other dramatiſts can only gain attention by hyperbolical or aggravated characters, by fabulous and unexampled excellence or depravity, as the writers of barbarous romances invigorated the reader by a giant and a dwarf; and he that ſhould form his expectations of human affairs from the play, or from the tale, would be equally deceived. Shakeſpeare has no heroes, his ſcenes are occupied only by men, who act and ſpeak as the reader thinks that he ſhould himſelf have ſpoken or acted on the ſame occaſion: Even where the agency is ſupernatural, the dialogue is level with life. Other writers diſguiſe the moſt natural paſſions and moſt frequent incidents; ſo that he who contemplates them in the book will not know them in the world: Shakeſpeare approximates the remote, and familiarizes the wonderful; the event which he repreſents will not happen, but if it were poſſible, its effects would probably be ſuch as he has aſſigned; and it may be ſaid, that he has not only ſhown human nature as it acts in real exigencies, but as it would be found in trials to which it cannot be expoſed.

“ This therefore is the praiſe of Shakeſpeare, that his drama is the mirror of life; that he who has mazed his imagination, in following the phantoms which other writers raiſe up before him, may here be cured of his delirious ecſtaſies, by reading human ſentiments in human language: by ſcenes from which a hermit may eſtimate

mate the tranſactions of the world, and a confeſſor predict the progreſs of the paſſions."

The learning of Shakeſpeare has frequently been a ſubject of inquiry. That he poſſeſſed much claſſical knowledge does not appear, yet he was certainly acquainted with the Latin poets, particularly with Terence, as Colman has juſtly remarked, which appears from his uſing the word *thraſonical*. Nor was he unacquainted with French and Italian. We are indeed told, that the paſſages in which theſe languages occur might be impertinent additions of the players; but is it probable, that any of the players ſo far ſurpaſſed Shakeſpeare?

That much knowledge is ſcattered over his works is very juſtly obſerved by Pope; but it is often ſuch knowledge as books did not ſupply. "There is, however, proof enough (ſays Dr Johnſon) that he was a very diligent reader; nor was our language then ſo indigent of books, but that he might very liberally indulge his curioſity without excurſion into foreign literature. Many of the Roman authors were tranſlated, and ſome of the Greek; the Reformation had filled the kingdom with theological learning; moſt of the topics of human diſquiſition had found Engliſh writers; and poetry had been cultivated, not only with diligence, but ſucceſs. This was a ſtock of knowledge ſufficient for a mind ſo capable of appropriating and improving it."

The works of Shakeſpeare conſiſt of 35 dramatic pieces. The following is the chronological order which Mr Malone has endeavoured to eſtabliſh, after a minute inveſtigation, in which he has in general been ſucceſsful:

1. Firſt Part of King Henry VI.	1589
2. Second Part of King Henry VI.	1591
3. Third Part of King Henry VI.	1591
4. A Midſummer Night's Dream	1592
5. Comedy of Errors	1593
6. Taming of the Shrew	1594
7. Love's Labour Loſt	1594
8. Two Gentlemen of Verona	1595
9. Romeo and Juliet	1595
10. Hamlet	1596
11. King John	1596
12. King Richard II.	1597
13. King Richard III.	1597
14. Firſt Part of King Henry IV.	1597
15. Second Part of King Henry IV.	1598
16. The Merchant of Venice	1598
17. All's Well that Ends Well	1598
18. King Henry V.	1599
19. Much Ado about Nothing	1600
20. As you like it	1600
21. Merry Wives of Windſor	1601
22. King Henry VIII.	1601
23. Troilus and Creſſida	1602
24. Meaſure for Meaſure	1603
25. The Winter's Tale	1604
26. King Lear	1605
27. Cymbelline	1605
28. Macbeth	1606
29. Julius Cæſar	1607
30. Antony and Cleopatra	1608
31. Timon of Athens	1609
32. Coriolanus	1610
33. Othello	1611
34. The Tempeſt	1612
35. Twelfth Night	1614

The firſt three of theſe, Mr Malone thinks, there is very ſtrong reaſon to believe are not the original productions of Shakeſpeare; but that he probably altered them, and added ſome new ſcenes.

In the firſt folio edition in 1623, theſe plays were entitled "Mr William Shakeſpeare's Comedies, Hiſtories, and Tragedies." They have been publiſhed by various editors. The firſt folio edition by Iſaac Jaggard and Edward Blount; the ſecond, folio, 1632, by Thomas Cotes for Robert Allot; the third, 1664, for P. C.; the fourth, 1685, for H. Herringman, E. Brewſter, and R. Bentley. Rowe publiſhed an 8vo edition in 1709, in 7 vols, and a 12mo edition in 1714, in 9 vols; for which he received 36l. 10s. Pope publiſhed a 4to edition in 1725, in 6 vols, and a 12mo in 1728, in 10 vols; for which he was paid 217l. 12s. Theobald gave a new edition in 8vo in 1733, in 7 vols, another in 12mo in 1740, in 8 vols; and received for his labour 652l. 10s. Sir Thomas Hanmer publiſhed an edition in 1744, in 6 vols 4to. Dr Warburton's 8vo edition came out in 1747, in 8 vols; for which he was paid 560l. The editions publiſhed ſince that time, are Dr Johnſon's in 1765, in 8 vols 8vo. Stevens's in 1766, in 4 vols 8vo. Capell's in 1768, in 10 vols, crown 8vo; for this the author was paid 300l. A ſecond edition of Hanmer's in 1771, 6 vols. Johnſon's and Stevens's in 1773, in 10 vols 8vo; a ſecond edition in 1778; a third by Reed in 1785; and Malone's crown 8vo edition in 1789, in 10 vols.

The moſt authentic of the old editions is that of 1623. "At laſt (ſays Dr Johnſon) an edition was undertaken by Rowe; not becauſe a poet was to be publiſhed by a poet, for Rowe ſeems to have thought very little on correction or explanation, but that our author's works might appear like thoſe of his fraternity, with the appendages of a life and recommendatory preface. Rowe has been clamorouſly blamed for not performing what he did not undertake; and it is time that juſtice be done him, by confeſſing, that though he ſeems to have had no thought of corruption beyond the printer's errors, yet he has made many emendations, if they were not made before, which his ſucceſſors have received without acknowledgment, and which, if they had produced them, would have filled pages with cenſures of the ſtupidity by which the faults were committed, with diſplays of the abſurdities which they involved, with oſtentatious expoſitions of the new reading, and ſelf-congratulations on the happineſs of diſcovering it."

The nation had been for many years content enough with Mr Rowe's performance, when Mr Pope made them acquainted with the true ſtate of Shakeſpeare's text, ſhowed that it was extremely corrupt, and gave reaſon to hope that there were means of reforming it. Mr Pope's edition, however, he obſerves, fell below his own expectations; and he was ſo much offended, when he was found to have left any thing for others to do, that he paſſed the latter part of his life in a ſtate of hoſtility with verbal criticiſm.

The only taſk, in the opinion of Mr Malone, for which Pope was eminently and indiſputably qualified, was

was to mark the faults and beauties of his author.—When he undertook the office of a commentator, every anomaly of language, and every expreſſion that was currently in uſe, were conſidered as errors or corruptions, and the text was altered or amended, as it was called, at pleaſure. Pope is openly charged with being one of the great corrupters of Shakeſpeare's text.

Pope was ſucceeded by Theobald, who collated the ancient copies, and rectified many errors. He was, however, a man of narrow comprehenſion and of little learning, and what is worſe, in his reports of copies and editions, he is not to be truſted without examination. From the liberties taken by Pope, the edition of Theobald was juſtly preferred, becauſe he profeſſed to adhere to the ancient copies more ſtrictly, and illuſtrated a few paſſages by extracts from the writers of our poet's age. Still, however, he was a conſiderable innovator; and while a few arbitrary changes made by Pope were detected, innumerable ſophiſtications were ſilently adopted.

Sir Thomas Hanmer, who comes next, was a man of critical abilities, and of extenſive learning. His corrections are commonly juſt, but ſometimes capricious. He is cenſurable, too, for receiving without examination almoſt all the innovations of Pope.

The original and predominant error of Warburton's commentary, is acquieſcence in his firſt thoughts; that precipitation which is produced by conſciouſneſs of quick diſcernment; and that confidence which preſumes to do, by ſurveying the ſurface, what labour only can perform by penetrating to the bottom. His notes exhibit ſometimes perverſe interpretations, and ſometimes improbable conjectures; he at one time gives the author more profundity of meaning than the ſentence admits, and at another diſcovers abſurdities where the ſenſe is plain to every other reader. But his emendations are likewiſe often happy and juſt; and his interpretation of obſcure paſſages learned and ſagacious.

It has indeed been ſaid by his defenders, that his great object was to diſplay his own learning; and certainly in ſpite of the clamour raiſed againſt him for ſubſtituting his own chimerical conceits inſtead of the genuine text of Shakeſpeare, his work increaſed his reputation. But as it is of little value as a commentary on Shakeſpeare, ſince Warburton is now gone, his work will probably ſoon ſink into oblivion.

In 1765 Dr Johnſon's edition, which had long been impatiently expected, was given to the public. His vigorous and comprehenſive underſtanding threw more light on his author than all his predeceſſors had done. The character which he gave of each play is generally juſt. His refutation of the falſe gloſſes of Theobald and Warburton, and his numerous explications of involved and difficult paſſages, entitle him to the gratitude of every admirer of Shakeſpeare.

The laſt editor is Mr Malone, who was eight years employed in preparing his edition. By collating the moſt authentic copies, he has been careful to purify the text. He has been ſo induſtrious, in order to diſcover the meaning of the author, that he has ranſacked many volumes, and truſts that, beſides his additional illuſtrations, not a ſingle valuable explication of any obſcure paſſage in theſe plays has ever appeared, which he has not inſerted in his edition. He rejects Titus Andronicus, as well as the three plays formerly mentioned, as not being the authentic productions of Shakeſpeare. To the whole he has added an appendix, and a copious gloſſary.—Of this work a leſs expenſive edition has been publiſhed in 7 vols 12mo, in which the general introductory obſervations prefixed to the different plays are preſerved, and the numerous notes abridged.

This judicious commentator has certainly done more for the elucidation and correction of Shakeſpeare than all who came before him, and has followed with indefatigable patience the only road which a commentator of Shakeſpeare ought to obſerve.

Within 50 years after our poet's death, Dryden ſays that he was become "a little obſolete;" and in the beginning of the 18th century Lord Shafteſbury complains of his rude unpoliſhed ſtyle, and his antiquated phraſe and wit. Theſe complaints were owing to the great revolution which the Engliſh language has undergone, and to the want of an enlightened commentator. Theſe complaints are now removed, for an enlightened commentator has been found in Mr Malone.

We have only farther to add, that in the year 1790 a copious index to the remarkable paſſages and words in the plays of Shakeſpeare was publiſhed by the Reverend Mr Ayſcough; a gentleman to whom the literary world is much indebted for ſeveral very valuable keys of knowledge. In fine, the admirers of Shakeſpeare are now, by the labours of ſeveral eminent men, furniſhed with every help that can enable them to underſtand the ſenſe and to taſte the beauties of this illuſtrious poet.

SHAKLES. See SHACKLES.

SHALE, in *Mineralogy*, a kind of SCHISTUS, of a black colour and ſlaty ſtructure, or a clay hardened into a ſtony conſiſtence, and ſo much impregnated with bitumen that it becomes ſomewhat like a coal. The acid emitted from ſhale, during its calcination, uniting itſelf to the argillaceous earth of the ſhale, forms alum. About 120 tons of calcined ſhale will make one ton of alum. The ſhale, after being calcined, is ſteeped in water, by which means the alum, which is formed during the calcination of the ſhale, is diſſolved: this diſſolved alum undergoes various operations before it is formed into the alum of the ſhops. Watſon's Chemical Eſſays, vol. ii. p. 315. See ALUM, CHEMISTRY *Index*.

This kind of ſlate forms large ſtrata in Derbyſhire; and that which lies near the ſurface of the earth is of a ſofter and more ſhivery texture than that which lies deeper. It is alſo found in large ſtrata, generally above the coal, in moſt coal counties of this kingdom.

SHALLOP, SHALLOOP, or SLOOP, is a ſmall light veſſel, with only a ſmall main-maſt and fore-maſt, and lug-ſails, to haul up, and let down on occaſion.—Shallops are commonly good ſailers, and are therefore often uſed as tenders upon men of war.

SHALLOT, or ESCHALOT. See ALLIUM, BOTANY and GARDENING *Index*.

SHAMANS are wizards or conjurers, in high repute among ſeveral idolatrous nations inhabiting different parts of Ruſſia. By their enchantments they pretend to cure diſeaſes, to divert misfortunes, and to foretel futurity. They are great obſervers of dreams, by the interpretation of which they judge of their good or bad fortune. They pretend likewiſe to chiromancy, and to foretel a man's good or ill ſucceſs by the lines of his

his hand. By theſe and ſuch like means they have a very great aſcendancy over the underſtandings, and a great influence on the conduct, of thoſe people.

SHAMBLES, among miners, a ſort of niches or landing places, left at ſuch diſtances in the adits of the mines, that the ſhovel-men may conveniently throw up the ore from ſhamble to ſhamble, till it comes to the top of the mine.

SHAMOIS, Chamois, or Shammy, a kind of leather, either dreſſed in oil or tanned, much eſteemed for its ſoftneſs, pliancy, &c. It is prepared from the ſkin of the chamois, or ſhamois, a kind of rupicapra, or wild goat, called alſo iſard, inhabiting the mountains of Dauphiny, Savoy, Piedmont, and the Pyrenees. Beſides the ſoftneſs and warmth of the leather, it has the faculty of bearing ſoap without damage; which renders it very uſeful on many accounts.

In France, &c. ſome wear the ſkin raw, without any preparation. Shammy leather is uſed for the purifying of mercury, which is done by paſſing it through the pores of this ſkin, which are very cloſe. The true chamois leather is counterfeited with common goat, kid, and even with ſheep ſkins, the practice of which makes a particular profeſſion, called by the French *chamoiſure*. The laſt, though the leaſt eſteemed, is yet ſo popular, and ſuch vaſt quantities of it are prepared, eſpecially about Orleans, Marſeilles, and Tholouſe, that it may be proper to give the method of preparation.

Manner of ſhamoiſing, or of preparing ſheep, goat, or kid ſkins in oil, in imitation of ſhammy.—The ſkins, being waſhed, drained, and ſmeared over with quicklime on the fleſhy ſide, are folded in two lengthwiſe, the wool outwards, and laid in heaps, and ſo left to ferment eight days, or, if they had been left to dry after flaying, then fifteen days.

Then they are waſhed out, drained, and half dried; laid on a wooden leg, or horſe, the wool ſtripped off with a round ſtaff for that purpoſe, and laid in a weak pit, the lime whereof had been uſed before, and has loſt the greateſt part of its force.

After 24 hours they are taken out, and left to drain 24 more; they are then put in another ſtronger pit. This done, they are taken out, drained, and put in again, by turns; which begins to diſpoſe them to take oil; and this practice they continue for ſix weeks in ſummer, or three months in winter: at the end whereof they are waſhed out, laid on the wooden leg, and the ſurface of the ſkin on the wool ſide peeled off, to render them the ſofter; then made into parcels, ſteeped a night in the river, in winter more, ſtretched ſix or ſeven over one another on the wooden leg, and the knife paſſed ſtrongly on the fleſhy ſide, to take off any thing ſuperfluous, and render the ſkin ſmooth. Then they are ſteeped, as before, in the river, and the ſame operation is repeated on the wool ſide; they are then thrown into a tub of water, with bran in it, which is brewed among the ſkins till the greateſt part ſticks to them, and then ſeparated into diſtinct tubs, till they ſwell, and riſe of themſelves above the water. By this means the remains of the lime are cleared out; they are then wrung out, hung up to dry on ropes, and ſent to the mill, with the quantity of oil neceſſary to ſcour them: the beſt oil is that of ſtock-fiſh. Here they are firſt thrown in bundles into the river for 12 hours, then laid in the mill-trough, and fulled without oil till they be well ſoftened; then oiled with the hand, one by one, and thus formed into parcels of four ſkins each; which are milled and dried on cords a ſecond time; then a third; and then oiled again, and dried. This proceſs is repeated as often as neceſſity requires; when done, if there be any moiſture remaining, they are dried in a ſtove, and made up into parcels wrapped up in wool; after ſome time they are opened to the air, but wrapped up again as before, till ſuch time as the oil ſeems to have loſt all its force, which it ordinarily does in 24 hours. The ſkins are then returned from the mill to the chamoiſer to be ſcoured; which is done by putting them in a lixivium of wood aſhes, working and beating them in it with poles, and leaving them to ſteep till the ley hath had its effect; then they are wrung out, ſteeped in another lixivium, wrung again; and this is repeated till all the greaſe and oil be purged out. When this is done, they are half dried, and paſſed over a ſharp-edged iron inſtrument, placed perpendicular in a block, which opens, ſoftens, and makes them gentle. Laſtly, they are thoroughly dried, and paſſed over the ſame inſtrument again; which finiſhes the preparation, and leaves them in the form of ſhammy.

Kid and goat ſkins are ſhamoiſed in the ſame manner as thoſe of ſheep, excepting that the hair is taken off without the uſe of any lime; and that when brought from the mill they undergo a particular preparation called *ramalling*, the moſt delicate and difficult of all the others. It conſiſts in this, that, as ſoon as brought from the mill, they are ſteeped in a fit lixivium, taken out, ſtretched on a round wooden leg, and the hair is ſcraped off with the knife; this makes them ſmooth, and in working to caſt a kind of fine knap. The difficulty is in ſcraping them evenly.

SHANK, or *SHANK-Painter*, in a ſhip, is a ſhort chain faſtened under the foremaſt ſhrouds, by a bolt, to the ſhip's ſides, having at the other end a rope faſtened to it. On this ſhank-painter the whole weight of the aft part of the anchor reſts, when it lies by the ſhip's ſide. The rope, by which it is hauled up, is made faſt about a timber-head.

Shank, in the manege, that part of a horſe's fore-leg which lies between the knee and the fetlock.

SHANKER, or Chancre, in *Medicine*, a malignant ulcer, uſually occaſioned by ſome venereal diſorder. See Medicine, N° 350.

SHANNON, the largeſt river in Ireland, and one of the fineſt in the Britiſh dominions, not only on account of its rolling 200 miles, but alſo of its great depth in moſt places, and the gentleneſs of its current, by which it might be made exceedingly ſerviceable to the improvement of the country, the communication of its inhabitants, and conſequently the promoting of inland trade, through the greateſt part of its long courſe. But the peculiar prerogative of the Shannon is its ſituation, running from north to ſouth, and ſeparating the province of Connaught from Leinſter and Munſter, and of conſequence dividing the greateſt part of Ireland into what lies on the eaſt and that on the weſt of the river; watering in its paſſage the valuable county of Leitrim, the plentiful ſhire of Roſcommon, the fruitful county of Galway, and the pleaſant county of Clare; the ſmall but fine ſhire of Longford, the King's county, and fertile county of Meath in Leinſter, the populous county of Tipperary, the ſpacious ſhire of Limerick,

rick, and the rough but pleaſant county of Kerry in Munſter; viſiting 10 counties in its paſſage, and having on its banks the following remarkable places, viz. Leitrim, Jameſtown, Laneſborough, Athlone, Clonfert, Killaloe, and Limerick; at 20 leagues below the latter it ſpreads gradually ſeveral miles in extent, ſo that ſome have conſidered its expanſion as a lake. It at laſt joins its waters to the ſea, being navigable all that way for the largeſt veſſels.

SHANSCRIT, the language of the Bramins of Hindoſtan. See PHILOLOGY, ſect. v.

SHARE *of a PLOUGH*, that part which cuts the ground; the extremity forwards being covered with a ſharp-pointed iron, called the *point of the ſhare*, and the end of the wood behind the *tail of the ſhare*.

SHARK. See SQUALUS, ICHTHYOLOGY *Index*.

SHARON, a name common to three cantons of Paleſtine. The firſt lay between Mount Tabor and the ſea of Tiberias; the ſecond between the city of Cæſarea of Paleſtine, and Joppa; and the third lay beyond Jordan. To give an idea of perfect beauty, Iſaiah ſaid, the glory of Lebanon and the beauty of Carmel muſt be joined to the abundance of Sharon. (Iſaiah xxxiii. 9. xxxi. 2.). The plains of Sharon are of vaſt extent; and, when ſurveyed by the Abbé Mariti a few years ago, they were ſown with cucumbers; and he informs us, that ſuch a number is annually produced, as not only to ſupply the whole neighbourhood, but alſo all the coaſts of Cyprus and the city of Damietta. In the middle of the plain, between Arſus and Lydda, riſes a ſmall mountain, upon the ridge of which there is a ſmall village called Sharon, from the name of the ancient city whoſe king was conquered by Joſhua.

SHARP, JAMES, archbiſhop of St Andrew's, was born of a good family in Banffſhire in 1618. He devoted himſelf very early to the church, and was educated for that purpoſe in the univerſity of Aberdeen. When the ſolemn league and covenant was framed in 1638, the learned men in that ſeminary, and young Sharp in particular, declared themſelves decidedly againſt it. To avoid the inſults and indignities to which he was ſubjected in conſequence of this conduct, he retired to England, where he contracted an acquaintance with ſome of the moſt celebrated divines in that country.

At the commencement of the civil wars he returned to Scotland. During his journey thither, he accidentally met with Lord Oxenford, who was ſo charmed with his converſation, that he invited him to his houſe. While he reſided with that nobleman, he became known to the earl of Rothes, who procured him a profeſſorſhip at St Andrew's. By the intereſt of the earl of Crawford he was ſoon after appointed miniſter of Crail; where he conducted himſelf, it is ſaid, in an exemplary manner.

Sharp had always inclined to the cauſe of royalty, and had for ſome time kept up a correſpondence with his exiled prince. After the death of the protector he began to declare himſelf more openly, and ſeems to have enjoyed a great ſhare of the confidence of Monk, who was at that time planning the reſtoration of Charles II. When that general marched to London, the preſbyterians ſent Sharp to attend him in order to ſupport their intereſts. At the requeſt of General Monk and the chief preſbyterians in Scotland, Mr Sharp was ſent over to the king at Breda to procure from him, if poſſible, the eſtabliſhment of preſbyterianiſm. On his return, he aſſured his friends that "he had found the king very affectionate to Scotland, and reſolved not to wrong the ſettled government of the church: but he apprehended they were miſtaken who went about to eſtabliſh the preſbyterian government."

Charles was ſoon after reſtored without any terms. All the laws paſſed in Scotland ſince the year 1633 were repealed; the king and his miniſters reſolved at all hazards to reſtore prelacy. Mr Sharp, who had been commiſſioned by the Scotch preſbyterians to manage their intereſts with the king, was prevailed upon to abandon the party; and as a reward for his compliance, he was made archbiſhop of St Andrew's. This conduct rendered him very odious in Scotland; he was accuſed of treachery and perfidy, and reproached by his old friends as a traitor and renegado. The abſurd and wanton cruelties which were afterwards committed, and which were imputed in a great meaſure to the archbiſhop, rendered him ſtill more deteſted. Nor is it probable that theſe accuſations were without foundation: the very circumſtance of his having been formerly of the preſbyterian party would induce him, after forſaking them, to treat them with ſeverity. Beſides, it is certain, that when after the rout at Pentland-hills he received an order from the king to ſtop the executions, he kept it for ſome time before he produced it to council.

There was one Mitchell a preacher, and a deſperate fanatic, who had formed the deſign of taking vengeance for theſe cruelties by aſſaſſinating the archbiſhop. He fired a piſtol at him as he was ſitting in his coach; but the biſhop of Orkney, lifting up his hand at the moment, intercepted the ball. Though this happened in the midſt of Edinburgh, the primate was ſo much deteſted, that nobody ſtopped the aſſaſſin; who, having walked leiſurely home, and thrown off his diſguiſe, returned, and mixed unſuſpected with the crowd. Some years after, the archbiſhop obſerving a man eyeing him with keenneſs, ſuſpected that he was the aſſaſſin, and ordered him to be brought before him. It was Mitchell. Two loaded piſtols were found in his pocket. The primate offered him a pardon if he would confeſs the crime; the man complied; but Sharp, regardleſs of his promiſe, conducted him to the council. The council alſo gave him a ſolemn promiſe of pardon if he would confeſs his guilt, and diſcover his accomplices. They were much diſappointed to hear that only one man was privy to his purpoſe, who was ſince dead. Mitchell was then brought before a court of juſtice, and ordered to make a third confeſſion, which he refuſed. He was impriſoned for ſeveral years, and then tried. His own confeſſion was urged againſt him. It was in vain for him to plead the illegality of that evidence, and to appeal to the promiſe of pardon previouſly given. The council took an oath that they had given no ſuch promiſe; and Mitchell was condemned. Lauderdale, who at that time governed Scotland, would have pardoned him, but the primate inſiſted on his execution; obſerving, that if aſſaſſins were permitted to go unpuniſhed, his life muſt be continually in danger. Mitchell was accordingly executed.

Sharp had a ſervant, one Carmichael, who by his cruelty had rendered himſelf particularly odious to the zealots. Nine men formed the reſolution of waylaying him in Magus-moor, about three miles from St Andrew's.

Sharp.

drew's. While they were waiting for this man, the primate himſelf appeared with very few attendants. This they looked upon as a declaration of heaven in their favour; and calling out, "the Lord has delivered him into our hands," they ran up to the carriage. They fired at him without effect; a circumſtance which was afterwards imputed to magic. They then diſpatched him with their ſwords, regardleſs of the tears and intreaties of his daughter, who accompanied him (A).

Thus fell Archbiſhop Sharp, whoſe memory is even at preſent deteſted by the common people of Scotland. His abilities were certainly good, and in the early part of his life he appears with honour and dignity. But his conduct afterwards was too cruel and inſincere to merit approbation. His treatment of Mitchell was mean and vindictive. How far he contributed to the meaſures adopted againſt the preſbyterians is not certain. They were equally cruel and impolitic; nor did their effects ceaſe with the meaſures themſelves. The unheard-of cruelties exerciſed by the miniſters of Charles II. againſt the adherents of the covenant, raiſed ſuch a flame of enthuſiaſm and bigotry as is not yet entirely extinguiſhed.

Sharp, *Dr John*, archbiſhop of York, was deſcend-from the Sharps of Little Norton, a family of Bradford Dale in Yorkſhire; and was ſon of an eminent tradeſman of Bradford, where he was born in 1644. He was educated at Cambridge, and in 1667 entered into orders. That ſame year he became domeſtic chaplain to Sir Heneage Finch, then attorney-general. In 1672 he was collated to the archdeaconry of Berkſhire. In 1675 he was inſtalled a prebendary in the cathedral church of Norwich; and the year following was inſtituted into the rectory of St Bartholomew near the Royal Exchange, London. In 1681 he was, by the intereſt of his patron Sir Heneage Finch, then lord high chancellor of England, made dean of Norwich; but in 1686 was ſuſpended for taking occaſion, in ſome of his ſermons, to vindicate the doctrine of the church of England in oppoſition to Popery. In 1688 he was ſworn chaplain to King James II. being then probably reſtored after his ſuſpenſion, for it is certain that he was chaplain to King Charles II. and attended as a court chaplain at the coronation of King James II. In 1689 he was declared dean of Canterbury; but never could be perſuaded to fill up any of the vacancies made by the deprived biſhops. Upon the death of Dr Lamplugh, he was promoted to the ſee of York. In 1702 he preached the ſermon at the coronation of Queen Anne; and the ſame year was ſworn of the privy-council, and made lord almoner to her majeſty. He died at Bath in 1713; and was interred in the cathedral of York, where a monument is erected to his memory.—His ſermons, which were collected after his death, and publiſhed in 7 vols 8vo, are juſtly admired.

Sharp.

Sharp, *Abraham*, an eminent Engliſh mathematician and aſtronomer, was born at Little Horton, near Bradford, in the year 1651. He was put apprentice to a merchant at Mancheſter; but ſo ſtrongly was he inclined to the ſtudy of mathematics, that he ſoon found his ſituation both irkſome and diſagreeable. By the mutual conſent, therefore, of his maſter and himſelf, he quitted the buſineſs of a merchant. He then removed to Liverpool, where he wholly devoted himſelf to mathematical ſtudies, and where, for a ſubſiſtence, he taught writing and accounts.

Soon after this, a merchant from London, in whoſe houſe the celebrated Mr Flamſteed then lodged, engaged Mr Sharp to be his book-keeper. With this eminent aſtronomer he ſoon contracted an intimate friendſhip, and by his recommendation he obtained a more profitable employment in the dock-yard of Chatham, where he continued till his friend and patron called him to his aſſiſtance. Mr Sharp was chiefly employed in the conſtruction of the mural arch, which he finiſhed in the courſe of 14 months ſo entirely to the ſatisfaction of Mr Flamſteed, that he ſpoke of him in terms of the higheſt praiſe. In the opinion of Mr Smeaton, this was the firſt good inſtrument of the kind, and Mr Sharp the firſt artiſt who cut delicate diviſions on aſtronomical inſtruments. When this inſtrument was conſtructed, Mr Sharp was but 25, and Mr Flamſteed 30 years of age. Mr Sharp aſſiſted his friend in making a catalogue of nearly 3000 fixed ſtars, with their longitudes and magnitudes, their right aſcenſions and polar diſtances, with the variations of the ſame while they change their longitude by one degree.

But from the fatigue of conſtantly obſerving the ſtars by night, in a cold thin air, added to a weakly conſtitution, his health was much impaired; for the recovery of which he requeſted leave to retire to his houſe at Horton, where, as ſoon as he felt himſelf recovering, he began to fit up an obſervatory of his own, and the teleſcopes he made uſe of were all of his own conſtruction, and the lenſes ground and adjuſted with his own hands.

It was about this time that he aſſiſted Mr Flamſteed in calculating moſt of the tables in the ſecond volume of his *Hiſtoria Cæleſtis*, as appears by their letters, to be ſeen in the hands of Mr Sharp's friends at Horton. The mathematician, ſays Dr Hutton, meets with ſomething extraordinary in Sharp's elaborate treatiſe of *Geometry Improved*; by a large and accurate table of ſegments of circles, its conſtruction and various uſes in the ſolution of ſeveral difficult problems, with compendious tables for finding a true proportional part; and their uſe in theſe or any other tables exemplified in making logarithms,

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(A) Such is the account given by all our hiſtorians of the murder of Archbiſhop Sharp; and that he fell by the hands of fanatics, whom he perſecuted, is certain. A tradition, however, has been preſerved in different families deſcended from him, which may be mentioned, and is in itſelf certainly not incredible. The primate, it ſeems, who, when miniſter of Crail, was peculiarly ſevere in puniſhing the ſin of fornication, had, in the plenitude of his archiepiſcopal authority, taken notice of a criminal amour carried on between a nobleman high in office and a lady of ſome faſhion who lived within his dioceſe. This interference was in that licentious age deemed very impertinent; and the archbiſhop's deſcendants believe that the proud peer inſtigated the deluded rabble to murder their anceſtor.

logarithms, or their natural numbers, to 60 places of figures; there being a table of them for all primes to 1100, true to 61 figures. His conciſe treatiſe of Polyedra, or ſolid bodies of many baſes, both of the regular ones and others; to which are added, 12 new ones, with various methods of forming them, and their exact dimenſions in ſurds or ſpecies, and in numbers; illuſtrated with a variety of copperplates, neatly engraved by his own hands. Indeed, few of the mathematical inſtrument makers could exceed him in exactly graduating or neatly engraving mathematical or aſtronomical inſtruments. He poſſeſſed a remarkably clear head for contriving, and an extraordinary hand for executing any thing, not only in mechanics, but likewiſe in drawing, writing, and making the moſt beautiful figures in all his calculations and conſtructions.

The quadrature of the circle was undertaken by him for his own amuſement, in the year 1699, deduced from two different ſeries, by which the truth of it was proved to 72 places of figures, as may be ſeen in Sherwin's Tables of Logarithms. In the ſame book may likewiſe be ſeen his ingenious improvements on the making of logarithms, and the conſtructing of the natural ſines, tangents, and ſecants.

Mr Sharp kept up a correſpondence with moſt of the eminent mathematicians and aſtronomers of his time, as Flamſteed, Newton, Halley, Wallis, Hodgſon, &c. the anſwers to whoſe letters are all written on the backs or empty ſpaces, of the letters he received, in a ſhort hand of his own invention. Being one of the moſt accurate and indefatigable computers who ever exiſted; he was many years the common reſource for Flamſteed, Sir Jonas Moor, Halley, and others, in all ſorts of troubleſome and delicate calculations.

Mr Sharp was never married, and ſpent his time as a hermit. He was of a middle ſtature, very thin, of a weakly conſtitution; but remarkably feeble during the laſt 3 or 4 years before his death, which happened on the 18th of July 1742, in the 91ſt year of his age.

He was very irregular as to his meals, and uncommonly ſparing in his diet, which he frequently took in the following manner. A little ſquare hole, reſembling a window, formed a communication between the room where he uſually ſtudied, and another where a ſervant could enter; and before this hole he had contrived a ſliding board. It often happened, that the breakfaſt, dinner, and ſupper, have remained untouched, when the ſervant was gone to remove what was left,—ſo deeply was he engaged in calculations.

SHARP, in *Muſic*. See INTERVAL.

SHASTAH, the ſame as SHASTER.

SHASTER, SHASTAH, or BEDANG, the name of a ſacred book, in high eſtimation among the idolaters of Hindoſtan, containing all the dogmas of the religion of the bramins, and all the ceremonies of their worſhip; and ſerving as a commentary on the VEDAM.

The term *Shaſter* denotes "ſcience" or "ſyſtem;" and is applied to other works of aſtronomy and philoſophy, which have no relation to the religion of the Indians. None but the bramins and rajahs of India are allowed to read the Vedam; the prieſts of the Banians, called *Shuderers*, may read the Shaſter; and the people, in general, are allowed to read only the Paran or Pouran, which is a commentary on the Shaſter.

The Shaſter is divided into three parts: the firſt containing the moral law of the Indians; the ſecond, the rites and ceremonies of their religion; and the third, the diſtribution of the people into tribes or claſſes, with the duties pertaining to each claſs.

The principal precepts of morality, contained in the firſt part of the Shaſter, are the following: that no animal be killed, becauſe the Indians attribute ſouls to brute animals as well as to mankind; that they neither hear nor ſpeak evil, nor drink wine, nor eat fleſh, nor touch any thing that is unclean; that they obſerve the feaſts, prayers, and waſhings, which their law preſcribes; that they tell no lies, nor be guilty of deceit in trade; that they neither oppreſs nor offer violence to one another; that they celebrate the ſolemn feaſts and faſts, and appropriate certain hours of ordinary ſleep to cultivate a diſpoſition for prayer; and that they do not ſteal or defraud one another.

The ceremonies, contained in the ſecond part of the Shaſter, are ſuch as theſe: that they waſh often in the rivers, hereby obtaining the pardon of their ſins; that they mark their forehead with red, in token of their relation to the Deity; that they preſent offerings and prayers under certain trees, ſet apart for this purpoſe; that they pray in the temples, make oblations to their pagodas or idols, ſing hymns, and make proceſſions, &c.; that they make pilgrimages to diſtant rivers, and eſpecially to the Ganges, there to waſh themſelves and make offerings; that they make vows to particular ſaints, according to their reſpective departments; that they render homage to the Deity at the firſt ſight of the ſun; that they pay their reſpect to the ſun and moon, which are the two eyes of the Deity; and that they treat with particular veneration thoſe animals that are deemed more pure than others; as the cow, buffalo, &c.; becauſe the ſouls of men have tranſmigrated into theſe animals.

The third part of the Shaſter records the diſtribution of the people into four claſſes: the firſt being that of the bramins or prieſts, appointed to inſtruct the people; the ſecond, that of the kutteris or nobles, who are the magiſtrates; the third, that of the ſhudderis or merchants; and the fourth, that of the mechanics. Each perſon is required to remain in the claſs in which he was born, and to purſue the occupation aſſigned to him by the Shaſter. According to the bramins, the Shaſter was imparted by God himſelf to Brahma, and by him to the bramins; who communicated the contents of it to the people.

Modern writers have given us very different accounts of the antiquity and importance of the Shaſter. Mr Holwell, who had made conſiderable progreſs in the tranſlation of this book, apprehends, that the mythology as well as the coſmogony of the Egyptians, Greeks, and Romans, was borrowed from the doctrines of the bramins, contained in it, even to the copying of their exteriors of worſhip, and the diſtribution of their idols, though groſsly mutilated and adulterated. With reſpect to the Vedam and Shaſter, or ſcriptures of the Gentoos, this writer informs us, that *Vedam*, in the Malabar language, ſignifies the ſame as *Shaſter* in the Shanſcrit; and that the firſt book is followed by the Gentoos of the Malabar and Coromandel coaſts, and alſo of the iſland of Ceylon. The Shaſter is followed by the Gentoos of the provinces of Bengal, and by all the

Gentoos of the reſt of India, commonly called *India Proper*, along the courſe of the rivers Ganges and Jumna to the Indus. Both theſe books (he ſays) contain the inſtitutes of their reſpective religion and worſhip, as well as the hiſtory of their ancient rajahs and princes, often couched under allegory and fable. Their antiquity is contended for by the partiſans of each; but he thinks, that the ſimilitude of their names, idols, and great part of their worſhip, leaves little room to doubt, nay plainly evinces, that both theſe ſcriptures were originally one. He adds, if we compare the great purity and chaſte manners of the Shaſter with the great abſurdities and impurities of the Vedam, we need not heſitate to pronounce the latter a corruption of the former.

With regard to the high original of theſe ſcriptures, the account of the bramins is as follows. Brahma (that is, "Mighty Spirit"), about 4866 years ago, aſſumed the form of man and the government of Indoſtan. He tranſlated the divine law (deſigned for the reſtoration of mankind, who had offended in a pre-exiſtent ſtate, and who are now in their laſt ſcene of probation, to the dignity from which they were degraded) out of the language of angels into the well known Shanſcrit language, and called his tranſlation the *Chartah Bhade Shaſtah of Birmah*, or *the Six Scriptures of Divine Words of the Mighty Spirit*. He appointed the bramins, deriving their name from him, to preach the word of God; and the doctrines of the Shaſter were accordingly preached in their original purity 1000 years. About this time there was publiſhed a paraphraſe on the Chartah Bhade; and about 500 years afterwards, a ſecond expoſition, called the *Aughtorrah Bhade Shaſta*, or *Eighteen Books of Divine Words*, written in a character compounded of the common Indoſtan and the Shanſcrit. This innovation produced a ſchiſm among the Gentoos; on which occaſion, it is ſaid, thoſe of Coromandel and Malabar formed a ſcripture of their own, which they pretended to be founded on the Chartah Bhade of Bramah, and called it *the Vedam of Birmah*, or *Divine Words of the Mighty Spirit*. The original Chartah Bhade was thrown aſide, and at length wholly unknown, except to a few families; who can ſtill read and expound it in the Shanſcrit character. With the eſtabliſhment of the Aughtorrah Bhade, and Vedam, which, according to the Gentoo account, is 3366 years ago, their polytheiſm commenced; and the principles of religion became ſo obſcure, and their ceremonies ſo numerous, that every head of a family was obliged to keep a bramin as a guide both in faith and practice. Mr Holwell is of opinion, that the Chartah Bhade, or Original Scriptures, are not copied from any other ſyſtem of theology, promulgated to or obtruded upon mankind. The Gentoos do not attribute them to Zoroaſter; and Mr Holwell ſuppoſes that both Zoroaſter and Pythagoras viſited Indoſtan, not to inſtruct, but to be inſtructed.

From the account of Mr Dow, we learn, that the books which contain the religion and philoſophy of the Hindoos are diſtinguiſhed by the name of *Bedas;* that they are four in number, and like the ſacred writings of other nations, ſaid to be penned by the Divinity. Beda, he ſays, in the Shanſcrit language, literally ſignifies *ſcience;* and theſe books treat not only of religion and moral duties, but of every branch of philoſophic knowledge. The bramins maintain, that the Bedas are the divine laws which Brimha, at the creation of the world, delivered for the inſtruction of mankind; but they affirm, that their meaning was perverted in the firſt age by the ignorance and wickedneſs of ſome princes, whom they repreſent as evil ſpirits, who then haunted the earth.

The firſt credible account we have of the Bedas is, that about the commencement of the Cal Jug, of which era the year 1768 was the 4886th year, they were written, or rather collected, by a great philoſopher and reputed prophet, called *Beäſs Muni*, or *Beäſs the Inſpired*.

The Hindoos (ſays Mr Dow) are divided into two great religious ſects: the followers of the doctrine of Bedang, which is the original Shaſter or commentary upon the Bedas; and thoſe who adhere to the principles of the Neadirſen. The original Shaſter is called *Bedang*, and is a commentary upon the Bedas. This book, he ſays, is erroneouſly called in Europe the *Vedam*. It is aſcribed to Beäſs Muni, and is ſaid to have been reviſed ſome years after by one Serrider Swami, ſince which it has been reckoned ſacred, and not ſubject to any farther alterations.

Almoſt all the Hindoos of the Decan, and thoſe of the Malabar and Coromandel coaſts, are of this ſect. The followers of the Bedang Shaſter do not allow that any phyſical evil exiſts; they maintain that God created all things perfectly good; but that man, being a free agent, may be guilty of moral evil, which may be injurious to himſelf, but can be of no detriment to the general ſyſtem of nature. God, they ſay, being perfectly benevolent, never puniſhed the wicked otherwiſe than by the pain and affliction which are the natural conſequences of evil actions; and hell, therefore is no other than a conſciouſneſs of evil.

The Neadirſen Shaſter is ſaid to have been written by a philoſopher called *Goutam*, near four thouſand years ago. The bramins, from Mr Dow's account of their ſacred books, appear to believe invariably in the unity, eternity, omniſcience, and omnipotence of God; and the polytheiſm of which they have been accuſed is no more than a ſymbolical worſhip of the divine attributes, which they divide into three claſſes. Under the name of *Brimha*, they worſhip the wiſdom and creative power of God; under the appellation of *Biſhen*, his providential and preſerving quality; and under that of *Shibah*, that attribute which tends to deſtroy.

As few of our readers may have an opportunity of peruſing the Shaſter, we ſhall, by way of ſpecimen, ſubjoin a paſſage from it, which, though it contains ſome metaphyſical myſteries concerning the creation, yet diſcovers views of God ſo enlightened that they would not diſgrace more refined nations. The paſſage which we ſhall quote is the firſt chapter of the Shaſter, which is a dialogue between Brimha the Wiſdom of the Divinity, and Narud or Reaſon, who is repreſented as the ſon of Brimha. Narud deſires to be inſtructed by his father; and for that purpoſe puts the following queſtions to him:

" *Narud.* O father! thou firſt of God, thou art ſaid to have created the world, and thy ſon Narud, aſtoniſhed at what he beholds, is deſirous to be inſtructed how all theſe things were made.

" *Brimha.* Be not deceived, my ſon! do not imagine that I was the creator of the world, independent of the Divine Mover, who is the great original eſſence and creator of all things. Look, therefore, only upon me as the inſtrument of the great *will*, and a part of his being, whom he called forth to execute his eternal deſigns.

“ *Narud.* What ſhall we think of God ?

“ *Brimha.* Being immaterial, he is above all conception ; being inviſible, he can have no form ; but, from what we behold in his works, we may conclude that he is eternal, omnipotent, knowing all things, and preſent everywhere.

“ *Narud.* How did God create the world ?

“ *Brimha.* Affection dwelt with God from all eternity. It was of three different kinds ; the creative, the preſerving, and the deſtructive. This firſt is repreſented by Brimha, the ſecond by Biſhen, and the third by Shibah. You, O Narud ! are taught to worſhip all the three in various ſhapes and likeneſſes, as the Creator, the Preſerver, and the Deſtroyer. The affection of God then produced power, and power, at a proper conjunction of time and fate, embraced goodneſs, and produced matter. The three qualities then acting upon matter, produced the univerſe in the following manner : From the oppoſite actions of the creative and deſtructive quality in matter, ſelf-motion firſt aroſe. Self-motion was of three kinds ; the firſt inclining to plaſticity, the ſecond to diſcord, and the third to reſt. The diſcordant actions then produced the Akaſh (a kind of celeſtial element), which inviſible element poſſeſſed the quality of conveying ſound ; it produced air, a palpable element ; fire, a viſible element ; water, a fluid element ; and earth, a ſolid element.

“ The Akaſh diſperſed itſelf abroad. Air formed the atmoſphere ; fire, collecting itſelf, blazed forth in the hoſt of heaven ; water roſe to the ſurface of the earth, being forced from beneath by the gravity of the latter element. Thus broke forth the world from the veil of darkneſs, in which it was formerly comprehended by God. Order roſe over the univerſe. The ſeven heavens were formed, and the ſeven worlds were fixed in their places ; there to remain till the great diſſolution, when all things ſhall be abſorbed into God.

“ God ſeeing the earth in full bloom, and that vegetation was ſtrong from its ſeeds, called forth for the firſt time intellect, which he endued with various organs and ſhapes, to form a diverſity of animals upon the earth. He endued the animals with five ſenſes; feeling, ſeeing, ſmelling, taſting, and hearing ; but to man he gave reflection, to raiſe him above the beaſts of the field.

“ The creatures were created male and female, that they might propagate their ſpecies upon the earth. Every herb bore the ſeed of its kind, that the world might be clothed with verdure, and all animals provided with food.

“ *Narud.* What doſt thou mean, O father ! by Intellect ?

“ *Brimha.* It is a portion of the *great ſoul* of the univerſe breathed into all creatures, to animate them for a certain time.

“ *Narud.* What becomes of it after death ?

“ *Brimha.* It animates other bodies, or returns, like a drop, into that unbounded ocean from which it firſt aroſe.

“ *Narud.* Shall not then the ſouls of good men receive rewards ? nor the ſouls of the bad meet with puniſhment ?

“ *Brimha.* The ſouls of men are diſtinguiſhed from thoſe of other animals ; for the firſt are endued with reaſon, and with a conſciouſneſs of right and wrong. If therefore man ſhall adhere to the firſt, as far as his powers ſhall extend, his ſoul, when diſengaged from the body by death, ſhall be abſorbed into the divine eſſence, and ſhall never more reanimate fleſh : But the ſouls of thoſe who do evil are not, at death, diſengaged from all the elements. They are immediately clothed with a body of fire, air, and akaſh, in which they are for a time puniſhed in hell. After the ſeaſon of their grief is over, they reanimate other bodies ; but till they ſhall arrive at a ſtate of purity they can never be abſorbed into God.

“ *Narud.* What is the nature of that abſorbed ſtate which the ſouls of good men enjoy after death ?

“ *Brimha.* It is a participation of the divine nature, where all paſſions are utterly unknown, and where conſciouſneſs is loſt in bliſs.

“ *Narud.* Thou ſayeſt, O father, that unleſs the ſoul is perfectly pure it cannot be abſorbed into God : now, as the actions of the generality of men are partly good and partly bad, whither are their ſpirits ſent immediately after death ?

“ *Brimha.* They muſt atone for their crimes in hell, where they muſt remain for a ſpace proportioned to the degree of their iniquities ; then they riſe to heaven to be rewarded for a time for their virtues ; and from thence they will return to the world to reanimate other bodies.

“ *Narud.* What is time ?

“ *Brimha.* Time exiſted from all eternity with God: but it can only be eſtimated ſince motion was produced, and only be conceived by the mind, from its own conſtant progreſs.

“ *Narud.* How long ſhall this world remain ?

“ *Brimha.* Until the four jugs ſhall have revolved. Then Rudder (the ſame with *Shibah*, the deſtroying quality of God), with the ten ſpirits of diſſolution, ſhall roll a comet under the moon, that ſhall involve all things in fire, and reduce the world into aſhes. God ſhall then exiſt alone, for matter will be totally annihilated.”

Thoſe who deſire more information on this ſubject many conſult Dow's Hiſtory of Indoſtan, and Holwell's Intereſting Hiſtorical Events.

SHAW, Dr Thomas, known to the learned world by his travels to Barbary and the Levant, was born at Kendal in Weſtmoreland about the year 1692. He was appointed chaplain to the Engliſh conſul at Algiers, in which ſtation he continued for ſeveral years ; and from thence took proper opportunities of travelling into different parts. He returned in 1733 ; was elected fellow of the Royal Society ; and publiſhed the account of his travels at Oxford, folio, 1738. In 1740 he was nominated principal of St Edmond-hall, which he raiſed from a ruinous ſtate by his munificence ; and was regius profeſſor of Greek at Oxford until his death, which happened in 1751. Dr Clayton, biſhop of Clogher, having attacked theſe Travels in his Deſcription of the Eaſt, Dr Shaw publiſhed a ſupplement by way of vindication, which is incorporated into the ſecond edition of his Travels, prepared by himſelf, and publiſhed in 4to, 1757.

SHAWIA, a genus of plants, belonging to the claſs ſyngeneſia, and order polygamia ſegregata, of which the characters are the following; the calyx is imbricated with five or ſix leaves, the three interior of which are larger; the corolla is five-cleft; there is one oblong ſeed. One ſpecies only has been diſcovered, which is a native of New Zealand.

SHAWLS, are woollen handkerchiefs, an ell wide, and near two long. The wool is ſo fine and ſilky, that the whole handkerchief may be contained in the two hands cloſed. It is the produce of a Tibet ſheep; but ſome ſay that no wool is employed but that of lambs torn from the belly of their mother before the time of birth. The moſt beautiful ſhawls come from Caſhmire: their price is from 150 livres (about ſix guineas) to 1200 livres (or 50l. ſterling).

In the Tranſactions of the Society for Encouraging Arts, Manufactures, &c. for the year 1792, we are informed that a ſhawl counterpane, four yards ſquare, manufactured by Mr P. J. Knights of Norwich, was preſented to the ſociety; and that, upon examination, it appeared to be of greater breadth than any goods of equal fineneſs and texture that had ever before been preſented to the ſociety, or to their knowledge woven in this country. The ſhawls of Mr Knights's manufacture, it is ſaid, can ſcarcely be diſtinguiſhed from Indian ſhawls, though they can be afforded at one-twentieth part of the price. When the ſhawl is 16 quarters ſquare, Mr Knights ſays it may be retailed at 20l.; if it conſiſted of 12 quarters, and embroidered as the former, it will coſt 15l.; if plain, with a fringe only, a ſhawl of 16 quarters ſquare may be ſold at 8l. 8s.; if 12 quarters and fringed, at 6l. 6s.

Mr Knights maintains, that his counterpane of four yards ſquare is equal in beauty, and ſuperior in ſtrength, to the Indian counterpanes, which are ſold at 200 guineas. The principal conſumption of this cloth is in train-dreſſes for ladies; as likewiſe for long ſcarfs, in imitation of the real Indian ſcarfs, which are ſold from 60l. to 80l.; whereas ſcarfs of this fabric are ſold for as many ſhillings, and the ladies ſquare ſhawls in proportion.

SHEADING, a riding, tything, or diviſion, in the iſle of Man; the whole iſland being divided into ſix ſheadings; in every one of which is a coroner or chief conſtable, appointed by the delivery of a rod at the annual convention.

SHEARBILL, the *Rhynchops Nigra* of Linnæus, the *Black Skimmer* of Pennant and Latham, and *Cutwater* of Cateſby. See ORNITHOLOGY *Index*.

SHEATHING, in the ſea-language, is the caſing that part of a ſhip which is to be under water with firboard of an inch thick; firſt laying hair and tar mixed together under the boards, and then nailing them on, in order to prevent worms from eating the ſhip's bottom.—Ships of war are now generally ſheathed with copper: but copper ſheathing is liable to be corroded by the action of ſalt water, and ſomething is ſtill wanting to effect this purpoſe. It is very probable that tar might anſwer very well.

In the Corniſh mines, copper or braſs pumps are often placed in the deepeſt parts, and are conſequently expoſed to the vitriolic or other mineral waters with which ſome of theſe mines abound, and which are known to have a much ſtronger effect on copper than ſea water. Theſe pumps are generally about ſix feet long, and are ſcrewed together, and made tight by the interpoſition of a ring of lead, and the joinings are afterwards tarred. One of theſe pumps was ſo much corroded as to render it unfit for uſe; but the ſpots of tar, which by accident had dropped on it, preſerved the parts they covered from the action of the water. Theſe projected in ſome places more than a quarter of an inch; and the joints were ſo far defended by the thin coat of tar, that it was as perfect as when it came from the hands of the manufacturer. If tar thus effectually defends copper from theſe acrid waters, can there remain a doubt of its preſerving it from the much milder waters of the ſea?

SHEATS, in a ſhip, are ropes bent to the clews of the ſails, ſerving in the lower ſails to haul aft the clews of the ſail; but in topſails they ſerve to haul home the clew of the ſail cloſe to the yard-arm.

SHEAVE, in *Mechanics*, a ſolid cylindrical wheel, fixed in a channel, and moveable about an axis, as being uſed to raiſe or increaſe the mechanical powers applied to remove any body.

SHEBBEARE, JOHN, a political writer, was born at Bideford in Devonſhire, in the year 1709. He received the rudiments of his education at the free grammar ſchool of Exeter. It has been often obſerved, that the future life of a man may be gathered from his puerile character; and accordingly Shebbeare, while a boy at ſchool, gave the ſtrongeſt indications of his future eminence in miſanthropy and learning, by the extraordinary tenaciouſneſs of his memory and the readineſs of his wit, as well as the malignity of his diſpoſition; being univerſally regarded as a young man of ſurpriſing genius, while at the ſame time he was deſpiſed for his malicious temper.

About the age of 16, Shebbeare was bound apprentice to an eminent ſurgeon in his native town, under whom he acquired a conſiderable ſhare of medical knowledge. His talent for lampoon appeared at this early period, and he could not forbear from exerciſing it on his maſter; but the chief marks for the arrows of his wit were the gentlemen of the corporation, ſome of whom laughed at ſuch trifles, while ſuch as were irritable often commenced proſecutions againſt him, but without ſucceſs. He was frequently ſummoned to appear at the ſeſſions, for daring to ſpeak and write diſreſpectfully of the magiſtrates; but the laugh was always on the ſide of Shebbeare.

When his time was out, he ſet up for himſelf, then diſcovering a taſte for chemiſtry; ſoon after which he married an amiable young woman with no fortune, but of reſpectable connections. Failing in buſineſs at Bideford, he went to Briſtol in 1736, entering into partnerſhip with a chemiſt, and never afterwards viſited his native town.

The attention of the public was, in the year 1739, attracted by an epitaph to the memory of Thomas Coſter, Eſq. M. P. for Briſtol, in which he contrived to raiſe emotions of pity, grief, and indignation. In the following year he publiſhed a pamphlet on the Briſtol waters, after which we know little or nothing reſpecting him for a number of years. He was at Paris in 1752, where he obtained, it is ſaid, the degree of doctor in medicine, a fact, however, which many are diſpoſed to queſtion. About this time he began to emerge from obſcurity, and draw the attention of the public, by pamphlets written with ſuch virulence and celerity as it would be difficult to equal in the moſt intemperate times. In 1754 he commenced his career with a work denominated the *Marriage Act*, a political novel, in which he treated the legiſlature with ſuch freedom that he was apprehended, but ſoon after ſet at liberty.

The moſt celebrated performances, however, were a ſeries of letters to the People of England, written in a vigorous and energetic ſtyle, well calculated to make an impreſſion on common readers; and they were of courſe read with avidity, and diligently circulated. They galled the miniſtry, who at firſt were too eager to puniſh the author. When the third letter was publiſhed, warrants were iſſued by Lord Holderneſſe in March 1756, to take up both the publiſher and the author; a proſecution which appears to have been dropt. On the 12th of January 1758, the ſame nobleman ſigned a general warrant for apprehending the author, printer, and publiſhers of a wicked, audacious, and treaſonable libel, entitled, "A ſixth letter to the people of England, on the progreſs of national ruin, in which is ſhewn that the preſent grandeur of France and calamities of this nation are owing to the influence of Hanover on the councils of England;" and them having found, to ſeize and apprehend, together with their books and papers.

Government having received information that a ſeventh letter was in the preſs, all the copies were ſeized and ſuppreſſed by virtue of another warrant, dated January 23. In Eaſter term an information was filed againſt him by the attorney-general, and on the 17th of June the information was tried, when Shebbeare was found guilty; and on the 28th of November he received ſentence, by which he was fined 5l. ordered to ſtand in the pillory December 5. at Charing Croſs, to be confined three years, and to give ſecurity for his good behaviour for ſeven years, himſelf in 500l. and two others in 250l. each. During his confinement, he declared he never received as preſents more than 20 guineas from all the world.

He was detained in priſon during the whole time of the ſentence, and with ſome degree of rigour; for when his life was in danger from a bad ſtate of health, and he applied to the court of King's-bench for permiſſion to be carried into the rules a few hours in a day; though Lord Mansfield acceded to the petition, the prayer of it was denied and defeated by Judge Foſter. At the termination of the time of his ſentence, a new reign commenced; and ſhortly afterwards, during Mr Grenville's adminiſtration, a penſion of 200l. a-year was granted him by the crown, through the influence of Sir John Philips; and he ever after became devoted to the ſervice of government. He was of courſe abuſed in almoſt every periodical work, which he ſeems in general to have had the good ſenſe to neglect. Dr Smollet introduced him, in no very reſpectful light, under the name of Ferret, in Sir Launcelot Greaves; and Mr Hogarth made him one of the group in the third election print.

During the latter part of his life he ſeems to have written but little. He ſtrenuouſly ſupported the miniſtry during the American war, having publiſhed, in 1775, an anſwer to the printed ſpeech of Edmund Burke, Eſq. ſpoken in the houſe of commons, April 19. 1774, wherein he inveſtigates his knowledge of polity, legiſlature, human kind, hiſtory, commerce, and finance; his arguments are examined; the conduct of adminiſtration is boldly defended, and his talents as an orator clearly expoſed to view. An eſſay on the origin, progreſs, and eſtabliſhment of National Society; in which the principles of government, the definition of phyſical, moral, civil, and religious liberty contained in Dr Price's obſervations, &c. are examined and controverted; together with a juſtification of the legiſlature in reducing America to obedience by force.

His publications of a ſatirical, political, and medical nature, amount to 34, beſides a novel, called Filial Piety, in which hypocriſy and bluſtering courage are very properly chaſtiſed. He died on the 1ſt of Auguſt 1788, leaving behind him the character of a benevolent man among thoſe who were beſt acquainted with him; a character which, from the manner he ſpeaks of his connections, he probably deſerved.

SHEEP, in *Zoology*. See Ovis and Wool.

1
Sheep ſerve a wonderfull variety of purpoſes.

Amongſt the various animals with which Divine Providence has ſtored the world for the uſe of man, none is to be found more innocent, more uſeful, or more valuable than the ſheep. The ſheep ſupplies us with food and clothing, and finds ample employment for our poor at all times and ſeaſons of the year, whereby a variety of manufactures of woollen cloth is carried on without interruption to domeſtic comfort and loſs to friendly ſociety or injury to health, as is the caſe with many other occupations. Every lock of wool that grows on its back becomes the means of ſupport to ſtaplers, dyers, pickers, ſcourers, ſcriblers, carders, combers, ſpinners, ſpoolers, warpers, queelers, weavers, fullers, tuckers, burlers, ſhearmen, preſſers, clothiers, and packers, who, one after another, tumble and toſs, and twiſt, and bake and boil, this raw material, till they have each extracted a livelihood out of it; and then comes the merchant, who, in his turn, ſhips it (in its higheſt ſtate of improvement) to all quarters of the globe, from whence he brings back every kind of riches to his country, in return for this valuable commodity which the ſheep affords.

Beſides this, the uſeful animal, after being deprived of his coat, produces another againſt the next year; and when we are hungry, and kill him for food, he gives us his ſkin to employ the fell-mongers and parchment-makers, who ſupply us with a durable material for ſecuring our eſtates, rights, and poſſeſſions; and if our enemies take the field againſt us, ſupplies us with a powerful inſtrument for rouſing our courage to repel their attacks. When the parchment-maker has taken as much of the ſkin as he can uſe, the glue-maker comes after and picks up every morſel that is left, and therewith ſupplies a material for the carpenter and cabinet-maker, which they cannot do without, and which is eſſentially neceſſary before we can have elegant furniture in our houſes; tables, chairs, looking-glaſſes, and a hundred other articles of convenience: and when the winter nights come on, while we are deprived of the cheering light of the ſun, the ſheep ſupplies us with an artificial mode of light, whereby we preſerve every pleaſure of domeſtic ſociety, and with whoſe aſſiſtance we can continue our work, or write or read, and improve

our

our minds, or enjoy the ſocial mirth of our tables. Another part of the ſlaughtered animal ſupplies us with an ingredient neceſſary for making good common ſoap, a uſeful ſtore for producing cleanlineſs in every family, rich or poor. Neither need the horns be thrown away; for they are converted by the button-makers and turners into a cheap kind of buttons, tips for bows, and many uſeful ornaments. From the very trotters an oil is extracted uſeful for many purpoſes, and they afford good food when baked in an oven.

Even the bones are uſeful alſo; for by a late invention of Dr Higgins, they are found, when reduced to aſhes, to be an uſeful and eſſential ingredient in the compoſition of the fineſt artificial ſtone in ornamental work for chimney-pieces, cornices of rooms, houſes, &c. which renders the compoſition more durable by effectually preventing its cracking (A).

If it is objected to the meek inoffenſive creature, that he is expenſive while living, in eating up our graſs, &c. it may be anſwered that it is quite the contrary; for he can feed where every other animal has been before him and grazed all they could find; and that if he takes a little graſs on our downs or in our fields, he amply repays us for every blade of graſs in the richneſs of the manure which he leaves behind him. He protects the hands from the cold wintry blaſt, by providing them with the ſofteſt leather gloves. Every gentleman's library is alſo indebted to him for the neat binding of his books, for the ſheath of his ſword, and for caſes for his inſtruments; in ſhort, not to be tedious in mentioning the various uſes of leather, there is hardly any furniture or utenſil of life but the ſheep contributes to render either more uſeful, convenient, or ornamental.

As the ſheep is ſo valuable an animal, every piece of information concerning the proper method of managing it muſt be of importance. It will not therefore be uſeleſs or unentertaining to give ſome account of the manner of managing ſheep in Spain, a country famous for producing the beſt wool in the world.

2
Account of the Spaniſh ſheep

In Spain there are two kinds of ſheep: the coarſe-woolled ſheep, which always remain in their native country, and are houſed every night in winter; and the fine-woolled ſheep, which are always in the open air, and travel every ſummer from the cool mountains of the northern parts of Spain, to feed in winter on the ſouthern warm plains of Andaluſia, Mancha, and Eſtremadura. Of theſe latter, it appears from accurate computations, that there are about five millions (B); and that the wool and fleſh of a flock of 10,000 ſheep produced yearly about 24 reals a head, about the value of 12 Engliſh ſixpences, one of which belongs to the owner, three to the king, and the other eight are allowed for the expences of paſture, tythes, ſhepherds, dogs, ſalt, ſhearing, &c. Ten thouſand ſheep form a flock, which is divided into ten tribes, under the management of one perſon, who has abſolute dominion over fifty ſhepherds and fifty dogs.

3
Of Segovia,

Bourgoanne's Travels, vol. i. p. 53.

M. Bourgoanne, a French gentleman, who reſided many years in Spain, and directed his inquiries chiefly to the civil government, trade, and manufactures, of that country, gives the following account of the wandering ſheep of Segovia. "It is (ſays he) in the neighbouring mountains that a part of the wandering ſheep feed during the fine ſeaſon. They leave them in the month of October, paſs over thoſe which ſeparate the two Caſtiles, croſs New Caſtile, and diſperſe themſelves in the plains of Eſtramadura and Andaluſia. For ſome years paſt thoſe of the two Caſtiles, which are within reach of the Sierra-Morena, go thither to paſs the winter; which, in that part of Spain, is more mild; the length of their day's journey is in proportion to the paſture they meet with. They travel in flocks from 1000 to 1200 in number, under the conduct of two ſhepherds; one of whom is called the *Mayoral*, the other the *Zagal*. When arrived at the place of their deſtination, they are diſtributed in the paſtures previouſly aſſigned them. They return in the month of April; and whether it be habit or natural inſtinct that draws them towards the climate, which at this ſeaſon becomes moſt proper for them, the inquietude which they manifeſt might, in caſe of need, ſerve as an almanac to their conductors."

Mr Arthur Young, in that patriotic work which he conducted with great induſtry and judgment, the Annals of Agriculture, gives us a very accurate and intereſting account of the Pyrenean or Catalonian ſheep.

4
Of Catalonia. *Annals of Agriculture*, vol. viii. p. 195.

"On the northern ridge, bearing to the weſt, are the paſtures of the Spaniſh flocks. This ridge is not, however, the whole; there are two other mountains, quite in a different ſituation, and the ſheep travel from one to another as the paſturage is ſhort or plentiful. I examined the ſoil of theſe mountain paſtures, and found it in general ſtony; what in the weſt of England would be

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(A) Any curious perſon would be much entertained to ſee the manufactory of bone aſh, now (about 1794) carried on by Mr Miniſh of White-chapel, New Road, wherein the bones of ſheep and cows undergo many ingenious proceſſes. 1. There is a mill to break them; 2. A cauldron to extract their oil, marrow, and fat; 3. A reverberatory to heat them red hot; 4. An oven for thoſe bones to moulder to aſhes; 5. A ſtill to collect the fumes of the burnt bones into a brown fluid, from whence hartſhorn is made; 6. Furnaces for making parts thereof into Glauber's ſalts; 7. A ſand heat containing twelve jars, for collecting a cryſtallizing vapour into ſal-ammoniac.

(B) In the 16th century the travelling ſheep were eſtimated at ſeven millions: under Philip III. the number was diminiſhed to two millions and a half. Uſtariz, who wrote at the beginning of the 18th century, made it amount to four millions. The general opinion is, that at preſent it does not exceed five millions. If to this number the eight millions of ſtationary ſheep be added, it will make nearly thirteen millions of animals, all managed contrary to the true intereſts of Spain, for the advantage of a few individuals. For the proprietors of ſtationary flocks alſo have privileges which greatly reſemble thoſe of the members of the Meſta. According to Arriquebar Spain contains eight millions of fine-woolled ſheep, ten millions of coarſe-woolled, and five hundred thouſand bulls, oxen, and cows.

be called a *ſtone braſh*, with ſome mixture of loam, and in a few places a little peaty. The plants are many of them untouched by the ſheep: many ferns, narciſſus, violets, &c. but burnet (*poterium ſanguiſorba*) and the narrow-leaved plantain (*plantago lanceolata*) were eaten, as may be ſuppoſed, cloſe. I looked for trefoils, but found ſcarcely any: it was very apparent that ſoil and peculiarity of herbage had little to do in rendering theſe heights proper for ſheep. In the northern parts of Europe, the tops of mountains half the height of theſe (for we were above ſnow in July) are bogs, all are ſo which I have ſeen in our iſlands, or at leaſt the proportion of dry land is very trifling to that which is extremely wet: Here they are in general very dry. Now a great range of dry land, let the plants be what they may, will in every country ſuit ſheep. The flock is brought every night to one ſpot, which is ſituated at the end of the valley on the river I have mentioned, and near the port or paſſage of Picada: it is a level ſpot ſheltered from all winds. The ſoil is eight or nine inches deep of old dung, not at all incloſed: from the freedom from wood all around, it ſeems to be choſen partly for ſafety againſt wolves and bears. Near it is a very large ſtone, or rather rock, fallen from the mountain. This the ſhepherds have taken for a ſhelter, and have built a hut againſt it; their beds are ſheep ſkins, and their door ſo ſmall that they crawl in. I ſaw no place for fire; but they have it, ſince they dreſs here the fleſh of their ſheep, and in the night ſometimes keep off the bears, by whirling fire-brands: four of them belonging to the flock mentioned above lie here. I viewed their flock very carefully, and by means of our guide and interpreter, made ſome inquiries of the ſhepherds, which they anſwered readily, and very civilly. A Spaniard at Venaſque, a city in the Pyrenees, gives 600 livres French (the livre is 10½d. Engliſh) a-year for the paſturage of this flock of 2000 ſheep. In the winter he ſends them into the lower parts of Catalonia, a journey of 12 or 13 days, and when the ſnow is melted in the ſpring, they are conducted back again. They are the whole year kept in motion, and moving from ſpot to ſpot, which is owing to the great range they every where have of paſture. They are always in the open air, never houſed or under cover, and never taſte of any food but what they can find on the hills.

"Four ſhepherds, and from four to ſix large Spaniſh dogs, have the care of this flock: the latter are in France called of the *Pyrenees breed*; they are black and white, of the ſize of a large wolf, a large head and neck, armed with collars ſtuck with iron ſpikes. No wolf can ſtand againſt them; but bears are more potent adverſaries: if a bear can reach a tree, he is ſafe; he riſes on his hind legs, with his back to the tree, and ſets the dogs at defiance. In the night the ſhepherds rely entirely on their dogs; but on hearing them bark are ready with fire-arms, as the dogs rarely bark if a bear is not at hand. I was ſurpriſed to find that they are fed only with bread and milk. The head ſhepherd is paid 120 livres a-year wages and bread; the others 80 livres and bread. But they are allowed to keep goats, of which they have many which they milk every day. Their food is milk and bread, except the fleſh of ſuch ſheep or lambs as accidents give them. The head ſhepherd keeps on the mountain top, or an elevated ſpot, from whence he can the better ſee around while the flock traverſes the declivities. In doing this the ſheep are expoſed to great danger in places that are ſtony; for by walking among the rocks, and eſpecially the goats, they move the ſtones, which, rolling down the hills, acquire an accelerated force enough to knock a man down, and ſheep are often killed by them; yet we ſaw how alert they were to avoid ſuch ſtones, and cautiouſly on their guard againſt them. I examined the ſheep attentively. They are in general polled, but ſome have horns; which in the rams turn backwards behind the ears and project half a circle forward; the ewes horns turn alſo behind the ears, but do not project; the legs white or reddiſh; ſpeckled faces, ſome white, ſome reddiſh; they would weigh fat, I reckon, on an average, from 15 lb. to 18 lb. a quarter. Some tails ſhort, ſome left long. A few black ſheep among them: ſome with a very little tuft of wool on their foreheads. On the whole they reſemble thoſe on the South Downs; their legs are as ſhort as thoſe of that breed; a point which merits obſervation, as they travel ſo much and ſo well. Their ſhape is very good; round ribs and flat ſtraight backs; and would with us be reckoned handſome ſheep; all in good order and fleſh. In order to be ſtill better acquainted with them, I deſired one of the ſhepherds to catch a ram for me to feel, and examine the wool, which I found very thick and good of the carding ſort, as may be ſuppoſed. I took a ſpecimen of it, and alſo of a hoggit, or lamb of laſt year. In regard to the mellow ſoftneſs under the ſkin, which, in Mr Bakewell's opinion, is a ſtrong indication of a good breed, with a diſpoſition to fatten, he had it in a much ſuperior degree to many of our Engliſh breeds, to the full as much ſo as the South Downs, which are for that point the beſt ſhort-woolled ſheep which I know in England. The fleece was on his back, and weighed, as I gueſſed, about 8 lb. Engliſh; but the average, they ſay, of the flock is from four to five, as I calculated by reducing the Catalonian pound of 12 oz. to ours of 16, and is all ſold to the French at 30s. the lb. French. This ram had the wool of the back part of his neck tied cloſe, and the upper tuft tied a ſecond knot by way of ornament; nor do they ever ſhear this part of the fleece for that reaſon: we ſaw ſeveral in the flock with this ſpecies of decoration. They ſaid that this ram would ſell in Catalonia for 20 livres. A circumſtance which cannot be too much commended, and deſerves univerſal imitation, is the extreme docility they accuſtom them to. When I deſired the ſhepherd to catch one of his rams, I ſuppoſed he would do it with his crook, or probably not be able to do it at all; but he walked into the flock, and ſingling out a ram and a goat, bid them follow him, which they did immediately; and he talked to them while they were obeying him, holding out his hand as if to give them ſomething. By this method he brought me the ram, which I caught, and held without difficulty."

5
What ſheep produce the beſt wool.

The beſt ſort of ſheep for fine wool are thoſe bred in Herefordſhire, Devonſhire, and Worceſterſhire; but they are ſmall, and black-faced, and bear but a ſmall quantity. Warwick, Leiceſterſhire, Buckingham, and Northamptonſhire, breed a large-boned ſheep, of the beſt ſhape and deepeſt wool we have. The marſhes of Lincolnſhire breed a very large kind of ſheep, but their wool is not good, unleſs the breed be mended by bringing in ſheep of other counties among them, which is a ſcheme of late very profitably followed there. In this

this county, it is no uncommon thing to give fifty guineas for a ram, and a guinea for the admiſſion of an ewe to one of theſe valuable males, or twenty guineas for the uſe of it for a certain number of ewes during one ſeaſon. Suffolk alſo breeds a very valuable kind of ſheep. The northern counties in general breed ſheep with long but hairy wool: however, the wool which is taken from the neck and ſhoulders of the Yorkſhire ſheep is uſed for mixing with Spaniſh wool in ſome of their fineſt cloths.

Wales produces a ſmall hardy kind of ſheep, which has the beſt taſted fleſh, but the worſt wool of all. Nevertheleſs it is of more extenſive uſe than the fineſt Segovian fleeces; for the benefit of the flannel manufacture is univerſally known. The ſheep of Ireland vary like thoſe of Great Britain; thoſe of the ſouth and eaſt being large and their fleſh rank: thoſe of the north and the mountainous parts ſmall and their fleſh ſweet. The fleeces in the ſame manner differ in degrees of value. Scotland breeds a ſmall kind, and their fleeces are coarſe.

But the new Leiceſterſhire breed is the moſt faſhionable, and of courſe the moſt profitable breed in the iſland. Joſeph Altom of Clifton, who raiſed himſelf from a plough-boy, was the firſt who diſtinguiſhed himſelf in the midland counties of England for a ſuperior breed of ſheep. How he improved his breed is not known; but it was cuſtomary for eminent farmers in his time to go to Clifton in ſummer to chooſe and purchaſe ram-lambs, for which they paid two or three guineas. This man was ſucceeded by Mr Bakewell; and it may reaſonably be ſuppoſed that the breed, by means of Altom's ſtock, had paſſed the firſt ſtage of improvement before Mr Bakewell's time. Still, however, it muſt be acknowledged, that the Leiceſterſhire breed of ſheep owes its preſent high ſtate of improvement to the ability and care of Mr Bakewell.

6 Account of Mr Bakewell's breed. *Marſhall's Midland Counties,* vol. i. p. 382.

“The manner in which Mr Bakewell raiſed his ſheep to the degree of celebrity in which they deſervedly ſtand, is, notwithſtanding the recentneſs of the improvement, and its being done in the day of thouſands now living, a thing in diſpute; even among men high in the profeſſion, and living in the very diſtrict in which the improvement has been carried on!

7 How it is ſuppoſed he improved it.

“Some are of opinion that he effected it by a croſs with the Wiltſhire breed; an improbable idea, as their form altogether contradicts it: others, that the Ryeland breed were uſed for this purpoſe; and with ſome ſhow of probability. If any croſs whatever was uſed the Ryeland breed, whether we view the form, the ſize, the wool, the fleſh, or the fatting quality, is the moſt probable inſtrument of improvement.

“Theſe ideas, however, are regiſtered merely as matters of opinion. It is more than probable that Mr Bakewell alone is in poſſeſſion of the ſeveral minutiæ of improvement; and the public can only hope that at a proper time the facts may be communicated for the direction of future improvers.

“Whenever this ſhall take place, it will moſt probably come out that no croſs with any alien breed whatever has been uſed; but that the improvement has been effected by ſelecting individuals from kindred breeds; from the ſeveral breeds or varieties of long-woolled ſheep, with which Mr Bakewell was ſurrounded on almoſt every ſide, and by breeding, *inandin* (c), with this ſelection: ſolicitouſly ſeizing the ſuperior accidental varieties produced; aſſociating theſe varieties; and ſtill continuing to ſelect, with judgment, the ſuperior individuals.

8 Deſcrip of his e and we ders.

“It now remains to give a deſcription of the ſuperior claſs of individuals of this breed, eſpecially ewes and wedders, in full condition, but not immoderately fat. The rams will require to be diſtinguiſhed afterwards.

“The head is long, ſmall, and hornleſs, with ears ſomewhat long, and ſtanding backward, and with the noſe ſhooting forward. The neck thin, and clean toward the head; but taking a conical form; ſtanding low, and enlarging every way at the baſe; the fore-end altogether ſhort. The boſom broad, with the ſhoulders, ribs, and chine extraordinary full. The loin broad, and the back level. The haunches comparatively full toward the hips, but light downward; being altogether ſmall in proportion to the fore-parts. The legs, at preſent, of a moderate length; with the bone extremely fine. The bone throughout remarkably light. The carcaſe, when fully fat, takes a remarkable form; much wider than it is deep, and almoſt as broad as it is long. Full on the ſhoulder, wideſt on the ribs, narrowing with a regular curve towards the tail; approaching the form of the turtle nearer perhaps than any other animal. The pelt is thin, and the tail ſmall. The wool is ſhorter than long wools in general, but much longer than the middle wools; the ordinary length of ſtaple five to ſeven inches, varying much in fineneſs and weight.”

9 Fatten markab well.

This breed ſurpaſſes every other in beauty of form; they are full and weighty in the fore quarters; and are remarkable for ſmallneſs of bone. Mr Marſhall, who has been of ſo much benefit to agriculture and his country by his publications, informs us, in his Rural Economy of the Midland Counties, that he has ſeen a rib of a ſheep of this breed contraſted with one of a Norfolk ſheep: the diſparity was ſtriking; the latter nearly twice the ſize; while the meat which covered the former was three times the thickneſs: conſequently the proportion of meat to bone was in the one incomparably greater than in the other. Therefore, in this point of view, the improved breed has a decided preference: for ſurely while mankind continue to eat fleſh and throw away bone, the former muſt be, to the conſumer at leaſt, the more valuable.

The criterions of good and bad fleſh while the animal is alive differ in different ſpecies, and are not properly ſettled in the ſame ſpecies. One ſuperior breeder is of opinion, that if the fleſh is not looſe, it is of courſe good; holding, that the fleſh of ſheep is never found in a ſtate of hardneſs, like that of ill-fleſhed cattle: while others make a fourfold diſtinction of the fleſh of ſheep; as looſeneſs, mellowneſs, firmneſs, hardneſs: conſidering the firſt and the laſt equally exceptionable, and the ſecond and third equally deſirable; a happy mixture of the two being deemed the point of perfection.

(c) *Inandin* is a term uſed in the midland counties of England to expreſs breeding from the ſame family

FIRST RATE SHIP OF WAR WITH RIGGING &c AT ANCHOR.

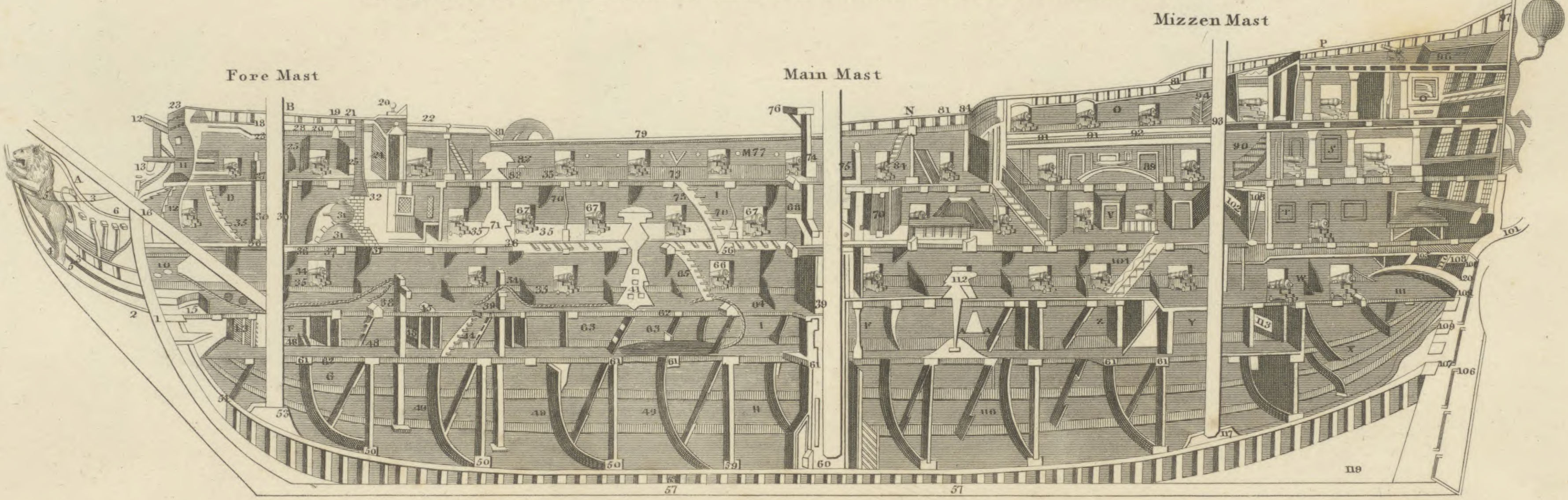
Engd by W&D Lizars Edinr

SHIP. PLATE CCCCLXXXI.

Fig. 3. Fig. 4. Fig. 5.

Fig. 2.

THE SECTION OF A FIRST RATE SHIP OF WAR, SHEWING ITS VARIOUS TIMBERS AND APARTMENTS.



Engraved by W. & D. Lizars Edin.r

SHIP. *PLATE CCCCLXXXII.*

Fig. 8.

Fig 7.

Fig. 6.

Fig. 10.

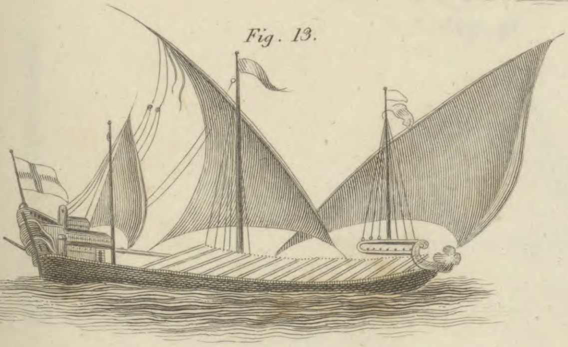
Fig. 12.

Fig. 9.

Fig. 14.

Fig. 11.

Fig. 13.



E. Mitchell Sculp.^t

Machine for drawing SHIP BOLTS. PLATE CCCCLXXXIII.

Fig. 1.

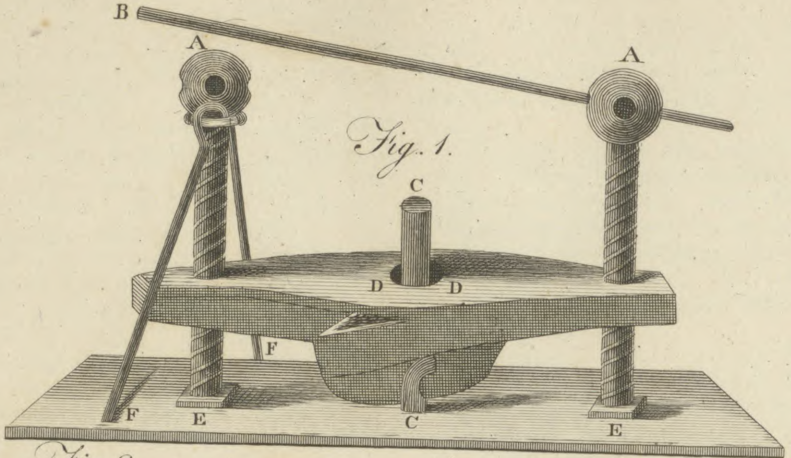


Fig. 2.

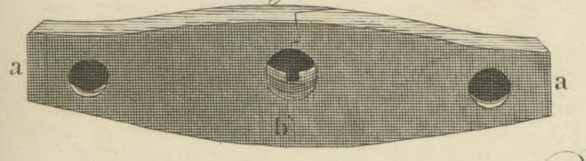


Fig. 3.

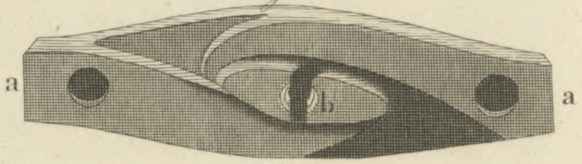


Fig. 4.

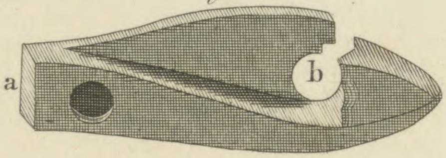


Fig. 5.

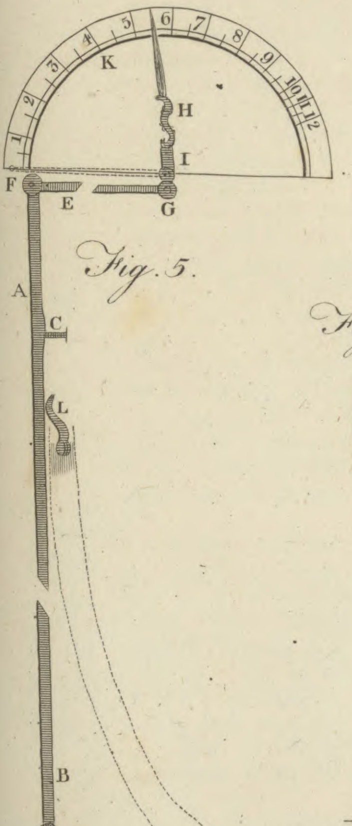


Fig. 6.

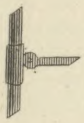


Fig. 7.

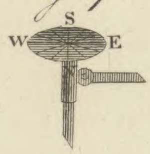


Fig. 8.

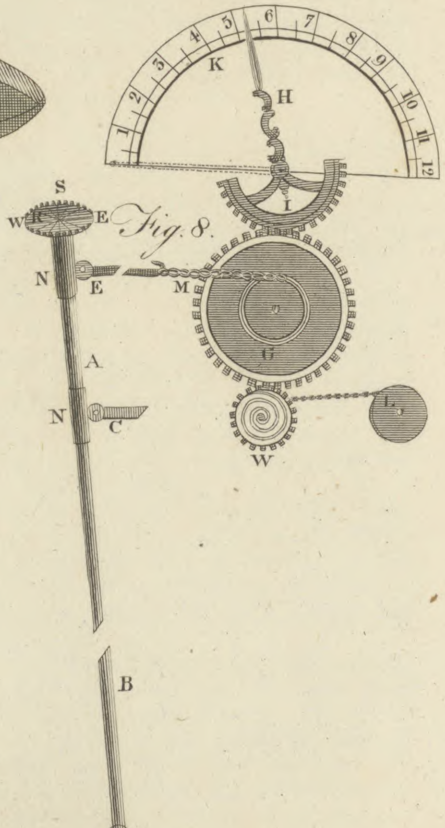
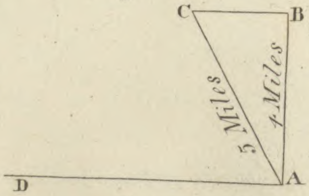


Fig. 9.



E.Mitchell Sculpt.

The fleſh of ſheep, when ſlaughtered, is well known to be of various qualities. Some is compoſed of large coarſe grains, interſperſed with wide empty pores like a ſponge: others, of large grains, with wide pores filled with fat; others, of fine cloſe grains, with ſmaller pores filled with fat: and a fourth, of cloſe grains, without any intermixture of fatneſs.

The fleſh of ſheep, when dreſſed, is equally well known to poſſeſs a variety of qualities: ſome mutton is coarſe, dry, and inſipid; a dry ſponge, affording little or no gravy of any colour. Another ſort is ſomewhat firmer, imparting a light-coloured gravy only. A third plump, ſhort, and palatable; affording a mixture of white and red gravy. A fourth likewiſe plump and well-flavoured, but diſcharging red gravy, and this in various quantities.

It is likewiſe obſervable, that ſome mutton, when dreſſed, appears covered with a thick, tough, parchment-like integument; others with a membrane comparatively fine and flexible. But theſe, and ſome of the other qualities of mutton, may not be wholly owing to breed, but in part to the age and the ſtate of fatneſs at the time of ſlaughter. Examined in this light, whether we conſider the degree of fatneſs, or their natural propenſity to a ſtate of fatneſs, even at an early age, the improved breed of Leiceſterſhire ſheep appears with many ſuperior advantages.

Midland Counties, vol. i. p. 398.

The degree of fatneſs to which the individuals of this breed are capable of being raiſed, will perhaps appear incredible to thoſe who have not had an opportunity of being convinced by their own obſervation. "I have ſeen wedders (ſays Mr Marſhall) of only two ſhear (two or three years old) ſo loaded with fat as to be ſcarcely able to make a run; and whoſe fat lay ſo much without the bone, it ſeemed ready to be ſhaken from the ribs on the ſmalleſt agitation.

"It is common for the ſheep of this breed to have ſuch a projection of fat upon the ribs, immediately behind the ſhoulder, that it may be eaſily gathered up in the hand, as the flank of a fat bullock. Hence it has gained, in technical language, the name of the *fore-flank;* a point which a modern breeder never fails to touch in judging of the quality of this breed of ſheep.

"What is, perhaps, ſtill more extraordinary, it is not rare for the rams, at leaſt of this breed, to be 'cracked on the back;' that is, to be cloven along the top of the chine, in the manner fat ſheep generally are upon the rump. This mark is conſidered as an evidence of the beſt blood.

"Extraordinary, however, as are theſe appearances while the animals are living, the facts are ſtill more ſtriking after they are ſlaughtered. At Litchfield, in February 1785, I ſaw a fore quarter of mutton, fatted by Mr Prineep of Croxall, and which meaſured upon the ribs four inches of fat. It muſt be acknowledged, however, that the Leiceſterſhire breed do not produce ſo much wool as moſt other long-woolled ſheep."

As the practice of letting rams by the ſeaſon is now become profitable, it may be uſeful to mention the method of rearing them.

10 How the rams are reared.

"The principal ram-breeders ſave annually twenty, thirty, or perhaps forty ram lambs; caſtration being ſeldom applied, in the firſt inſtance, to the produce of a valuable ram, for in the choice of theſe lambs they are led more by blood or parentage, than by form; on which, at an early age, little dependence can be placed. Their treatment from the time they are weaned, in July or Auguſt, until the time of ſhearing, the firſt week in June, conſiſts in giving them every indulgence of keep, in order to puſh them forward for the ſhow; it being the common practice to let ſuch as are fit to be let the firſt ſeaſon, while they are yet yearlings—provincially 'ſharhogs.'

"Their firſt paſture, after weaning, is pretty generally, I believe, clover that has been mown early, and has got a ſecond time into head; the heads of clover being conſidered as a moſt forcing food of ſheep. After this goes off, turnips, cabbages, colewort, with hay, and (report ſays) with corn. But the uſe of this the breeders ſeverally deny, though collectively they may be liable to the charge.

"Be this as it may, ſomething conſiderable depends on the *art of making up*, not lambs only, but rams of all ages. Fat, like charity, covers a multitude of faults; and beſides, is the beſt evidence of their fatting quality which their owners can produce (*i. e.* their natural propenſity to a ſtate of fatneſs), while in the fatneſs of the ſharhogs is ſeen their degree of inclination to fat at an early age.

"Fatting quality being the one thing needful in grazing ſtock, and being found, in ſome conſiderable degree at leaſt, to be hereditary, the fatteſt rams are of courſe the beſt; though other attachments, well or ill placed, as to form or faſhionable points, will perhaps have equal or greater weight in the minds of ſome men, even in this enlightened age. Such ſhearlings as will not make up ſufficiently as to form and fatneſs, are either kept on to another year to give them a fair chance, or are caſtrated, or butchered while ſharhogs."

11 What ſums Mr Bakewell received for letting them.

From the firſt letting, about 40 years ago, to the year 1780, the prices kept gradually riſing from fifteen ſhillings to a guinea, and from one to ten. In 1780 Mr Bakewell let ſeveral at ten guineas each; and, what is rather inexplicable, Mr Parkinſon of Quarndon let one the ſame year for twenty-five guineas; a price which then aſtoniſhed the whole country.

From that time to 1786 Mr Bakewell's ſtock roſe rapidly from ten to a hundred guineas; and that year he let two thirds of one ram (reſerving one third of the uſual number of ewes to himſelf) to two principal breeders, for a hundred guineas each, the entire ſervices of the ram being rated at three hundred guineas! Mr Bakewell making that year, by letting twenty rams only, more than a thouſand pounds!

Since that time the prices have been ſtill riſing. Four hundred guineas have been repeatedly given. Mr Bakewell, this year (1789) makes, ſays Mr Marſhall, twelve hundred guineas by three rams (brothers, we believe); two thouſand of ſeven; and, of his whole letting, full three thouſand guineas!

Beſide this extraordinary ſum made by Mr Bakewell, there are ſix or ſeven other breeders who make from five hundred to a thouſand guineas each. The whole amount of moneys produced that year in the midland counties, by letting rams of the modern breed for one ſeaſon only, is eſtimated, by thoſe who are adequate to the ſubject, at the almoſt incredible ſum of ten thouſand pounds.

Rams previous to the ſeaſon are reduced from the cumbrous fat ſtate in which they are ſhown. The uſual

12 The treatment of the rams and choice of the ewes.

time of ſending them out is the middle of September. They are conveyed in carriages of two wheels with ſprings, or hung in ſlings, 20 or 30 miles a-day, ſometimes to the diſtance of 200 or 300 miles. They are not turned looſe among the ewes, but kept apart in a ſmall incloſure, where a couple of ewes only are admitted at once. When the ſeaſon is over, every care is taken to make the rams look as fat and handſome as poſſible.

In the choice of ewes the breeder is led by the ſame criterions as in the choice of rams. Breed is the firſt object of conſideration. Excellency, in any ſpecies or variety of live-ſtock, cannot be attained with any degree of certainty, let the male be ever ſo excellent, unleſs the females employed likewiſe inherit a large proportion of the genuine blood, be the ſpecies or variety what it may. Hence no prudent man ventures to give the higher prices for the Diſhley rams, unleſs his ewes are deeply tinctured with the Diſhley blood. Next to breed is fleſh, fat, form, and wool.

After the lambs are weaned, the ewes are kept in common feeding places, without any alteration of paſture, previous to their taking the ram. In winter they are kept on graſs, hay, turnips, and cabbages. As the heads of the modern breed are much finer than moſt others, the ewes lamb with leſs difficulty.

The female lambs, on being weaned, are put to good keep, but have not ſuch high indulgence ſhown them as the males, the prevailing practice being to keep them from the ram the firſt autumn.

At weaning time, or previouſly to the admiſſion of the ram, the ewes are culled, to make room for the thaves or ſhearlings, whoſe ſuperior blood and faſhion intitle them to a place in the breeding flock. In the work of culling, the ram breeder and the mere grazier go by ſomewhat different guides. The grazier's guide is principally age, ſeldom giving his ewes the ram after they are four ſhear. The ram-breeder, on the contrary, goes chiefly by merit; an ewe that has brought him a good ram or two is continued in the flock ſo long as ſhe will breed. There are inſtances of ewes having been prolific to the tenth or twelfth year; but in general the ewes of this breed go off at ſix or ſeven ſhear.

In the practice of ſome of the principal ram-breeders, the culling ewes are never ſuffered to go out of their hands until after they are ſlaughtered, the breeders not only fatting them, but having them butchered, on their premiſes. There are others, however, who ſell them; and ſometimes at extraordinary prices. Three, four, and even ſo high as ten guineas each, have been given for theſe outcaſts.

There are in the flocks of ſeveral breeders ewes that would fetch at auction twenty guineas each. Mr Bakewell is in poſſeſſion of ewes which, if they were now put up to be ſold to the beſt bidder, would, it is eſtimated, fetch no leſs than fifty each, and perhaps, through the preſent ſpirit of contention, much higher prices.

13 Inſtructions for purchaſing ſheep.

The following inſtructions for purchaſing ſheep, we hope, will be acceptable to our country readers.—The farmer ſhould always buy his ſheep from a worſe land than his own, and they ſhould be big-boned, and have a long greaſy wool, curling cloſe and well. Theſe ſheep always breed the fineſt wool, and are alſo the moſt approved of by the butcher for ſale in the market. For the choice of ſheep to breed, the ram muſt be young, and his ſkin of the ſame colour with his wool, for the lambs will be of the ſame colour with his ſkin. He ſhould have a large long body; a broad forehead, round, and well-riſing; large eyes; and ſtraight and ſhort noſtrils. The polled ſheep, that is, thoſe which have no horns, are found to be the beſt breeders. The ewe ſhould have a broad back; a large bending neck; ſmall, but ſhort, clean, and nimble legs; and a thick, deep wool covering her all over.

To know whether they be ſound or not, the farmer ſhould examine the wool that none of it be wanting, and ſee that the gums be red, the teeth white and even, and the briſket-ſkin red, the wool firm, the breath ſweet, and the feet not hot. Two years old is the beſt time for beginning to breed; and their firſt lambs ſhould not be kept too long, to weaken them by ſuckling, but be ſold as ſoon as conveniently may be. They will breed advantageouſly till they are ſeven years old. The farmers have a method of knowing the age of a ſheep, as a horſe's is known, by the mouth. When a ſheep is one ſhear, as they expreſs it, it has two broad teeth before; when it is two ſhear, it will have four; when three, ſix; and when four, eight. After this their mouths begin to break.

The difference of land makes a very great difference in the ſheep. The fat paſtures breed ſtraight tall ſheep, and the barren hills and downs breed ſquare ſhort ones; woods and mountains breed tall and ſlender ſheep; but the beſt of all are thoſe bred upon new-ploughed land and dry grounds. On the contrary, all wet and moiſt lands are bad for ſheep, eſpecially ſuch as are ſubject to be overflowed, and to have ſand and dirt left on them. The ſalt marſhes are, however, an exception to this general rule, for their ſaltneſs makes amends for their moiſture; ſalt, by reaſon of its drying quality, being of great advantage to ſheep.

14 When rams ought to be admitted to the ewes.

As to the time of putting the rams to the ewes, the farmer muſt conſider at what time of the ſpring his graſs will be fit to maintain them and their lambs, and whether he has turnips to do it till the graſs comes; for very often both the ewes and lambs are deſtroyed by the want of food; or if this does not happen, if the lambs are only ſtinted in their growth by it, it is an accident that they never recover. The ewe goes 20 weeks with lamb, and according to this it is eaſy to calculate the proper time. The beſt time for them to yean is in April, unleſs the owner has very forward graſs or turnips, or the ſheep are field ſheep. Where you have not incloſures to keep them in, then it may be proper they ſhould yean in January, that the lambs may be ſtrong by May day, and be able to follow the dam over the fallows and water-furrows; but then the lambs that come ſo early muſt have a great deal of care taken of them, and ſo indeed ſhould all other lambs at their firſt falling, elſe while they are weak the crows and magpies will pick their eyes out.

When the ſheep are turned into fields of wheat or rye to feed, it muſt not be too rank at firſt, for if it be, it generally throws them into ſcourings. Ewes that are big ſhould be kept but bare, for it is very dangerous to them to be fat at the time of their bringing forth their young. They may be well fed, indeed, like cows, a fortnight beforehand, to put them in heart. Mortimer's Huſbandry, p. 243.

The feeding ſheep with turnips is one great advantage to the farmers. When they are made to eat turnips they ſoon fatten, but there is ſome difficulty in bringing this about. The old ones always refuſe them at firſt, and will ſometimes faſt three or four days, till almoſt famiſhed; but the young lambs fall to at once. The common way, in ſome places, of turning a flock of ſheep at large into a field of turnips, is very diſadvantageous, for they will thus deſtroy as many in a fortnight as would keep them a whole winter. There are three other ways of feeding them on this food, all of which have their ſeveral advantages.

15 The firſt way of feeding ſheep with turnips. The firſt way is to divide the land by hurdles, and allow the ſheep to come upon ſuch a portion only at a time as they can eat in one day, and ſo advance the hurdles farther into the ground daily till all be eaten. This is infinitely better than the former random method; but they never eat them clean even this way, but leave the bottoms and outſides ſcooped in the ground: the people pull up theſe indeed with iron crooks, and lay them before the ſheep again, but they are commonly ſo fouled with the creature's dung and urine, and with the dirt from their feet, that they do not care for them; they eat but little of them, and what they do eat does not nouriſh them like the freſh roots.

16 The ſecond. The ſecond way is by incloſing the ſheep in hurdles, as in the former; but in this they pull up all the turnips which they ſuppoſe the ſheep can eat in one day, and daily remove the hurdles over the ground whence they have pulled up the turnips: by this means there is no waſte, and leſs expence, for a perſon may in two hours pull up all thoſe turnips; the remaining ſhells of which would have employed three or four labourers a-day to get up with their crooks out of the ground trodden hard by the feet of the ſheep; and the worſt is, that as in the method of pulling up firſt, the turnips are eaten up clean, in this way, by the hook, they are waſted, the ſheep do not eat any great part of them, and when the ground comes to be tilled afterwards for a crop of corn, the fragments of the turnips are ſeen in ſuch quantities on the ſurface, that half the crop at leaſt ſeems to have been waſted.

17 The third, which is the beſt. The third manner is to pull up the turnips, and remove them in a cart or waggon to ſome other place, ſpreading them on a freſh place every day; by this method the ſheep will eat them up clean, both root and leaves. The great advantage of this methed is, when there is a piece of land not far off which wants dung more than that where the turnips grow, which perhaps is alſo too wet for the ſheep in winter, and then the turnips will, by the too great moiſture and dirt of the ſoil, ſometimes ſpoil the ſheep, and give them the rot. Yet ſuch ground will often bring forth more and larger turnips than dry land, and when they are carried off, and eaten by the ſheep on ploughed land, in dry weather, and on green ſward in wet weather, the ſheep will ſucceed much better; and the moiſt ſoil where the turnips grew not being trodden by the ſheep, will be much fitter for a crop of corn than if they had been fed with turnips on it. The expence of hurdles, and the trouble of moving them, are ſaved in this caſe, which will counterbalance at leaſt the expence of pulling the turnips and carrying them to the places where they are to be eaten. They muſt always be carried off for oxen.

18 Diſeaſes of ſheep. The diſeaſes to which ſheep are ſubject are theſe, rot, red-water, foot-rot and hoving, ſcab, dunt, rickets, fly-ſtruck, flux, and burſting. Of each of theſe we ſhall give the beſt deſcription in our power, with the moſt approved remedies.

19 The rot. The *rot*, which is a very pernicious diſeaſe, has of late engaged the attention of ſcientific farmers. But neither its nature nor its cauſe has yet been fully aſcertained. Some valuable and judicious obſervations have, however, been made upon it, which ought to be circulated, as they may perhaps, in many caſes, furniſh an antidote for this malignant diſtemper, or be the means of leading others to ſome more efficacious remedy. Some have ſuppoſed the rot owing to the quick growth of graſs or herbs that grow in wet places. Without premiſing, that all bounteous Providence has given to every animal its peculiar taſte, by which it diſtinguiſhes the food proper for its preſervation and ſupport, if not vitiated by fortuitous circumſtances, it ſeems very difficult to diſcover on philoſophical principles why the quick growth of graſs ſhould render it noxious, or why any herb ſhould at one ſeaſon produce fatal effects, by the admiſſion of pure water only into its component parts, which at other times is perfectly innocent, although brought to its utmoſt ſtrength and maturity by the genial influence of the ſun. Beſides, the conſtant practice of moſt farmers in the kingdom, who with the greateſt ſecurity feed their meadows in the ſpring, when the graſs ſhoots quick and is full of juices, militates directly againſt this opinion.

Mr Arthur Young aſcribes this diſeaſe to moiſture. In confirmation of this opinion, which has been generally adopted, we are informed, in the Bath Society papers*, by a correſpondent, that there was a paddock adjoining to his park which had for ſeveral years cauſed the rot in moſt of the ſheep which were put into it. In 1769 he drained it, and from that time his ſheep were free from this malady. But there are facts which render it doubtful that moiſture is the ſole cauſe. We are told, the dry limed land in Derbyſhire will produce the rot as well as water meadows and ſtagnant marſhes; and that in ſome wet grounds ſheep ſuſtain no injury for many weeks.

20 Its cauſe. Without attempting to enumerate other hypotheſes which the ingenious have formed on this ſubject, we ſhall purſue a different method in order to diſcover the cauſe. On diſſecting ſheep that die of this diſorder, a great number of inſects called *flukes* (ſee FASCIOLA) are found in the liver. That theſe flukes are the cauſe of the rot, therefore, is evident; but to explain how they come into the liver is not ſo eaſy. It is probable that they are ſwallowed by the ſheep along with their food while in the egg ſtate. The eggs depoſited in the tender germ are conveyed with the food into the ſtomach and inteſtines of the animals, whence they are received into the lacteal veſſels, carried off in the chyle, and paſs into the blood; nor do they meet with any obſtruction until they arrive at the capillary veſſels of the liver. Here, as the blood filtrates through the extreme branches, anſwering to thoſe of the *vena porta* in the human body, the ſecerning veſſels are too minute to admit the impregnated ova, which, adhering to the membrane, produce thoſe animalculæ that feed upon the liver and deſtroy the ſheep. They much reſemble the flat fiſh called plaice, are ſometimes as large as a ſilver two-pence, and are found both in the liver and in

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* Vol. I. art. xlvi.

the pipe (anſwering to that of the *vena cava*) which conveys the blood from the liver to the heart.

The common and moſt obvious objection to that opinion is, that this inſect is never found but in the liver, or in ſome parts of the viſcera, of ſheep that are diſeaſed more or leſs; and that they muſt therefore be bred there. But this objection will loſe its force, when we conſider that many inſects undergo ſeveral changes, and exiſt under forms extremely different from each other. Some of them may therefore appear and be well known under one ſhape, and not known to be the ſame under a ſecond or third. The fluke may be the laſt ſtate of ſome aquatic animal which we at preſent very well know under one or other of its previous forms.

If this be admitted, it is eaſy to conceive that ſheep may, on wet ground eſpecially, take multitudes of theſe ova or eggs in with their food; and that the ſtomach and viſcera of the ſheep being a proper nidus for them, they of courſe hatch, and appearing in their fluke or laſt ſtate, feed on the liver of the animal, and occaſion this diſorder.

It is a ſingular fact, "that no ewe ever has the rot while ſhe has a lamb by her ſide." The reaſon of this may be, that the impregnated ovum paſſes into the milk, and never arrives at the liver. The rot is fatal to ſheep, hares, and rabbits; and ſometimes to calves; but never infeſts animals of a larger ſize.

21 and moſt approved cures.

Miller ſays that parſley is a good remedy for the rot in ſheep. Perhaps a ſtrong decoction of this plant, or the oil extracted from its ſeeds, might be of ſervice. Salt is alſo a uſeful remedy. It ſeems to be an acknowledged fact, that ſalt marſhes never produce the rot. Salt indeed is pernicious to moſt inſects. Common ſalt and water expel worms from the human body; and ſea-weed, if laid in a garden, will drive away inſects; but if the ſalt is ſeparated by ſteeping it in the pureſt ſpring-water for a few days, it abounds with animalculæ of various ſpecies.

Liſle, in his book of huſbandry, informs us of a farmer who cured his whole flock of the rot by giving each ſheep a handful of Spaniſh ſalt for five or ſix mornings ſucceſſively. The hint was probably taken from the Spaniards, who frequently give their ſheep ſalt to keep them healthy. On ſome farms perhaps the utmoſt caution cannot always prevent this diſorder. In wet and warm ſeaſons the prudent farmer will remove his ſheep from the lands liable to rot. Thoſe who have it not in their power to do this may give each ſheep a ſpoonful of common ſalt, with the ſame quantity of flour, in a quarter of a pint of water, once or twice a-week. At the commencement of the rot the ſame remedy given four or five mornings ſucceſſively will in all probability effect a cure. The addition of the flour and water, it is ſuppoſed, not only abates the pungency of the ſalt, but diſpoſes it to mix with the chyle in a more gentle and efficacious manner.

A farmer of a conſiderable lordſhip in Bohemia viſiting the hot-wells of Carlſbad, related how he preſerved his flocks of ſheep from the mortal diſtemper which raged in the wet year 1760, of which ſo many periſhed. His preſervative was very ſimple and very cheap: "He fed them every night, when turned under a ſhed, cover, or ſtables, with haſhed fodder ſtraw; and, by eating it greedily, they all eſcaped."

22 Red water.

"*Red water* is a diſorder moſt prevalent on wet grounds. I have heard (ſays Mr Arthur Young) that it has ſometimes been cured by tapping, as for a dropſy. This operation is done on one ſide of the belly towards the flank, juſt below the wool.

23 Foot-rot.

"The *foot-rot* and *hoving*, which is very common on low fenny grounds, is cured by keeping the part clean, and lying at reſt in a dry paſture."

24 Scab.

The *ſcab* is a cutaneous diſeaſe owing to an impurity of the blood, and is moſt prevalent in wet lands or in rainy ſeaſons. It is cured by tobacco-water, brimſtone, and alum, boiled together, and then rubbed over the ſheep. If only partial, tar and greaſe may be ſufficient. But the ſimpleſt and moſt efficacious remedy for this diſeaſe was communicated to the Society for the Encouragement of Arts, &c. by Sir Joſeph Banks.

25 Remedy recommended by Sir Joſeph Banks.

"Take one pound of quickſilver, half a pound of Venice turpentine, half a pint of oil of turpentine, and four pounds of hogs lard (c). Let them be rubbed in a mortar till the quickſilver is thoroughly incorporated with the other ingredients; for the proper mode of doing which, it may be proper to take the advice, or even the aſſiſtance, of ſome apothecary or other perſon uſed to make ſuch mixtures.

"The method of uſing the ointment is this: Beginning at the head of the ſheep, and proceeding from between the ears along the back to the end of the tail, the wool is to be divided in a furrow till the ſkin can be touched; and as the furrow is made, the finger ſlightly dipped in the ointment is to be drawn along the bottom of it, where it will leave a blue ſtain on the ſkin and adjoining wool: from this furrow ſimilar ones muſt be drawn down the ſhoulders and thighs to the legs, as far as they are woolly; and if the animal is much infected, two more ſhould be drawn along each ſide parallel to that on the back, and one down each ſide between the fore and hind legs.

"Immediately after being dreſſed, it is uſual to turn the ſheep among other ſtock, without any fear of the infection being communicated; and there is ſcarcely an inſtance of a ſheep ſuffering any injury from the application. In a few days the blotches dry up, the itching ceaſes, and the animal is completely cured: it is generally, however, thought proper not to delay the operation beyond Michaelmas.

"The *hippoboſca ovina*, called in Lincolnſhire *ſheep fagg*, an animal well known to all ſhepherds, which lives among the wool, and is hurtful to the thriving of ſheep, both by the pain its bite occaſions and the blood it ſucks, is deſtroyed by this application, and the wool is not at all injured. Our wool-buyers purchaſe the fleeces on which the ſtain of the ointment is viſible, rather in preference to others, from an opinion that the uſe of it

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(c) By ſome unaccountable miſtake the laſt ingredient, the four pounds of hogs lard, is omitted in the receipt publiſhed in the Tranſactions of the Society; a circumſtance that might be productive of bad effects.—The leaf which contained the receipt has ſince been cancelled, and a new one printed.

it having preſerved the animal from being vexed either with the ſcab or faggs, the wool is leſs liable to the defects of joints or knots; a fault obſerved to proceed from every ſudden ſtop in the thriving of the animal, either from want of food or from diſeaſe.

“ This mode of curing was brought into that part of Lincolnſhire where my property is ſituated about 12 years ago, by Mr Stephenſon of Mareham, and is now ſo generally received, that the ſcab, which uſed to be the terror of the farmers, and which frequently deterred the more careful of them from taking the advantage of paſturing their ſheep in the fertile and extenſive commons with which that diſtrict abounds, is no longer regarded with any apprehenſion: by far the moſt of them have their flock anointed in autumn, when they return from the common, whether they ſhow any ſymptoms of ſcab or not; and having done ſo, conclude them ſafe for ſome time from either giving or receiving infection. There are people who employ themſelves in the buſineſs, and contract to anoint our large ſheep at five ſhillings a ſcore, inſuring for that price the ſucceſs of the operation; that is, agreeing, in caſe many of the ſheep break out afreſh, to repeat the operation gratis even ſome months afterwards.”

26 he dunt. The *dunt* is a diſtemper cauſed by a bladder of water gathering in the head. No cure for this has yet been diſcovered.

27 ickets. The *rickets* is a hereditary diſeaſe for which no antidote is known. The firſt ſymptom is a kind of lightheadedneſs, which makes the affected ſheep appear wilder than uſual when the ſhepherd or any perſon approaches him. He bounces up ſuddenly from his lair, and runs to a diſtance, as though he were purſued by dogs. In the ſecond ſtage the principal ſymptom is the ſheep's rubbing himſelf againſt trees, &c. with ſuch fury as to pull off his wool and tear away his fleſh. “ The diſtreſſed animal has now a violent itching in his ſkin, the effect of a highly inflamed blood; but it does not appear that there is ever any cutaneous eruption or ſalutary critical diſcharge. In ſhort, from all circumſtances, the fever appears now to be at its height.”— The laſt ſtage of this diſeaſe “ ſeems only to be the progreſs of diſſolution, after an unfavourable criſis. The poor animal, as condemned by Nature, appears ſtupid, walks irregularly (whence probably the name *rickets*), generally lies, and eats little: theſe ſymptoms increaſe in degree till death, which follows a general conſumption, as appears upon diſſection of the carcaſe; the juices and even ſolids having ſuffered a general diſſolution.

In order to diſcover the ſeat and nature of this diſeaſe, ſheep that die of it ought to be diſſected. This is ſaid to have been done by one gentleman, Mr Beal; and he found in the brain or membranes adjoining a maggot about a quarter of an inch long, and of a browniſh colour. A few experiments might eaſily determine this fact.

28 ly-ſtruck. The *fly-ſtruck* is cured by clipping the wool off as far as infected, and rubbing the parts dry with lime or wood-aſhes; curriers oil will heal the wounds, and prevent their being ſtruck any more; or they may be cured with care, without clipping, with oil of turpentine, which will kill all the vermin where it goes; but the former is the ſureſt way.

29 Flux. The *flux* is another diſeaſe to which ſheep are ſubject. The beſt remedy is ſaid to be, to houſe the ſheep immediately when this diſtemper appears, to keep them very warm, and feed them on dry hay, giving them frequent glyſters of warm milk and water. The cauſe of that diſtemper is either their feeding on wet lands, or on graſs that is become moſſy by the lands having been fed many years without being ploughed. When the farmer perceives his ſheep-walks to become moſſy, or to produce bad graſs, he ſhould either plough or manure with hot lime, making kilns either very near or in the ſheep-walks, becauſe the hotter the lime is put on, the ſweeter the graſs comes up, and that early in the year.

30 And burſting. *Burſting*, or as it is called in ſome places the *blaſt*, attacks ſheep when driven into freſh graſs or young clover. They overeat themſelves, foam at the mouth, ſwell exceedingly, breathe very quick and ſhort, then jump up, and inſtantly fall down dead. In this caſe, the only chance of ſaving their life is by ſtabbing them in the maw with an inſtrument made for the purpoſe. The inſtrument is a hollow tube, with a pointed weapon paſſing through it. A hole is made with the pointed weapon; which is immediately withdrawn, and the hole is kept open by inſerting the tube till the wind is diſcharged.

31 Account of the noſe-worms which infeſt ſheep. Sheep are infeſted with worms in their noſe called *œſtrus ovis*, and produced from the egg of a large two-winged fly. The frontal ſinuſes above the noſe in ſheep and other animals are the places where theſe worms live and attain their full growth. Theſe ſinuſes are always full of a ſoft white matter, which furniſhes theſe worms with a proper nouriſhment, and are ſufficiently large for their habitation; and when they have here acquired their deſtined growth, in which they are fit to undergo their changes for the fly-ſtate, they leave their old habitation, and, falling to the earth, bury themſelves there; and when theſe are hatched into flies, the female, when ſhe has been impregnated by the male, knows that the noſe of a ſheep or other animal is the only place for her to depoſit her eggs, in order to their coming to maturity. Mr Valliſnieri, to whom the world owes ſo many diſcoveries in the inſect claſs, is the firſt who has given any true account of the origin of theſe worms. But though their true hiſtory had been till that time unknown, the creatures themſelves were very early diſcovered, and many ages ſince were eſteemed great medicines in epilepſies.

The fly produced from this worm has all the time of its life a very lazy diſpoſition, and does not like to make any uſe either of its legs or wings. Its head and corſelet together are about as long as its body, which is compoſed of five rings, ſtreaked on the back; a pale yellow and brown are there diſpoſed in irregular ſpots; the belly is of the ſame colours, but they are there more regularly diſpoſed, for the brown here makes three lines, one in the middle, and one on each ſide, and all the intermediate ſpaces are yellow. The wings are nearly of the ſame length with the body, and are a little inclined in their poſition, ſo as to lie upon the body: they do not, however, cover it; but a naked ſpace is left between them. The ailerons or petty wings which are found under each of the wings are of a whitiſh colour, and perfectly cover the balancers, ſo that they are not to be ſeen without lifting up theſe.

The fly will live two months after it is firſt produced,

ced, but will take no nouriſhment of any kind; and poſſibly it may be of the ſame nature with the butterflies, which never take any food during the whole time of their living in that ſtate. Reaumur, Hiſt. Inſ. vol. iv. p. 552, &c.

32 Compoſition for marking ſheep.

To find a proper compoſition for marking ſheep is a matter of great importance, as great quantities of wool are every year rendered uſeleſs by the pitch and tar with which they are uſually marked. The requiſite qualities for ſuch a compoſition are, that it be cheap, that the colour be ſtrong and laſting, ſo as to bear the changes of weather, and not to injure the wool. Dr Lewis recommends for this purpoſe melted tallow, with ſo much charcoal in fine powder ſtirred into it as is ſufficient to make it of a full black colour, and of a thick conſiſtence. This mixture, being applied warm with a marking iron, on pieces of flannel, quickly fixed or hardened, bore moderate rubbing, reſiſted the ſun and rain, and yet could be waſhed out freely with ſoap, or ley, or ſtale urine. In order to render it ſtill more durable, and prevent its being rubbed off, with the tallow may be melted an eighth, ſixth, or fourth, of its weight of tar, which will readily waſh out along with it from the wool. Lewis's Com. Phil. Techn. p. 361.

SHEEP-Stealing. See THEFT.

SHEERING, in the ſea-language. When a ſhip is not ſteered ſteadily, they ſay ſhe ſheers, or goes ſheering; or when, at anchor, ſhe goes in and out by means of the current of the tide, they alſo ſay ſhe ſheers.

SHEERNESS, a fort in Kent, ſeated on the point where the river Medway falls into the Thames. It was built by King Charles II. after the inſult of the Dutch, who burnt the men of war at Chatham. The buildings belonging to it, in which the officers lodge, make a pretty little neat town; and there is alſo a yard and a dock, a chapel and a chaplain. Mr Lyons, who failed with the honourable Captain Phipps in his voyage towards the Pole, fixed the longitude of Sheerneſs to 0. 48′ E. its latitude 51° 25′.

SHEERS, a name given to an engine uſed to hoiſt or diſplace the lower maſts of a ſhip. The ſheers employed for this purpoſe in the royal navy are compoſed of ſeveral long maſts, whoſe heels reſt upon the ſide of the hulk, and having their heads declining outward from the perpendicular, ſo as to hang over the veſſel whoſe maſts are to be fixed or diſplaced. The tackles, which extend from the head of the maſt to the ſheer-heads, are intended to pull in the latter toward the maſt-head, particularly when they are charged with the weight of a maſt after it is raiſed out of any ſhip, which is performed by ſtrong tackles depending from the ſheer-heads. The effort of theſe tackles is produced by two capſterns, fixed on the deck for this purpoſe.

In merchant ſhips this machine is compoſed of two maſts or props, erected in the ſame veſſel wherein the maſt is to be planted, or from whence it is to be removed. The lower ends of theſe props reſt on the oppoſite ſides of the deck, and their upper parts are faſtened acroſs, ſo as that a tackle which hangs from the interſection may be almoſt perpendicularly above the ſtation of the maſt to which the mechanical powers are applied. Theſe ſheers are ſecured by ſtays which extend forward and aft to the oppoſite extremities of the veſſel.

SHEERS, aboard a ſhip, an engine uſed to hoiſt or diſplace the lower maſts of a ſhip.

SHEET-LEAD. See PLUMBERY.

SHEET, in ſea-language, a rope faſtened to one or both the lower corners of a ſail, to extend and retain it in a particular ſtation. When a ſhip ſails with a lateral wind, the lower corner of the main and fore ſail are faſtened by a tack and a ſheet; the former being to windward, and the latter to leeward; the tack, however, is entirely diffuſed with a ſtern wind, whereas the ſail is never ſpread without the aſſiſtance of one or both of the ſheets. The ſtay-ſails and ſtudding-ſails have only one tack and one ſheet each: the ſtay-ſail tacks are always faſtened forward, and the ſheet drawn aft; but the ſtudding-ſail tack draws the under clue of the ſail to the extremity of the boom, whereas the ſheet is employed to extend the inmoſt.

SHEFFIELD, a town in the weſt riding of Yorkſhire, about 162 miles from London, is a large, thriving town on the borders of Derbyſhire, with a population of 31,314 ſouls; has a fine ſtone bridge over the Don, and another over the Sheaf, and a church built in the reign of Henry I. It had a caſtle built in the reign of Henry III. in which, or elſe in the manor-houſe of the Park, Mary queen of Scots was priſoner 16 or 17 years; but after the death of Charles I. it was with ſeveral others, by order of parliament demoliſhed. In 1673 an hoſpital was erected here, and endowed with 200l. a-year. There is a charity-ſchool for 30 boys, and another for 30 girls. This town has been noted ſeveral hundred years for cutlers and ſmiths manufactures, which were encouraged and advanced by the neighbouring mines of iron, particularly for files, and knives or whittles; for the laſt of which eſpecially it has been a ſtaple for above 300 years; and it is reputed to excel Birmingham in theſe wares, as much as it is ſurpaſſed by it in locks, hinges, nails, and poliſhed ſteel. The firſt mills in England for turning grindſtones were alſo ſet up here. The houſes look black from the continual ſmoke of the forges. Here are 600 maſter cutlers, incorporated by the ſtyle of the *Cutlers of Hallamſhire* (of which this is reckoned the chief town), who employ no leſs than 40,000 perſons in the iron manufactures; and each of the maſters gives a particular ſtamp to his wares. There is a large market on Tueſday for many commodities, but eſpecially for corn, which is bought up here for the whole weſt riding, Derbyſhire, and Nottinghamſhire. It has fairs on Tueſday after Trinity-Sunday, and November 28. In the new market-place, erected by the duke of Norfolk, the ſhambles are built upon a moſt excellent plan, and ſtrongly incloſed. There are ſeveral other new good buildings, ſuch as a large and elegant octagon chapel belonging to the hoſpital or almſhouſes; likewiſe a good aſſembly-room and theatre. We muſt not omit the large ſteam-engine, lately finiſhed, for the purpoſe of poliſhing and grinding the various ſorts of hardware. The pariſh being very large, as well as populous, Mary I. incorporated 12 of the chief inhabitants, and their ſucceſſors for ever, by the ſtyle of the *Twelve Capital Burgeſſes of Sheffield*, empowering them to elect and ordain three prieſts to aſſiſt the vicar, who were to be paid out of certain lands and rents which ſhe gave out of the crown; and ſince this ſettlement two more chapels have been built in two hamlets of this pariſh,

riſh, which are ſerved by two of the aſſiſtants, while the third, in his turn, helps the vicar in his pariſh-church. James I. founded a free grammar-ſchool here, and appointed 13 ſchool-burgeſſes to manage the revenue, and appoint the maſter and uſher. A new chapel was built lately by the contributions of the people of the town and of the neighbouring nobility and gentry. Water is conveyed by pipes into Sheffield, whoſe inhabitants pay but a moderate rent for it. In the neighbourhood there are ſome mines of alum. The remains of the Roman fortification between this town and Rotheram, which is ſix miles lower down the river, are ſtill viſible; and here alſo is the famous trench of five miles long, by ſome called *Devil's* or *Dane's Bank*, and by others *Kemp Bank* and *Temple's Bank*. Weſt Long. 1. 29. N. Lat. 13. 20.

SHEFFIELD, *John*, duke of Buckinghamſhire, an eminent writer of the 17th and 18th century, of great perſonal bravery, and an able miniſter of ſtate, was born about 1650. He loſt his father at nine years of age; and his mother marrying Lord Offulſton, the care of his education was left entirely to a governor, who did not greatly improve him in his ſtudies. Finding that he was deficient in many parts of literature, he reſolved to devote a certain number of hours every day to his ſtudies; and thereby improved himſelf to the degree of learning he afterwards attained. Though poſſeſſed of a good eſtate, he did not abandon himſelf to pleaſure and indolence, but entered a volunteer in the ſecond Dutch war; and accordingly was in that famous naval engagement where the duke of York commanded as admiral: on which occaſion his lordſhip behaved ſo gallantly, that he was appointed commander of the Royal Catharine. He afterward made a campaign in the French ſervice under M. de Turenne. As Tangier was in danger of being taken by the Moors, he offered to head the forces which were ſent to defend it; and accordingly was appointed to command them. He was then earl of Mulgrave, and one of the lords of the bed-chamber to King Charles II. The Moors retired on the approach of his majeſty's forces; and the reſult of the expedition was the blowing up of Tangier. He continued in ſeveral great poſts during the ſhort reign of King James II. till that unfortunate prince was dethroned. Lord Mulgrave, though he paid his reſpects to King William before he was advanced to the throne, yet did not accept of any poſt in the government till ſome years after. In the ſixth year of William and Mary he was created marquis of Normanby in the county of Lincoln. He was one of the moſt active and zealous oppoſers of the bill which took away Sir John Fenwick's life; and exerted the utmoſt vigour in carrying through the Treaſon Bill, and the bill for Triennial Parliaments. He enjoyed ſome conſiderable poſts under King William, and enjoyed much of his favour and confidence. In 1702 he was ſworn lord privy-ſeal; and in the ſame year was appointed one of the commiſſioners to treat of an union between England and Scotland. In 1703 he was created duke of Normanby, and ſoon after duke of Buckinghamſhire. In 1711 he was made ſteward of her majeſty's houſehold, and preſident of the council. During Queen Anne's reign he was but once out of employment; and then he voluntarily reſigned, being attached to what were called the *Tory principles*. Her majeſty offered to make him lord chancellor; but he declined the office. He was inſtrumental in the change of the miniſtry in 1710. A circumſtance that reflects the higheſt honour on him is, the vigour with which he acted in favour of the unhappy Catalans, who afterward were ſo inhumanly ſacrificed. He was ſurvived by only one legitimate ſon (who died at Rome in 1735); but left ſeveral natural children. He died in 1721. He was admired by the poets of his age; by Dryden, Prior, and Garth. His Eſſay on Poetry was applauded by Addiſon, and his Rehearſal is ſtill read with pleaſure. His writings were ſplendidly printed in 1723, in two volumes 4to; and have ſince been reprinted in 1729, in two volumes 8vo. The firſt contains his poems on various ſubjects; the ſecond, his proſe works; which conſiſt of hiſtorical memoirs, ſpeeches in parliament, characters, dialogues, critical obſervations, eſſays, and letters. It may be proper to obſerve, that the edition of 1729 is caſtrated; ſome particulars relating to the revolution in that of 1723 having given offence.

SHEFFIELDIA, a genus of plants belonging to the claſs of pentandria, and to the order of monogynia. The corolla is bell-ſhaped; the filaments are ten; of which every ſecond is barren. The capſule conſiſts of one cell, which has four valves. There is only one ſpecies, the *repens*, a native of New Zealand.

SHEIBON, a diſtrict in Africa, lying on the ſouth-eaſt of the kingdom of Dar-Fur, where much gold is found both in duſt and in ſmall pieces. The idolatrous natives and ſavages collect the duſt in quills of the oſtrich and vulture, and in that condition diſpoſe of it to the merchants. On diſcovering a large piece of gold, they kill a ſheep on it before it is removed. Their marriage is a ſimple agreement to cohabit. The ſlaves brought in great numbers from this quarter, are partly priſoners of war among themſelves, and partly ſeduced by treachery, and ſold. In times of ſcarcity, it is ſaid, a father has been known to ſell his children.

There are ſome Mahometans at Sheibon, who wear clothing, and live among the idolaters; but it is not ſaid whether they are Arabs or not.

SHEIK, in the oriental cuſtoms, the perſon who has the care of the moſques in Egypt; his duty is the ſame as that of the imams at Conſtantinople. There are more or fewer of theſe to every moſque, according to its ſize or revenue. One of theſe is head over the reſt, and anſwers to a pariſh-prieſt with us; and has under him, in large moſques, the readers, and people who cry out to go to prayers; but in ſmall moſques the ſheik is obliged to do all this himſelf. In ſuch it is their buſineſs to open the moſque, to cry to prayers, and to begin their ſhort devotions at the head of the congregation, who ſtand rank and file in great order, and make all their motions together. Every Friday the ſheik makes an harangue to his congregation.

SHEIK-Bellet, the name of an officer in the Oriental nations. In Egypt the ſheik-bellet is the head of a city, and is appointed by the pacha. The buſineſs of this officer is to take care that no innovations be made which may be prejudicial to the Porte, and that they ſend no orders which may hurt the liberties of the people. But all his authority depends on his credit and intereſt, not his office: for the government of Egypt is of ſuch a kind, that often the people of the leaſt power by

Sheik
||
Shenan.

by their poſts have the greateſt influence: and a caia of the janizaries or Arabs, and ſometimes one of their meaneſt officers, an oda-baſha, finds means, by his parts and abilities, to govern all things.

SHEILDS. See Shields.

SHEKEL, the name of a weight and coin current among the ancient Jews. Dr Arbuthnot makes the weight of the ſhekel equal to 9 pennyweights $2\frac{4}{7}$ grains Troy weight; and the value equal to 2s. $3\frac{1}{8}$d. Sterling. The golden ſhekel was worth 1l. 16s. 6d.

SHELDRAKE. See Anas, Ornithology *Index*.

SHELF, among miners, the ſame with what they otherwiſe call *faſt ground*, or *faſt country;* being that part of the internal ſtructure of the earth which they find lying even and in an orderly manner, and evidently retaining its primitive form and ſituation.

SHELL, in *Natural Hiſtory*, a hard, and, as it were, ſtony covering, with which certain animals are defended, and thence called *ſhell fiſh*. For the claſſification and hiſtory, ſee Conchology.

Shells, in *Gunnery*, are hollow iron balls to throw out of mortars or howitzers, with a fuſe-hole of about an inch diameter, to load them with powder, and to receive the fuſe. The bottom, or part oppoſite to the fuſe, is made thicker than the reſt, that the fuſe may fall uppermoſt. But in ſmall elevations this does not always happen, nor indeed is it neceſſary; for, let the ſhell fall as it will, the fuſe ſets fire to the powder within, which burſts the ſhell, and cauſes great devaſtation. The ſhells had much better be of an equal thickneſs; for then they burſt into more pieces.

Meſſage **Shells**, are nothing more than howitz-ſhells, in the inſide of which a letter or other papers are put; the fuſe hole is ſtopped up with wood or cork, and the ſhells are fired out of a royal or howitz, either into a garriſon or camp. It is ſuppoſed, that the perſon to whom the letter is ſent knows the time, and accordingly appoints a guard to look out for its arrival.

Shell-*Fiſh*. Theſe animals are in general oviparous, very few inſtances having been found of ſuch as are viviparous. Among the oviparous kinds, anatomiſts have found that ſome ſpecies are of different ſexes, in the different individuals of the ſame ſpecies; but others are hermaphrodites, every one being in itſelf both male and female. In both caſes their increaſe is very numerous, and ſcarce inferior to that of plants, or of the moſt fruitful of the inſect claſs. The eggs are very ſmall, and are hung together in a ſort of cluſters by means of a glutinous humour, which is always placed about them, and is of the nature of the jelly of frog's ſpawn. By means of this, they are not only kept together in the parcel, but the whole cluſter is faſtened to the rocks, ſhells, or other ſolid ſubſtances; and thus they are preſerved from being driven on ſhore by the waves, and left where they cannot ſucceed.

Shell-*Gold*. See Gold.

SHELTIE, a ſmall but ſtrong kind of horſe, ſo called from Shetland, or Zetland, where they are produced.

SHELVES, in ſea-language, a general name given to any dangerous ſhallows, ſand banks, or rocks, lying immediately under the ſurface of the water, ſo as to intercept any ſhip in her paſſage, and endanger her deſtruction.

SHENAN. See *Dyeing of* Leather.

Shenſtone.

SHENSTONE, William, an admired Engliſh poet, the eldeſt ſon of a plain country gentleman, who farmed his own eſtate in Shropſhire, was born in November 1714. He learned to read of an old dame, whom his poem of the "School-miſtreſs" has delivered to poſterity; and ſoon received ſuch delight from books, that he was always calling for new entertainment, and expected that, when any of the family went to market, a new book ſhould be brought him, which, when it came, was in fondneſs carried to bed, and laid by him. It is ſaid, that when his requeſt had been neglected, his mother wrapped up a piece of wood of the ſame form, and pacified him for the night. As he grew older, he went for a while to the grammar-ſchool in Hales Owen, and was placed afterwards with Mr Crumpton, an eminent ſchoolmaſter at Solihul, where he diſtinguiſhed himſelf by the quickneſs of his progreſs. When he was young (June 1724,) he was deprived of his father; and ſoon after (Auguſt 1726) of his grandfather; and was, with his brother, who died afterwards unmarried, left to the care of his grandmother, who managed the eſtate. From ſchool he was ſent, in 1732, to Pembroke college in Oxford, a ſociety which for half a century has been eminent for Engliſh poetry and elegant literature. Here it appears that he found delight and advantage; for he continued his name there ten years, though he took no degree. After the firſt four years he put on the civilian's gown, but without ſhowing any intention to engage in the profeſſion. About the time when he went to Oxford, the death of his grandmother devolved his affairs to the care of the reverend Mr Dolman, of Brome, in Staffordſhire, whoſe attention he always mentioned with gratitude. —At Oxford he applied to Engliſh poetry; and in 1737, publiſhed a ſmall Miſcellany, without his name. He then for a time wandered about, to acquaint himſelf with life, and was ſometimes at London, ſometimes at Bath, or any place of public reſort; but he did not forget his poetry. He publiſhed, in 1740, his "Judgment of Hercules," addreſſed to Mr Lyttleton, whoſe intereſt he ſupported with great warmth at an election; this was two years afterwards followed by the "School-miſtreſs." Mr Dolman, to whoſe care he was indebted for his eaſe and leiſure, died in 1745, and the care of his fortune now fell upon himſelf. He tried to eſcape it a while, and lived at his houſe with his tenants, who were diſtantly related; but, finding that imperfect poſſeſſion inconvenient, he took the whole eſtate into his own hands, an event which rather improved its beauty than increaſed its produce. Now began his delight in rural pleaſures, and his paſſion of rural elegance; but in time his expences occaſioned clamours that overpowered the lambs bleat and the linnet's ſong, and his groves were haunted by beings very different from fauns and fairies. He ſpent his eſtate in adorning it, and his death was probably haſtened by his anxieties. He was a lamp that ſpent its oil in blazing. It is ſaid, that if he had lived a little longer, he would have been aſſiſted by a penſion; ſuch bounty could not have been more properly beſtowed, but that it was ever aſked is not certain; it is too certain that it never was enjoyed.—He died at the Leaſowes, of a putrid fever, about five on Friday morning, February 11. 1763; and was buried by the ſide of his brother, in the churchyard of Hales-Owen.

In his private opinions, our author adhered to no particular ſect, and hated all religious diſputes. Tenderneſs, in every ſenſe of the word, was his peculiar characteriſtic; and his friends, domeſtics, and poor neighbours, daily experienced the effects of his benevolence. This virtue he carried to an exceſs that ſeemed to border upon weakneſs; yet if any of his friends treated him ungenerouſly, he was not eaſily reconciled. On ſuch occaſions, however, he uſed to ſay, "I never will be a revengeful enemy; but I cannot, it is not in my nature, to be half a friend." He was no economiſt; for the generoſity of his temper prevented his paying a proper regard to the uſe of money: he exceeded therefore the bounds of his paternal fortune. But, if we conſider the perfect paradiſe into which he had converted his eſtate, the hoſpitality with which he lived, his charities to the indigent, and all out of an eſtate that did not exceed 300l. a-year, one ſhould rather wonder that he left any thing behind him, than blame his want of economy: he yet left more than ſufficient to pay all his debts, and by his will appropriated his whole eſtate to that purpoſe. Though he had a high opinion of many of the fair ſex, he forbore to marry. A paſſion he entertained in his youth was with difficulty ſurmounted. The lady was the ſubject of that admirable paſtoral, in four parts, which has been ſo univerſally read and admired, and which, one would have thought, muſt have ſoftened the proudeſt and moſt obdurate heart. His works have been publiſhed by Mr Dodſley, in 3 vols 8vo. The firſt volume contains his poetical works, which are particularly diſtinguiſhed by an amiable elegance and beautiful ſimplicity; the ſecond volume contains his proſe works; the third his letters, &c. *Biog. Dict.*

SHEPPEY, an iſland at the mouth of the river Medway, about 20 miles in circumference. It is ſeparated from the main land by a narrow channel; and has a fertile ſoil, which feeds great flocks of ſheep. The borough-town of Queenborough is ſeated thereon; beſides which it has ſeveral villages.

SHERARDIA, a genus of plants belonging to the tetrandria claſs, and in the natural method ranking under the 47th order, *Stellatæ*. See BOTANY *Index*.

SHERBET, or SHERBIT, a compound drink, firſt brought into England from Turkey and Perſia, conſiſting of water, lemon-juice, and ſugar, in which are diſſolved perfumed cakes made of excellent Damaſcus fruit, containing an infuſion of ſome drops of roſe water. Another kind of it is made of violets, honey, juice of raiſins, &c.

SHERIDAN, THOMAS, D. D. the intimate friend of Dean Swift, is ſaid by Shield, in Cibber's "Lives of the Poets," to have been born about 1684, in the county of Cavan, where, according to the ſame authority, his parents lived in no very elevated ſtate. They are deſcribed as being unable to afford their ſon the advantages of a liberal education; but he, being obſerved to give early indications of genius, attracted the notice of a friend to his family, who ſent him to the college of Dublin, and contributed towards his ſupport while he remained there. He afterwards entered into orders, and ſet up a ſchool in Dublin, which long maintained a very high degree of reputation, as well for the attention beſtowed on the morals of the ſcholars as for their proficiency in literature. So great was the eſtimation in which this ſeminary was held, that it is aſſerted to have produced in ſome years the ſum of 1000l. It does not appear that he had any conſiderable preferment; but his intimacy with Swift, in 1725, procured for him a living in the ſouth of Ireland worth about 150l. a-year, which he went to take poſſeſſion of, and, by an act of inadvertence, deſtroyed all his future expectations of riſing in the church; for being at Corke on the 1ſt of Auguſt, the anniverſary of King George's birth-day, he preached a ſermon, which had for its text, "Sufficient for the day is the evil thereof." On this being known, he was ſtruck out of the liſt of chaplains to the lord lieuteuant, and forbidden the caſtle.

This living Dr Sheridan afterwards changed for that of Dunboyne, which, by the knavery of the farmers, and power of the gentlemen in the neighbourhood, fell ſo low as 80l. per annum. He gave it up for the free ſchool of Cavan, where he might have lived well in ſo cheap a country on 80l. a-year ſalary, beſides his ſcholars; but the air being, as he ſaid, too moiſt and unwholeſome, and being diſguſted with ſome perſons who lived there, he ſold the ſchool for about 400l.; and having ſoon ſpent the money, he fell into bad health, and died Sept. 10. 1738, in his 55th year.

Lord Corke has given the following character of him: "Dr Sheridan was a ſchool-maſter, and in many inſtances perfectly well adapted for that ſtation. He was deeply verſed in the Greek and Roman languages, and in their cuſtoms and antiquities. He had that kind of good nature which abſence of mind, indolence of body, and careleſſneſs of fortune, produce; and although not over ſtrict in his own conduct, yet he took care of the morality of his ſcholars, whom he ſent to the univerſity remarkably well founded in all kinds of claſſical learning, and not ill inſtructed in the ſocial duties of life. He was ſlovenly, indigent, and cheerful. He knew books much better than men; and he knew the value of money leaſt of all. In this ſituation, and with this diſpoſition, Swift faſtened upon him as upon a prey with which he intended to regale himſelf whenever his appetite ſhould prompt him." His Lordſhip then mentions the event of the unlucky ſermon, and adds, "This ill-ſtarred, good-natured, inprovident man, returned to Dublin, unhinged from all favour at court, and even baniſhed from the caſtle. But ſtill he remained a punſter, a quibbler, a fiddler, and a wit. Not a day paſſed without a rebus, an anagram, or a madrigal. His pen and his fiddleſtick were in continual motion; and yet to little or no purpoſe, if we may give credit to the following verſes, which ſhall ſerve as the concluſion of his poetical character:

"With muſic and poetry equally bleſs'd,
"A bard thus Apollo moſt humbly addreſs'd;
"Great author of poetry, muſic, and light,
"Inſtructed by thee, I both fiddle and write;
"Yet unheeded I ſcrape, or I ſcribble all day,
"My tunes are neglected, my verſe flung away.
"Thy ſubſtitute here, Vice-Apollo, diſdains
"To vouch for my numbers, or liſt to my ſtrains.
"Thy manual ſign he refuſes to put
"To the airs I produce from the pen or the gut:
"Be thou then propitious, great Phœbus, and grant
"Relief, or reward, to my merit or want.

Sheridan, Sheriff.

"Tho' the Dean and Delany tranſcendently ſhine,
"O! brighten one ſolo or ſonnet of mine:
"Make one work immortal, 'tis all I requeſt.
"Apollo look'd pleas'd, and reſolving to jeſt,
"Replied——Honeſt friend, I've conſider'd your caſe,
"Nor diſlike your unmeaning and innocent face.
"Your petition I grant, the boon is not great,
"Your works ſhall continue, and here's the receipt:
"On rondeaus hereafter your fiddle-ſtrings ſpend,
"Write verſes in circles, they never ſhall end."

"One of the volumes of Swift's miſcellanies conſiſts almoſt entirely of letters between him and the Dean. He publiſhed a proſe tranſlation of Perſius; to which he added the beſt notes of former editors, together with many judicious ones of his own. This work was printed at London, 1739. in 12mo. *Biog. Dict.*

SHERIDAN, *Mrs Frances*, wife of Thomas Sheridan, M. A. was born in Ireland about the year 1724, but deſcended from a good Engliſh family which had removed thither. Her maiden name was Chamberlaine, and ſhe was grand-daughter of Sir Oliver Chamberlaine. The firſt literary performance by which ſhe diſtinguiſhed herſelf was a little pamphlet at the time of a violent party-diſpute relative to the theatre, in which Mr Sheridan had newly embarked his fortune. So well-timed a work exciting the attention of Mr Sheridan, he by an accident diſcovered his fair patroneſs, to whom he was ſoon afterwards married. She was a perſon of the moſt amiable character in every relation of life, with the moſt engaging manners. After lingering ſome years in a very weak ſtate of health, ſhe died at Blois, in the ſouth of France, in the year 1767. Her "Sydney Biddulph" may be ranked with the firſt productions of that claſs in ours or in any other language. She alſo wrote a little romance in one volume called *Nourjahad*, in which there is a great deal of imagination productive of an admirable moral. And ſhe was the authoreſs of two comedies, "The Diſcovery" and "The Dupe."

Blackſt. Comment. vol. i. p. 339.

SHERIFF, an officer, in each county in England, nominated by the king, inveſted with a judicial and miniſterial power, and who takes place of every nobleman in the county during the time of his office.

The ſheriff is an officer of very great antiquity in this kingdom, his name being derived from two Saxon words, ſignifying the *reeve*, *bailiff*, or *officer* of the ſhire. He is called in Latin *vice-comes*, as being the deputy of the earl or *comes*, to whom the cuſtody of the ſhire is ſaid to have been committed at the firſt diviſion of this kingdom into counties. But the earls, in proceſs of time, by reaſon of their high employments and attendance on the king's perſon, not being able to tranſact the buſineſs of the county, were delivered of that burden, reſerving to themſelves the honour, but the labour was laid on the ſheriff. So that now the ſheriff does all the king's buſineſs in the county; and though he be ſtill called *vice-comes*, yet he is entirely independent of, and not ſubject to, the earl; the king, by his letters patent, committing *cuſtodiam comitatus* to the ſheriff, and to him alone.

Sheriff.

Sheriffs were formerly choſen by the inhabitants of the ſeveral counties. In confirmation of which it was ordained, by ſtatute 28 Edw. I. c. 8. that the people ſhould have an election of ſheriffs in every ſhire where the ſhrievalty is not of inheritance. For anciently in ſome counties the ſheriffs were hereditary; as we apprehend they were in Scotland till the ſtatute 20 Geo. II. c. 43; and ſtill continue in the county of Weſtmoreland to this day; the city of London having alſo the inheritance of the ſhrievalty of Middleſex veſted in their body by charter. The reaſon of theſe popular elections is aſſigned in the ſame ſtatute, c. 13. "that the commons might chooſe ſuch as would not be a burden to them." And herein appears plainly a ſtrong trace of the democratical part of our conſtitution; in which form of government it is an indiſpenſable requiſite, that the people ſhould chooſe their own magiſtrates. This election was in all probability not abſolutely veſted in the commons, but required the royal approbation. For in the Gothic conſtitution, the judges of their county courts (which office is executed by the ſheriff) were elected by the people, but confirmed by the king; and the form of their election was thus managed: the people, or *incolæ territorii*, choſe twelve electors, and they nominated three perſons, *ex quibus rex unum confirmabat.* But, with us in England, theſe popular elections, growing tumultuous, were put an end to by the ſtatute 9 Edw. II. ſt. 2. which enacted, that the ſheriffs ſhould from thenceforth be aſſigned by the chancellor, treaſurer, and the judges; as being perſons in whom the ſame truſt might with confidence be repoſed. By ſtatutes 14 Edw. III. c. 7. 23 Hen. VI. c. 8. and 21 Hen. VIII. c. 20. the chancellor, treaſurer, preſident of the king's council, chief juſtices, and chief baron, are to make this election; and that on the morrow of All Souls, in the exchequer. And the king's letters patent, appointing the new ſheriffs, uſed commonly to bear date the ſixth day of November. The ſtatute of Cambridge, 12 Ric. II. c. 2. ordains, that the chancellor, treaſurer, keeper of the privy ſeal, ſteward of the king's houſe, the king's chamberlain, clerk of the rolls, the juſtices of the one bench and the other, barons of the exchequer, and all other that ſhall be called to ordain, name, or make juſtices of the peace, ſheriffs, and other officers of the king, ſhall be ſworn to act indifferently, and to name no man that ſueth to be put in office, but ſuch only as they ſhall judge to be the beſt and moſt ſufficient. And the cuſtom now is (and has been at leaſt ever ſince the time of Forteſcue, who was chief juſtice and chancellor to Henry the Sixth), that all the judges, together with the other great officers, meet in the exchequer chamber on the morrow of All Souls yearly, (which day is now altered to the morrow of St Martin, by the laſt act for abbreviating Michaelmas term), and then and there propoſe three perſons to the king, who afterwards appoints one of them to be ſheriff. This cuſtom of the twelve judges propoſing three perſons ſeems borrowed from the Gothic conſtitution before-mentioned: with this difference, that among the Goths the 12 nominors were firſt elected by the people themſelves. And this uſage of ours, at its firſt introduction, there is reaſon to believe, was founded upon ſome ſtatute, though not now to be found among our printed laws; firſt, becauſe it is materially different from the direction of all the ſtatutes before-mentioned; which it is hard to conceive that the judges would have countenanced by their concurrence, or that Forteſcue would have inſerted in his book, unleſs by the authority of ſome ſtatute; and alſo, becauſe a ſtatute is expreſsly referred to in the record, which Sir Edward Coke

tells

tells us he tranſcribed from the council book of 3d March, 34 Hen. VI. and which is in ſubſtance as follows. The king had of his own authority appointed a man ſheriff of Lincolnſhire, which office he refuſed to take upon him; whereupon the opinions of the judges were taken, what ſhould be done in this behalf. And the two chief juſtices, Sir John Forteſcue and Sir John Priſot, delivered the unanimous opinion of them all; "that the king did an error when he made a perſon ſheriff that was not choſen and preſented to him according to the ſtatute; that the perſon refuſing was liable to no fine for diſobedience, as if he had been one of the three perſons choſen according to the tenor of the ſtatute; that they would adviſe the king to have recourſe to the three perſons that were choſen according to the ſtatute, or that ſome other thrifty man be intreated to occupy the office for this year; and that, the next year, to eſchew ſuch inconveniences, the order of the ſtatute in this behalf made be obſerved." But notwithſtanding this unanimous reſolution of all the judges of England, thus entered in the council-book, and the ſtatute 34 and 35 Hen. VIII. c. 26. § 61. which expreſsly recognizes this to be the law of the land, ſome of our writers have affirmed, that the king, by his prerogative, may name whom he pleaſes to be ſheriff, whether choſen by the judges or not. This is grounded on a very particular caſe in the fifth year of Queen Elizabeth, when, by reaſon of the plague, there was no Michaelmas term kept at Weſtminſter; ſo that the judges could not meet there *in craſtino animarum* to nominate the ſheriffs: whereupon the queen named them herſelf, without ſuch previous aſſembly, appointing for the moſt part one of two remaining in the laſt year's liſt. And this caſe, thus circumſtanced, is the only authority in our books for the making theſe extraordinary ſheriffs. It is true, the reporter adds, that it was held that the queen by her prerogative might make a ſheriff without the election of the judges, *non obſtante aliquo ſtatuto in contrarium*; but the doctrine of *non obſtante*, which ſets the prerogative above the laws, was effectually demoliſhed by the bill of rights at the revolution, and abdicated Weſtminſter-hall when King James abdicated the kingdom. However, it muſt be acknowledged, that the practice of occaſionally naming what are called *pocket-ſheriffs*, by the ſole authority of the crown, hath uniformly continued to the reign of his preſent majeſty; in which, it is believed, few (if any) inſtances have occurred.

Sheriffs, by virtue of ſeveral old ſtatutes, are to continue in their office no longer than one year; and yet it hath been ſaid that a ſheriff may be appointed *durante bene placito*, or during the king's pleaſure; and ſo is the form of the royal writ. Therefore, till a new ſheriff be named, his office cannot be determined, unleſs by his own death, or the demiſe of the king; in which laſt caſe it was uſual for the ſucceſſor to ſend a new writ to the old ſheriff; but now, by ſtatute 1 Anne ſt. 1. c. 8. all officers appointed by the preceding king may hold their offices for ſix months after the king's demiſe, unleſs ſooner diſplaced by the ſucceſſor. We may farther obſerve, that by ſtatute 1 Ric. II. c. 11. no man that has ſerved the office of ſheriff for one year can be compelled to ſerve the ſame again within three years after.

We ſhall find it is of the utmoſt importance to have the ſheriff appointed according to law, when we conſider his power and duty. Theſe are either as a judge, as the keeper of the king's peace, as a miniſterial officer of the ſuperior courts of juſtice, or as the king's bailiff.

In his judicial capacity he is to hear and determine all cauſes of 40 ſhillings value and under, in his county court: and he has alſo a judicial power in divers other civil caſes. He is likewiſe to decide the elections of knights of the ſhire (ſubject to the controul of the Houſe of Commons), of coroners, and of verderors; to judge of the qualification of voters, and to return ſuch as he ſhall determine to be duly elected.

As the keepers of the king's peace, both by common law and ſpecial commiſſion, he is the firſt man in the county, and ſuperior in rank to any nobleman therein, during his office. He may apprehend, and commit to priſon, all perſons who break the peace, or attempt to break it; and may bind any one in a recognizance to keep the king's peace. He may, and is bound, *ex officio*, to purſue and take all traitors, murderers, felons, and other miſdoers, and commit them to gaol for ſafe cuſtody. He is alſo to defend his county againſt any of the king's enemies when they come into the land; and for this purpoſe, as well as for keeping the peace and purſuing felons, he may command all the people of his county to attend him; which is called the *poſſe comitatus*, or power of the county; which ſummons, every perſon, above 15 years old, and under the degree of a peer, is bound to attend upon warning, under pain of fine and impriſonment. But though the ſheriff is thus the principal conſervator of the peace in his county, yet, by the expreſs directions of the great charter, he, together with the conſtable, coroner, and certain other officers of the king, are forbidden to hold any pleas of the crown, or, in other words, to try any criminal offence. For it would be highly unbecoming, that the executioners of juſtice ſhould be alſo the judges; ſhould impoſe, as well as levy, fines and amercements; ſhould one day condemn a man to death, and perſonally execute him the next. Neither may he act as an ordinary juſtice of the peace during the time of his office; for this would be equally inconſiſtent, he being in many reſpects the ſervant of the juſtices.

In his miniſterial capacity, the ſheriff is bound to execute all proceſs iſſuing from the king's courts of juſtice. In the commencement of civil cauſes, he is to ſerve the writ, to arreſt, and to take bail; when the cauſe comes to trial, he muſt ſummon and return the jury; when it is determined, he muſt ſee the judgment of the court carried into execution. In criminal matters, he alſo arreſts and impriſons, he returns the jury, he has the cuſtody of the delinquent, and he executes the ſentence of the court, though it extend to death itſelf.

As the king's bailiff, it is his buſineſs to preſerve the rights of the king within his bailiwick; for ſo his county is frequently called in the writs: a word introduced by the princes of the Norman line; in imitation of the French, whoſe territory is divided into bailiwicks, as that of England into counties. He muſt ſeize to the king's uſe all lands devolved to the crown by attainder or eſcheat; muſt levy all fines and forfeitures; muſt ſeize and keep all waifs, wrecks, eſtrays, and the like, unleſs they be granted to ſome ſubject ; and muſt alſo collect the king's rents within his bailiwick, if commanded by proceſs from the exchequer.

To execute theſe various offices, the ſheriff has under him many inferior officers ; an under-ſheriff, bailiffs, and gaolers, who muſt neither buy, ſell, nor farm their offices, on forfeiture of 500l.

The under-ſheriff uſually performs all the duties of the office ; a very few only excepted, where the perſonal preſence of the high ſheriff is neceſſary. But no under ſheriff ſhall abide in his office above one year ; and if he does, by ſtatute 23 Hen. VI. c. 8. he forfeits 200l. a very large penalty in thoſe early days. And no under ſheriff or ſheriff's officer ſhall practiſe as an attorney during the time he continues in ſuch office : for this would be a great inlet to partiality and oppreſſion. But theſe ſalutary regulations are ſhamefully evaded, by practiſing in the names of other attorneys, and putting in ſham deputies by way of nominal under-ſheriffs : by reaſon of which, ſays Dalton, the under ſheriffs and bailiffs do grow ſo cunning in their ſeveral places, that they are able to deceive, and it may well be feared that many of them do deceive, both the king, the high ſheriff, and the county.

Sheriff, in Scotland. See Law, Part iii. ſect. 3.

SHERLOCK, **William**, a learned Engliſh divine in the 17th century, was born in 1641, and educated at Eton ſchool, where he diſtinguiſhed himſelf by the vigour of his genius and his application to ſtudy. Thence he was removed to Cambridge, where he took his degrees. In 1669 he became rector of the pariſh of St George, Botolph-lane, in London ; and in 1681 was collated to the prebend of Pancras, in the cathedral of St Paul's. He was likewiſe choſen maſter of the Temple, and had the rectory of Therfield in Hertfordſhire. After the Revolution he was ſuſpended from his preferment, for refuſing the oaths to King William and Queen Mary ; but at laſt he took them, and publicly juſtified what he had done. In 1691 he was inſtalled dean of St Paul's. His Vindication of the Doctrine of the Trinity engaged him in a warm controverſy with Dr South and others. Biſhop Burnet tells us, he was " a clear, a polite, and a ſtrong writer ; but apt to aſſume too much to himſelf, and to treat his adverſaries with contempt." He died in 1707. His works are very numerous ; among theſe are, 1. A Diſcourſe concerning the Knowledge of Jeſus Chriſt, againſt Dr Owen. 2. Several pieces againſt the Papiſts, the Socinians, and Diſſenters. 3. A practical Treatiſe on Death, which is much admired. 4. A practical Diſcourſe on Providence. 5. A practical Diſcourſe on the Future Judgment ; and many other works.

Sherlock, *Dr Thomas*, biſhop of London, was the ſon of the preceding Dr William Sherlock, and was born in 1678. He was educated in Catharine hall, Cambridge, where he took his degrees, and of which he became maſter : he was made maſter of the Temple very young, on the reſignation of his father ; and it is remarkable, that this maſterſhip was held by father and ſon ſucceſſively for more than 70 years. He was at the head of the oppoſition againſt Dr Hoadley biſhop of Bangor ; during which conteſt he publiſhed a great number of pieces. He attacked the famous Collins's "Grounds and Reaſons of the Chriſtian Religion," in a courſe of ſix ſermons, preached at the Temple church, which he intitled "The Uſe and Intent of Prophecy in the ſeveral Ages of the World." In 1728, Dr Sherlock was promoted to the biſhopric of Bangor ; and was tranſlated to Saliſbury in 1734. In 1747 he refuſed the archbiſhopric of Canterbury, on account of his ill ſtate of health ; but recovering in a good degree, accepted the ſee of London the following year. On occaſion of the earthquakes in 1750, he publiſhed an excellent Paſtoral Letter to the clergy and inhabitants of London and Weſtminſter : of which it is ſaid there were printed in 4to, 5000 ; in 8vo, 20,000 ; and in 12mo, about 30,000 ; beſide pirated editions, of which not leſs than 50,000 were ſuppoſed to have been ſold. Under the weak ſtate of body in which he lay for ſeveral years, he reviſed and publiſhed 4 vols of Sermons in 8vo, which are particularly admired for their ingenuity and elegance. He died in 1762, and by report worth 150,000l. " His learning," ſays Dr Nicholls, " was very extenſive : God had given him a great and an underſtanding mind, a quick comprehenſion, and a ſolid judgment. Theſe advantages of nature he improved by much induſtry and application. His ſkill in the civil and canon law was very conſiderable ; to which he had added ſuch a knowledge of the common law of England as few clergymen attain to. This it was that gave him that influence in all cauſes where the church was concerned ; as knowing preciſely what it had to claim from its conſtitutions and canons, and what from the common law of the land." Dr Nicholls then mentions his conſtant and exemplary piety, his warm and fervent zeal in preaching the duties and maintaining the doctrines of Chriſtianity, and his large and diffuſive munificence and charity ; particularly by his having given large ſums of money to the corporation of clergymen's ſons, to ſeveral of the hoſpitals, and to the ſociety for propagating the goſpel in foreign parts : alſo his bequeathing to Catharine-hall in Cambridge, the place of his education, his valuable library of books, and his donations for the founding a librarian's place and a ſcholarſhip, to the amount of ſeveral thouſand pounds.

SHERRIFFE of Mecca, the title of the deſcendants of Mahomet by Haſſan Ibn Ali. Theſe are divided into ſeveral branches, of which the family of Ali Bunemi, conſiſting at leaſt of three hundred individuals, enjoy the ſole right to the throne of Mecca. The Ali Bunemi are, again, ſubdivided into two ſubordinate branches, Darii Sajid, and Darii Barkad ; of whom ſometimes the one, ſometimes the other, have given ſovereigns to Mecca and Medina, when theſe were ſeparate ſtates.

Not only is the Turkiſh ſultan indifferent about the order of ſucceſſion in this family, but he ſeems even to foment the diſſenſions which ariſe among them, and favours the ſtrongeſt, merely that he may weaken them all. As the order of ſucceſſion is not determinately fixed, and the ſherriffes may all aſpire alike to the ſovereign power, this uncertainty of right, aided by the intrigues of the Turkiſh officers, occaſions frequent revolutions. The grand ſherriffe is ſeldom able to maintain himſelf on the throne ; and it ſtill ſeldomer happens that his reign is not diſturbed by the revolt of his neareſt relations. There have been inſtances of a nephew ſucceeding his uncle, an uncle ſucceeding his nephew ;

and ſometimes of a perſon, from a remote branch, coming in the room of the reigning prince of the ancient houſe.

When Niebuhr was in Arabia, in 1763, the reigning Sherriffe Meſad had ſitten fourteen years on the throne, and, during all that period, had been continually at war with the neighbouring Arabs, and with his own neareſt relations ſometimes. A few years before, the pacha of Syria had depoſed him, and raiſed his younger brother to the ſovereign dignity in his ſtead. But after the departure of the caravan, Jafar, the new ſherriffe, not being able to maintain himſelf on the throne, was obliged to reſign the ſovereignty again to Meſad. Achmet, the ſecond brother of the ſherriffe, who was much beloved by the Arabs, threatened to attack Mecca while Niebuhr was at Jidda. Our traveller was ſoon after informed of the termination of the quarrel, and of Achmet's return to Mecca, where he continued to live peaceably in a private character.

Theſe examples ſhow that the Muſſulmans obſerve not the law which forbids them to bear arms againſt their holy places. An Egyptian bey even preſumed, a few years ſince, to plant ſome ſmall cannons within the compaſs of the Kaaba, upon a ſmall tower, from which he fired over that ſacred manſion, upon the palace of Sherriffe Meſad, with whom he was at variance.

The dominions of the ſherriffe comprehend the cities of Mecca, Medina, Jambo, Taaif, Sadie, Ghunfude, Hali, and thirteen others leſs conſiderable, all ſituated in Hedjas. Near Taaif is the lofty mountain of Gazvan, which according to Arabian authors, is covered with ſnow in the midſt of ſummer. As theſe dominions are neither opulent nor extenſive, the revenue of their ſovereign cannot be conſiderable.

He finds a rich reſource, however, in the impoſts levied on pilgrims, and in the gratuities offered him by Muſſulman monarchs. Every pilgrim pays a tax of from ten to an hundred crowns, in proportion to his ability. The Great Mogul remits annually ſixty thouſand roupees to the ſherriffe, by an aſſignment upon the government of Surat. Indeed, ſince the Engliſh made themſelves maſters of this city, and the territory belonging to it, the nabob of Surat has no longer been able to pay the ſum. The ſherriffe once demanded it of the Engliſh, as the poſſeſſors of Surat; and, till they ſhould ſatisfy him, forbade their captains to leave the port of Jidda. But the Engliſh diſregarding this prohibition, the ſherriffe complained to the Ottoman Porte, and they communicated his complaints to the Engliſh ambaſſador. He at the ſame time opened a negociation with the nominal nabob, who reſides in Surat. But all theſe ſteps proved fruitleſs: and the ſovereign of Mecca ſeems not likely to be ever more benefited by the contribution from India.

The power of the ſherriffe extends not to ſpiritual matters; theſe are entirely managed by the heads of the clergy, of different ſects, who are reſident at Mecca. Rigid Muſſulmans, ſuch as the Turks, are not very favourable in their ſentiments of the ſherriffes, but ſuſpect their orthodoxy, and look upon them as ſecretly attached to the tolerant ſect of the Zeidi.

SHETLAND, the name of certain iſlands belonging to Scotland, and lying to the northward of Orkney. There are many convincing proofs that theſe iſlands were very early inhabited by the Picts, or rather by thoſe nations who were the original poſſeſſors of the Orkneys; and at the time of the total deſtruction of theſe nations, if any credit be due to tradition, their woods were entirely ruined (A) It is highly probable that the people in Shetland, as well as in the Orkneys, flouriſhed under their own princes dependent upon the crown of Norway; yet this ſeems to have been rather through what they acquired by fiſhing and commerce, than by the cultivation of their lands. It may alſo be reaſonably preſumed, that they grew thinner of inhabitants after they were annexed to the crown of Scotland; and it is likely that they revived again, chiefly by the very great and extenſive improvements which the Dutch made in the herring fiſhery upon their coaſts, and the trade that the crews of their buſſes, then very numerous, carried on with the inhabitants, neceſſarily reſulting from their want of proviſions and other conveniences.

There are many reaſons which may be aſſigned why theſe iſlands, though part of our dominions, have not hitherto been better known to us. They were commonly placed two degrees too far to the north in all the old maps, in order to make them agree with Ptolemy's deſcription of Thule, which he aſſerted to be in the latitude of 63 degrees; which we find urged by Camden as a reaſon why Thule muſt be one of the Shetland iſles, to which Speed alſo agrees, though from their being thus wrong placed he could not find room for them in his maps. Another, and that no light cauſe, was the many falſe, fabulous, and impertinent relations publiſhed concerning them (B), as if they were countries inhoſpitable and uninhabitable; and laſtly, the indolence, or rather indifference, of the natives, who, contenting themſelves with thoſe neceſſaries and conveniences procured by their intercourſe with other nations, and conceiving themſelves neglected by the mother country, have ſeldom troubled her with their applications.

There are few countries that have gone by more names than theſe iſlands; they were called in Icelandic, *Hialtlandia*, from *hialt*, the "hilt of a ſword;" this might be poſſibly corrupted into *Hetland*, *Hitland*, or *Hethland*, though ſome tell us this ſignifies a "high land." They have been likewiſe, and are ſtill in ſome maps called *Zetland* and *Zealand*, in reference, as has been ſuppoſed, to their ſituation. By the Danes, and by

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(A) The tradition is, that this was done by the Scots when they deſtroyed the Picts; but is more probably referred to the Norwegians rooting out the original poſſeſſors of Shetland.

(B) They repreſented the climate as intenſely cold; the ſoil as compoſed of crags and quagmire, ſo barren as to be incapable of bearing corn; to ſupply which, the people, after drying fiſh-bones, powdered them, then kneaded and baked them for bread. The larger fiſh-bones were ſaid to be all the fuel they had. Yet, in ſo dreary a country, and in ſuch miſerable circumſtances, they were acknowledged to be very long-lived, cheerful, and contented.

Shetland. by the natives, they are ſtyled *Yealtaland:* and notwithſtanding the oddneſs of the orthography, this differs very little, if at all, from their manner of pronouncing Zetland, out of which pronunciation grew the modern names of *Shetland* and *Shotland*.

The iſlands of *Shetland*, as we commonly call them, are well ſituated for trade. The neareſt continent to them is Norway; the port of Bergen lying 44 leagues eaſt, whereas they lie 46 leagues north-north-eaſt from Buchanneſs; eaſt-north-eaſt from Sanda, one of the Orkneys, about 16 or 18 leagues; ſix or ſeven leagues north-eaſt from Fair Iſle; 58 leagues eaſt from the Ferroe iſles; and at nearly the ſame diſtance north-eaſt from Lewis. The ſouthern promontory of the Mainland, called *Sumburgh Head*, lies in 59 degrees and 59 minutes of north latitude; and the northern extremity of Unſt, the moſt remote of them all, in the latitude of 61 degrees 15 minutes. The meridian of London paſſes through this laſt iſland, which lies about 2 degrees 30 minutes weſt from Paris, and about 5 degrees 15 minutes eaſt from the meridian of Cape Lizard. According to Gifford's Hiſtorical Deſcription of Zetland, the inhabited iſlands are 33, of which the principal is ſtyled *Mainland*, and extends in length from north to ſouth about 60 miles, and is in ſome places 20 broad, though in others not more than two.

It is impoſſible to ſpeak with preciſion; but, according to the beſt computation which we have been able to form, the Shetland iſles contain near three times as much land as the Orkneys: and they are conſidered as not inferior to the provinces of Utrecht, Zealand, and all the reſt of the Dutch iſlands taken together; but of climate and ſoil they have not much to boaſt. The longeſt day in the iſland of Unſt is 19 hours 15 minutes, and of conſequence the ſhorteſt day 4 hours and 45 minutes. The ſpring is very late, the ſummer very ſhort; the autumn alſo is of no long duration, dark, foggy, and rainy; the winter ſets in about November, and laſts till April, and ſometimes till May. They have frequently in that ſeaſon ſtorms of thunder, much rain, but little froſt or ſnow. High winds are indeed very frequent and very troubleſome, yet they ſeldom produce any terrible effects. The aurora borealis is as common here as in any of the northern countries. In the winter ſeaſon the ſea ſwells and rages in ſuch a manner, that for five or ſix months their ports are inacceſſible, and of courſe the people during that ſpace have no correſpondence with the reſt of the world.

The ſoil in the interior part of the Mainland, for the moſt part, is mountainous, mooriſh, and boggy, yet not to ſuch a degree as to render the country utterly impaſſable; for many of the roads here, and in ſome of the northern iſles, are as good as any other natural roads, and the people travel them frequently on all occaſions. Near the coaſt there are ſometimes for miles together flat pleaſant ſpots, very fertile both in paſture and corn. The mountains produce large crops of very nutritive graſs in the ſummer; and they cut conſiderable quantities of hay, with which they feed their cattle in the winter. They might with a little attention bring more of their country into cultivation: but the people are ſo much addicted to their fiſhery, and feel ſo little neceſſity of having recourſe to this method for ſubſiſtence, that they are content, how ſtrange ſoever that may ſeem to us, to let four parts in five of their land remain in a ſtate of nature.

They want not conſiderable quantities of marl in different iſlands, though they uſe but little; hitherto there has been no chalk found; limeſtone and freeſtone there are in the ſouthern parts of the Mainland in great quantities, and alſo in the neighbouring iſlands, particularly Fetlar; and conſiderable quantities of ſlate, very good in its kind. No mines have been hitherto wrought to any great extent; but there are in many places appearances of metallic ores, as thoſe of copper and iron; and it is ſaid, pieces of ſilver ore have been found. In ſome of the ſmaller iſles there are ſtrong appearances of iron; but, through the want of proper experiments being made, there is, in this reſpect at leaſt, hitherto nothing certain. Their meadows are incloſed with dikes, and produce very good graſs. The little corn they grow is chiefly barley, with ſome oats; though even in the northern extremity of Unſt the little land which they have is remarkable for its fertility. The hills abound with medicinal herbs; and their kitchen-gardens thrive as well, and produce as good greens and roots, as any in Britain. Of late years, and ſince this has been attended to, ſome gentlemen have had even greater ſucceſs than they expected in the cultivating of tulips, roſes, and many other flowers. They have no trees, and hardly any ſhrubs except juniper, yet they have a tradition that their country was formerly overgrown with woods; and it ſeems to be a confirmation of this, that the roots of timber-trees have been, and are ſtill, dug up at a great depth; and that in ſome, and thoſe too inacceſſible, places, the mountain-aſh is ſtill found growing wild. That this defect, viz. the want of wood at preſent, does not ariſe entirely from the ſoil or climate, appears from ſeveral late experiments; ſome gentlemen having raiſed aſh, maple, horſe-cheſnuts, &c. in their gardens. Though the inhabitants are without either wood or coals, they are very well ſupplied with fuel, having great plenty of heath and peat. The black cattle in this country are in general of a larger ſort than in Orkney, which is owing to their having more extenſive paſtures; a clear proof that ſtill farther improvements might be made in reſpect to ſize. Their horſes are ſmall, but ſtrong, ſtout, and well-ſhaped, live very hardy, and to a great age. They have likewiſe a breed of ſmall ſwine, the fleſh of which, when fat, is eſteemed very delicious. They have no goats, hares, or foxes; and in general no wild or venomous creatures of any kind except rats in ſome few iſlands. They have no moorfowl, which is the more remarkable, as there are every where immenſe quantities of heath; but there are many ſorts of wild and water-fowl, particularly the dunter-gooſe, clack-gooſe, ſolan-gooſe, ſwans, ducks, teal, whaps, foiſts, lyres, kittiwakes, maws, plovers, cormorants, &c. There is likewiſe the ember-gooſe, which is ſaid to hatch her egg under her wing. Eagles and hawks, as alſo ravens, crows, mews, &c. abound here.

All theſe iſlands are well watered; for there are everywhere excellent ſprings, ſome of them mineral and medicinal. They have, indeed, no rivers; but many pleaſant rills or rivulets, of different ſizes; in ſome of the largeſt they have admirable trouts, ſome of which are of 15 and even of 20 pounds weight. They have likewiſe many freſh-water lakes, well ſtored with trout and eels, and in moſt of them there are alſo large and fine flounders; in ſome very excellent cod. Theſe freſh-water lakes, if the country was better peopled, and the common people more at their eaſe, are certainly capable of great improvements. The ſea-coaſts of the Mainland of Shetland, in a ſtraight line, are 55 leagues; and therefore there cannot be a country conceived more proper for eſtabliſhing an extenſive fiſhery. What the inhabitants have been hitherto able to do, their natural advantages conſidered, does not deſerve that name, notwithſtanding they export large quantities of cod, tuſk, ling, and ſkate, inſomuch that the bounty allowed by acts of parliament amounts from 1400l. to 2000l. annually. Haddocks, whitings, turbot, and a variety of other fiſh, and in many of the inlets excellent oyſters, lobſters, muſcles, cockles, and other ſhell-fiſh are abundant, as well as multitudes of otters and ſeals: ambergris, and other ſpoils of the ocean, are ſometimes found upon the coaſts.

The inhabitants are a ſtout, well-made, comely people; the lower ſort of a ſwarthy complexion. The gentry are allowed, by all who have converſed with them, to be moſt of them polite, ſhrewd, ſenſible, lively, active, and intelligent perſons; and theſe, to the number of 100 families, have very handſome, ſtrong, well-built houſes, neatly furniſhed; their tables well ſerved; poliſhed in their manners, and exceedingly hoſpitable and civil to ſtrangers. Thoſe of an inferior rank are a hardy, robuſt, and laborious people, who, generally ſpeaking, get their bread by fiſhing in all weathers in their yawls, which are little bigger than Graveſend wherries; live hardily, and in the ſummer ſeaſon moſtly on fiſh; their drink, which, in reference to the Britiſh dominions, is peculiar to the country, is called *bland*, and is a ſort of butter-milk, long kept, and very ſour. Many live to great ages, though not ſo long as in former times. In reſpect, however, to the bulk of the inhabitants, from the poorneſs of living, from the nature of it, and from the drinking great quantities of corn-ſpirits of the very worſt ſort, multitudes are afflicted with an inveterate ſcurvy; from which thoſe in better circumſtances are entirely free, and enjoy as good health as in any other country in Europe. As they have no great turn to agriculture, and are perſuaded that their country is not fit for it, they do not (though probably they might) raiſe corn enough to ſupport them for more than two-thirds of the year. But they are much more ſucceſsful in their paſture-grounds, which are kept well incloſed, in good order, and, together with their commons, ſupply them plentifully with beef and mutton. They pay their rents generally in butter at Lammas, and in money at Martinmas. As to manufactures, they make a ſtrong coarſe cloth for their own uſe, as alſo linen. They make likewiſe of their own wool very fine ſtockings. They export, beſides the different kinds of fiſh already mentioned, ſome herrings, a conſiderable quantity of butter and train-oil, otter and ſeal ſkins, and no inconſiderable quantity of the fine ſtockings juſt mentioned. Their chief trade is to Leith, London, Hamburgh, Spain, and to the Straits. They import timbers, deals and ſome of their beſt oats, from Norway; corn and flour from the Orkneys, and from North Britain; ſpirits and ſome other things from Hamburgh; cloths and better ſort of linen from Leith; grocery, houſehold furniture, and other neceſſaries, from London. The duties to the ſuperior are generally let in farm; and are paid by the people in butter, oil, and money. The remains of the old Norwegian conſtitution are ſtill viſible in the diviſion of their lands; and they have ſome udalmen or freeholders amongſt them. But the Scots laws, cuſtoms, manners, dreſs, and language prevail; and they have a ſheriff, and other magiſtrates for the adminiſtration of juſtice, as well as a cuſtomhouſe, with a proper number of officers. In reference to their eccleſiaſtical concerns, they have a preſbytery, 12 miniſters, and an itinerant for Foula, Fair Iſland, and the Skerries. Each of theſe miniſters has a ſtipend of between 40 and 50 pounds, beſides a houſe and a glebe free from taxes. The number of ſouls in theſe iſlands may be about 20,000.

SHEW-BREAD, the loaves of bread which the prieſt of the week put every Sabbath-day upon the golden-table in the ſanctuary, before the Lord, in the temple of the Jews. They were twelve in number, and were offered to God in the name of the twelve tribes of Iſrael. They were ſhaped like a brick, were ten palms long and five broad, weighing about eight pounds each. They were unleavened, and made of fine flour by the Levites. The prieſts ſet them on the table in two rows, ſix in a row, and put frankincenſe upon them to preſerve them from moulding. They were changed every Sabbath, and the old ones belonged to the prieſt upon duty. Of this bread none but the prieſts might eat, except in caſes of neceſſity. It was called the *bread of faces*, becauſe the table of the ſhew bread, being almoſt over-againſt the ark of the covenant, the loaves might be ſaid to be ſet before the face of God. The original table was carried away to Babylon, but a new one was made for the ſecond temple. It was of wood overlaid with gold. This, with the candleſtick and ſome other ſpoils, was carried by Titus to Rome.

SHIANT or SCHANT ISLANDS, a cluſter of ſmall uninhabited iſlands, lying ſix miles from the S. E. coaſt of Lewis in Scotland, in W. Long. 6. 20. N. Lat. 57. 53.

SHIELD, an ancient weapon of defence, in form of a light buckler, borne on the arm to fend off lances, darts, &c. The form of the ſhield is repreſented by the eſcutcheon in coats of arms. The ſhield was that part of the ancient armour on which the perſons of diſtinction in the field of battle always had their arms painted; and moſt of the words uſed at this time to expreſs the ſpace that holds the arms of families are derived from the Latin word *ſcutum*. The French *eſcu* and *eſcuſſion*, and the Engliſh word *eſcutcheon*, or *ſcutcheon*, are evidently from this origin; and the Italian *ſcudo* ſignifies both the ſhield of arms and that uſed in war. The Latin name *clypeus*, for the ſame thing, ſeems alſo to be derived from the Greek word γλυφειν, *to engrave*; and it had this name from the ſeveral figures engraved on it, as marks of diſtinction of the perſon who wore it.

The ſhield in war, among the Greeks and Romans, was not only uſeful in defence, but it was alſo a badge of honour to the wearer; and he who returned from battle without it was always treated with infamy afterwards. People have at all times thought this honourable piece of the armour the propereſt place to engrave, or figure on the ſigns of dignity of the poſſeſſor of it; and hence, when arms came to be painted for families in aftertimes, the heralds always choſe to repreſent them upon the figure of a ſhield, but with ſeveral exterior additions and ornaments; as the helmet, ſupporters, and the reſt.

The form of the ſhield has not only been found different in various nations, but even the people of the ſame nation, at different times, have varied its form extremely; and among ſeveral people there have been ſhields of ſeveral forms and ſizes in uſe, at the ſame period of time, and ſuited to different occaſions. The moſt ancient and univerſal form of ſhields, in the earlier ages, ſeems to have been the triangular. This we ſee inſtances of in all the monuments and gems of antiquity: our own moſt early monuments ſhow it to have been the moſt antique ſhape alſo with us, and the heralds have found it the moſt convenient for their purpoſes, when they had any odd number of figures to repreſent; as if three, then two in the broad bottom part, and one in the narrow upper end, it held them very well; or if five, they ſtood as conveniently, as three below, and two above. The other form of a ſhield, now univerſally uſed, is ſquare, rounded and pointed at the bottom: this is taken from the figure of the Samnitie ſhield uſed by the Romans, and ſince copied very generally by the Engliſh, French, and Germans.

The Spaniards and Portugueſe have the like general form of ſhields, but they are round at the bottom without the point; and the Germans, beſide the Samnite ſhield, have two others pretty much in uſe: theſe are, 1. The bulging ſhield, diſtinguiſhed by its ſwelling or bulging out at the flanks; and, 2. The indented ſhield, or ſhield chancree, which has a number of notches and indentings all round its ſides. The uſe of the ancient ſhield of this form was, that the notches ſerved to reſt the lance upon, that it might be firm while it gave the thruſt; but this form being leſs proper for the receiving armorial figures, the two former have been much more uſed in the heraldry of that nation.

Beſide this different form of the ſhields in heraldry, we find them alſo often diſtinguiſhed by their different poſitions, ſome of them ſtanding erect, and others ſlanting various ways, and in different degrees; this the heralds expreſs by the word *pendant*, "hanging," they ſeeming to be hung up not by the centre, but by the right or left corner. The French call theſe *ecu pendant*, and the common antique triangular ones *ecu ancien*. The Italians call this *ſcuto pendente;* and the reaſon given for exhibiting the ſhield in theſe figures in heraldry is, that in the ancient tilts and tournaments, they who were to juſt at theſe military exerciſes, were obliged to hang up their ſhields with their armories, or coats of arms on them, out at the windows and balconies of the houſes near the place; or upon trees, pavilions, or the barriers of the ground, if the exerciſe was to be performed in the field.

Thoſe who were to fight on foot, according to Columbier, had their ſhields hung up by the right corner, and thoſe who were to fight on horſeback had theirs hung up by the left. This poſition of the ſhields in heraldry is called *couche* by ſome writers, though by the generality *pendant*.

It was very frequent in all parts of Europe, in arms given between the 11th and 14th centuries; but it is to be obſerved that the hanging by the left corner, as it was the token of the owner's being to fight on horſeback, ſo it was eſteemed the moſt honourable and noble ſituation; and all the pendant ſhields of the ſons of the royal family of Scotland and England, and of our nobility at the time, are thus hanging from the left corner. The hanging from this corner was a token of the owner's being of noble birth, and having fought in the tournaments before; but no ſovereign ever had a ſhield pendant any way, but always erect, as they never formally entered the liſts of the tournament.

The Italians generally have their ſhields of arms of an oval form; this ſeems to be done in imitation of thoſe of the popes and other dignified clergy: but their herald Petro Sancto ſeems to regret the uſe of this figure of the ſhield, as an innovation brought in by the painters and engravers as moſt convenient for holding the figures, but derogatory to the honour of the poſſeſſor, as not repreſenting either antiquity or honours won in war, but rather the honours of ſome citizen or perſon of learning. Some have carried it ſo far as to ſay, that thoſe who either have no ancient title to nobility, or have ſullied it by any unworthy action, cannot any longer wear their arms in ſhields properly figured, but were obliged to have them painted in an oval or round ſhield.

In Flanders, where this author lived, the round and oval ſhields are in the diſrepute he ſpeaks of; but in Italy, beſides the popes and dignified prelates, many of the firſt families of the laity have them.

The ſecular princes, in many other countries, alſo retain this form of the ſhield, as the moſt ancient and truly expreſſive of the Roman clypeus.

SHIELD, in *Heraldry*, the eſcutcheon, or field on which the bearings of coats of arms are placed. See HERALDRY.

SHIELDRAKE, or SHELDRAKE. See ANAS, ORNITHOLOGY *Index*.

SHIELDS, NORTH and SOUTH, two ſea-port towns, at the mouth of the Tyne, the one in Northumberland, the other in the county of Durham. South Shields contained above 200 ſalt-pans, 50 years ago; but now there are not more than five or ſix; and the duty, which is now only 10,000l. per annum, amounted formerly to 80,000l. South Shields has a conſiderable trade, in which not leſs than 500 veſſels from 100 to 500 tons burden are employed; and has nine dry docks for repairing, and 10 yards for building ſhips. This town has been much improved of late years. In the centre there is a large ſquare, in which there is a handſome town-hall, with a colonnade under it for the weekly market, and from which ſtreets branch out on all ſides. North Shields contains alſo ſome fine ſtreets and ſquares. The harbour is very commodious, and ſo ſpacious, that it is capable of receiving 2000 ſhips. It is defended by a fort, in which there is alſo a lighthouſe, correſponding with another on the top of the bank, to direct veſſels into the harbour. The population of North and South Shields is eſtimated at 25,000. W. Long. 1. 12. N. Lat. 55. 44.

SHIFTERS, on board a man of war, certain men who are employed by the cooks to ſhift and change the water in which the fleſh or fiſh is put, and laid for ſome time, in order to fit it for the kettle.

SHIFTING A TACKLE, in ſea-language, the act of removing the blocks of a tackle to a greater diſtance from each other, on the object to which they are applied, in order to give a greater ſcope or extent to their purchaſe. This operation is otherwiſe called *fleeting*. Shifting the helm denotes the alteration of its poſition, by by puſhing it towards the oppoſite ſide of the ſhip. Shifting the voyal, ſignifies changing its poſition on the capſtern, from the right to the left, and *vice verſa*.

SHILLING, an Engliſh ſilver coin, equal to twelve pence, or the twentieth part of a pound.

Freherus derives the Saxon *ſcilling*, whence our ſhilling, from a corruption of *ſiliqua*; proving the derivation by ſeveral texts of law, and, among others, by the 26th law, *De annuis legatis*. Skinner deduces it from the Saxon *ſcild*, "ſhield," by reaſon of the eſcutcheon of arms thereon.

Biſhop Hooper derives it from the Arabic *ſcheele*, ſignifying *a weight*; but others, with greater probability, deduce it from the Latin *ſicilicus*, which ſignified in that language *a quarter of an ounce*, or the 48th part of a Roman pound. In confirmation of this etymology it is alleged, that the ſhilling kept its original ſignification, and bore the ſame proportion to the Saxon pound as ſicilicus did to the Roman and the Greek, being exactly the 48th part of the Saxon pound; a diſcovery which we owe to Mr Lambarde*.

However, the Saxon laws reckon the pound in the round number at 50 ſhillings, but they really coined out of it only 48; the value of the ſhilling was fivepence; but it was reduced to fourpence above a century before the conqueſt; for ſeveral of the Saxon laws, made in Athelſtan's reign, oblige us to take this eſtimate. Thus it continued to the Norman times, as one of the Conqueror's laws ſufficiently aſcertains; and it ſeems to have been the common coin by which the Engliſh payments were adjuſted. After the conqueſt, the French *ſolidus* of twelvepence, which was in uſe among the Normans, was called by the Engliſh name of ſhilling; and the Saxon ſhilling of fourpence took a Norman name, and was called the *groat*, or great coin, becauſe it was the largeſt Engliſh coin then known in England.

It has been the opinion of the biſhops Fleetwood and Gibſon, and of the antiquaries in general, that, though the method of reckoning by pounds, marks, and ſhillings, as well as by pence and farthings, had been in conſtant uſe even from the Saxon times, long before the Norman conqueſt, there never was ſuch a coin in England as either a pound or a mark, nor any ſhilling, till the year 1504 or 1505, when a few ſilver ſhillings or twelvepences were coined, which have long ſince been ſolely confined to the cabinets of collectors.

Mr Clarke combats this opinion, alleging that ſome coins mentioned by Mr Folkes, under Edward I. were probably Saxon ſhillings new minted, and that Archbiſhop Aelfric expreſsly ſays†, that the Saxons had three names for their money, viz. mancuſes, ſhillings, and pennies. He alſo urges the different value of the Saxon ſhilling at different times, and its uniform proportion to the pound, as an argument that their ſhilling was a coin; and the teſtimony of the Saxon goſpels, in which the word we have tranſlated *pieces of ſilver* is rendered *ſhillings*, which, he ſays, they would hardly have done, if there had been no ſuch coin as a ſhilling then in uſe. Accordingly the Saxons expreſſed their ſhilling in Latin by *ſiclus* and *argenteus*. He farther adds, that the Saxon ſhilling was never expreſſed by *ſolidus* till after the Norman ſettlements in England; and howſoever it altered during the long period that elapſed from the conqueſt to the time of Henry VII. it was the moſt conſtant denomination of money in all payments, though it was then only a ſpecies of account, or the twentieth part of the pound ſterling: and when it was again revived as a coin, it leſſened gradually as the pound ſterling leſſened, from the 28th of Edward III. to the 43d of Elizabeth.

In the year 1560 there was a peculiar ſort of ſhilling ſtruck in Ireland, of the value of ninepence Engliſh, which paſſed in Ireland for twelvepence. The motto on the reverſe was, *poſui Deum adjutorem meum*. Eighty-two of theſe ſhillings, according to Malynes, went to the pound; they therefore weighed 20 grains one-fourth each, which is ſomewhat heavier in proportion than the Engliſh ſhilling of that time, 62 whereof went to the pound, each weighing 92 grains ſeven-eighths; and the Iriſh ſhilling being valued at the Tower at ninepence Engliſh, that is, one-fourth part leſs than the Engliſh ſhilling, it ſhould therefore proportionably weigh one-fourth part leſs, and its full weight be ſomewhat more than 62 grains; but ſome of them found at this time, though much worn, weighed 69 grains. In the year 1598, five different pieces of money of this kind were ſtruck in England for the ſervice of the kingdom of Ireland. Theſe were ſhillings to be current in Ireland at twelvepence each; half ſhillings to be current at ſixpence, and quarter ſhillings at threepence. Pennies and halfpennies were alſo ſtruck of the ſame kind, and ſent over for the payment of the army in Ireland. The money thus coined was of a very baſe mixture of copper and ſilver; and two years after there were more pieces of the ſame kinds ſtruck for the ſame ſervice, which were ſtill worſe; the former being three ounces of ſilver to nine ounces of copper; and theſe latter only two ounces eighteen pennyweights to nine ounces two pennyweights of the alloy.

The Dutch, Flemiſh, and Germans, have likewiſe their ſhilling, called *ſchelin*, *ſchilling*, *ſcalin*, &c. but theſe not being of the ſame weight or fineneſs with the Engliſh ſhilling, are not current at the ſame value. The Engliſh ſhilling is worth about 23 French ſols; thoſe of Holland and Germany about 11 ſols and a half; thoſe of Flanders about nine. The Dutch ſhillings are alſo called *ſols de gros*, becauſe equal to twelve gros. The Danes have copper ſhillings worth about one-fourth of a farthing ſterling.

SHILLUK, a town in Africa on the banks of the true Nile. The houſes are built of clay, and the clothing of the inhabitants conſiſts of long graſs, which they paſs round the waiſt and between the thighs. They are all black, and both ſexes ſhave their heads. Theſe people have the dominion of the river, and exact toll of all paſſengers. The meaning of the word Shilluk ſeems to be unknown. When they tranſport Mahometans acroſs the ferry, they ſometimes ſhew the importance which their ſituation gives them. After the Mahometan has placed himſelf in the boat, they aſk him, who is the maſter of that river? The other replies Ulloh or Rubbaric, God is the maſter of it. No, you muſt ſay that ſuch a one (naming his chief) is the maſter of it, or you ſhall not paſs. They are ſaid to be hoſpitable to ſuch as come among them in a peaceable manner, and as never betraying thoſe to whom they have once afforded protection. The particulars of their worſhip have not been deſcribed. Shilluk, according to Mr Browne's map, is in 13° N. Lat. 32° 26′ E. Long.

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* *Explicatio Rerum et Verborum in Leg. Sax. voc. Libra.*

† *Gram. Saxon.* p. 52.

Shiloh.

SHILOH, is a term famous among interpreters and commentators upon Scripture. It is found (Gen. xlix. 10.) to denote the Meſſiah. The patriarch Jacob foretells his coming in theſe words; "The ſceptre ſhall not depart from Judah, nor a lawgiver from between his feet, until Shiloh come; and unto him ſhall the gathering of the people be." The Hebrew text reads, יבא שלה ער כי *until Shiloh come.* All Chriſtian commentators agree, that this word ought to be underſtood of the Meſſiah, or Jeſus Chriſt; but all are not agreed about its literal and grammatical ſignification. St Jerome, who tranſlates it by *Qui mittendus eſt*, manifeſtly reads *Shiloach* "ſent," inſtead of *Shiloh*. The Septuagint have it Εως αν ελθη τα αποκειμενα αυτω; or, Εως αν ελθη ὡ αποκειται, (as if they had read שלן inſtead of שלה), i. e. "Until the coming of him to whom it is reſerved;" or, "Till we ſee arrive that which is reſerved for him."

It muſt be owned, that the ſignification of the Hebrew word *Shiloh* is not well known. Some tranſlate, "the ſceptre ſhall not depart from Judah, till he comes to whom it belongs;" שלה or שלי inſtead of לי אלן. Others, "till the coming of the peace-maker," or "the pacific; or, "of proſperity," שלה *proſperatus eſt. Shalah* ſignifies, "to be in peace, to be in proſperity;" others, "till the birth of him who ſhall be born of a woman that ſhall conceive without the knowledge of a man," שול or שליא *ſecundina, fluxus**; otherwiſe, "the ſceptre ſhall not depart from Judah, till its end, its ruin; till the downfal of the kingdom of the Jews," שאל or שלה *it has ceaſed, it has finiſhed*†. Some Rabbins have taken the name *Siloh* or *Shiloh*, as if it ſignified the city of this name in Paleſtine: "The ſceptre ſhall not be taken away from Judah till it comes to Shiloh; till it ſhall be taken from him to be given to Saul at Shiloh." But in what part of Scripture is it ſaid, that Saul was acknowledged as king or conſecrated at Shiloh? If we would underſtand it of Jeroboam the ſon of Nebat, the matter is ſtill as uncertain. The Scripture mentions no aſſembly at Shiloh that admitted him as king. A more modern author derives Shiloh from שלה, *fatigare*, which ſometimes ſignifies *to be weary, to ſuffer*; "till his labours, his ſufferings, his paſſion, ſhall happen."

But not to amuſe ourſelves about ſeeking out the grammatical ſignification of Shiloh, it is ſufficient for us to ſhow, that the ancient Jews are in this matter agreed with the Chriſtians: they acknowledge, that this word ſtands for the *Meſſiah the King*. It is thus that the paraphraſts Onkelos and Jonathan, that the ancient Hebrew commentaries upon Geneſis, and that the Talmudiſts themſelves, explain it. If Jeſus Chriſt and his apoſtles did not make uſe of this paſſage to prove the coming of the Meſſiah, it was becauſe then the completion of this prophecy was not ſufficiently manifeſt. The ſceptre ſtill continued among the Jews; they had ſtill kings of their own nation in the perſons of the Herods; but ſoon after the ſceptre was entirely taken away from them, and has never been reſtored to them ſince.

The Jews ſeek in vain to put forced meanings upon this prophecy of Jacob; ſaying, for example, that the ſceptre intimates the dominion of ſtrangers, to which they had been in ſubjection, or the hope of ſeeing one day the ſceptre or ſupreme power ſettled again among themſelves. It is eaſy to perceive, that all this is contrived to deliver themſelves out of perplexity. In vain likewiſe they take refuge in certain princes of the captivity, whom they pretend to have ſubſiſted beyond the Euphrates, exerciſing an authority over their nation little differing from abſolute, and being of the race of David. This pretended ſucceſſion of princes is perfectly chimerical; and though at certain times they could ſhow a ſucceſſion, it continued but a ſhort time, and their authority was too obſcure, and too much limited, to be the object of a prophecy ſo remarkable as this was.

Shiloh ‖ Ship.

SHINGLES, in building, ſmall pieces of wood, or quartered oaken boards, ſawn to a certain ſcantling, or, as is more uſual, cleft to about an inch thick at one end, and made like wedges, four or five inches broad, and eight or nine inches long.

Shingles are uſed inſtead of tiles or ſlates, eſpecially for churches and ſteeples; however, this covering is dear; yet, where tiles are very ſcarce, and a light covering is required, it is preferable to thatch; and where they are made of good oak, cleft, and not ſawed, and well ſeaſoned in water and the ſun, they make a ſure, light, and durable covering.

The building is firſt to be covered all over with boards, and the ſhingles nailed upon them.

SHIP, a general name for all large veſſels, particularly thoſe equipped with three maſts and a bowſprit; the maſts being compoſed of a lowermaſt, topmaſt, and top-gallant-maſt: each of theſe being provided with yards, ſails, &c. Ships, in general, are either employed for war or merchandiſe.

SHIPS of War are veſſels properly equipped with artillery, ammunition, and all the neceſſary martial weapons and inſtruments for attack or defence. They are diſtinguiſhed from each other by their ſeveral ranks or claſſes, called *rates*, as follows: Ships of the firſt rate mount from 100 guns to 110 guns and upwards; ſecond rate, from 90 to 98 guns; third rate, from 64 to 74 guns; fourth rate, from 50 to 60 guns; fifth rate, from 32 to 44 guns; and ſixth rates, from 20 to 28 guns. See the article RATE. Veſſels carrying leſs than 20 guns are denominated *ſloops*, *cutters*, *fire-ſhips* and *bombs*. It has lately been propoſed to reduce the number of theſe rates, which would be a ſaving to the nation, and alſo productive of ſeveral material advantages.

In Plate CCCCLXXX. is the repreſentation of a firſt rate, with rigging, &c. the ſeveral parts of which are as follows:

Plate CCCCLXXX. fig. 1.

Parts of the hull.—Fig. 1. A, The cathead; B, The fore-chain-wales, or chains; C, The main-chains; D, The mizen-chains; E, The entering port; F, The hawſe-holes; G, The poop lanterns; H, The cheſstree; I, The head; K, The ſtern.

1, The bowſprit. 2, Yard and ſail. 3, Gammoning. 4, Manrop. 5, Bobſtay. 6, Spritſail-ſheets. 7, Pendants. 8, Braces and pendants. 9, Halliards. 10, Lifts. 11, Clue-lines. 12, Spritſail-horſes. 13, Buntlines. 14, Standing lifts. 15, Bowſprit-ſhroud. 16, Jib-boom. 17, Jibſtay and ſail. 18, Halliards. 19, Sheets. 20, Horſes. 21, Jib guy. 22, Spritſail-topſail yard. 23, Horſes. 24, Sheets. 25, Lifts. 26, Braces and pendants. 27, Cap of bowſprit. 28, Jack ſtaff. 29, Truck. 30, Jack flag.—31, *Foremaſt*. 32. Runner and tackle. 33, Shrouds. 34, Laniards. 35. Stay and laniard. 36, Preventer-ſtay and laniard. 37, Woolding of the maſt. 38, Foreyard and ſail. 39, Horſes,

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* *Arab. Lud. de Dieu.*

† *Le Clerc in Geneſ.*

Horſes. 40, Top. 41, Crowfoot. 42, Jeers. 43, Yard-tackles. 44, Lifts. 45, Braces and pendants. 46, Sheets. 47, Foretacks. 48, Bowlines and bridles. 49, Fore buntlines. 50, Fore leechlines. 51, Preventer-brace. 52, Futtock-ſhrouds.—53, *Foretop-maſt*, 54, Shrouds and laniards. 55, Foretop-ſail yard and ſail. 56, Stay and ſail. 57, Runner. 58, Backſtays. 59, Halliards. 60, Lifts. 61, Braces and pendants. 62, Horſes. 63, Clew-lines. 64, Bowlines and bridles. 65, Reef-tackles. 66, Sheets. 67, Buntlines. 68, Croſs trees. 69, Cap. 70, Foretop-gallant-maſt. 71, Shrouds. 72, Yard and ſail. 73, Backſtays. 74, Stay. 75, Lifts. 76, Clewlines. 77, Braces and pendants. 78, Bowlines and bridles. 79, Flag-ſtaff. 80, Truck. 81, Flag-ſtay-ſtaff. 82, Flag of the lord high admiral.—83, *Mainmaſt*. 84, Shrouds. 85, Laniards. 86, Runner and tackle. 87, Futtock-ſhrouds. 88, Top-lantern. 89, Crank of ditto. 90, Stay. 91, Preventer-ſtay. 92, Stay-tackles. 93, Woolding of the maſt. 94, Jeers. 95, Yard-tackles. 96, Lifts. 97, Braces and pendants. 98, Horſes. 99, Sheets. 100, Tacks. 101, Bowlines and bridles. 102, Crow-foot. 103, Cap. 104, Top. 105, Buntlines. 106, Leechlines. 107, Yard and ſail.—108, *Main-topmaſt*. 109, Shrouds and laniards. 110, Yard and ſail. 111, Futtock-ſhrouds. 112, Backſtays. 113, Stay. 114, Stayſail and halliards. 115, Tye. 116, Halliards. 117, Lifts. 118, Clewlines. 119, Braces and pendants. 120, Horſes. 121, Sheets. 122, Bowlines and bridles. 123, Buntlines. 124, Reef-tackles. 125, Croſs-trees. 126, Cap.—127, *Maintop gallantmaſt*. 128, Shroud and laniards. 129, Yard and ſail. 130, Backſtays. 131, Stay. 132, Stayſail and halliards. 133, Lifts. 134, Braces and pendants. 135, Bowlines and bridles. 136, Clewlines. 137, Flagſtaff. 138, Truck. 139, Flagſtaff-ſtay. 140, Flag ſtandard.—141, *Mizenmaſt*. 142, Shrouds and laniards. 143, Cap. 144, Yard and ſail. 145, Block for ſignal halliards. 146, Sheet. 147, Pendant lines. 148, Peekbrails. 149, Stayſail. 150, Stay. 151, Derrick and ſpan. 152, Top. 153, Croſsjack yard. 154, Croſsjack lifts. 155, Croſsjack braces. 156, Croſsjack ſlings.—157, *Mizen-topmaſt*. 158, Shrouds and laniards. 159, Yard and ſail. 160, Backſtays. 161, Stay. 162, Halliards. 163, Lifts. 164, Braces and pendants. 165, Bowlines and bridles. 166, Sheets. 167, Clewlines. 168, Stayſail. 169, Croſstrees. 170, Cap. 171, Flagſtaff. 172, Flagſtaff-ſtay. 173, Truck. 174, Flag, union. 175, Enſign-ſtaff. 176, Truck. 177, Enſign. 178, Stern ladder. 179, Bower cable.

Plate CCLXXXI. fig. 2.

Fig. 2. Plate CCCCLXXXI. is a vertical longitudinal ſection of a firſt rate ſhip of war, with references to the principal parts; which are as follows:

A, Is the head containing,—1, The ſtem; 2, The knee of the head or cutwater; 3, The lower and upper cheek; 4, The trail-board; 5, The figure; 6, The gratings; 7. The brackets; 8, The falſe ſtem; 9, The breaſt hooks; 10, The hauſe holes; 11, The bulkhead forward; 12, The cathead; 13, The cathook; 14, Neceſſary ſeats; 15, The manger within board; 16, The bowſprit.

B, Upon the forecaſtle—17, The gratings; 18, The partners of the maſt; 19, The gunwale; 20, The belfry; 21, The funnel for ſmoke; 22, The gangway going off the forecaſtle; 23, The forecaſtle guns.

C, In the forecaſtle—24, The door of the bulkhead forward; 25, Officers cabins; 26, Staircaſe; 27, Fore-top-ſail ſheet bits; 28, The beams; 29, The carlings.

D, The middle gun-deck forward—30, The fore-jeer bits; 31, The oven and furnace of copper; 32, The captain's cook room; 33, The ladder or way to the forecaſtle.

E, The lower gun-deck forward—34, The knees fore and aft; 35, The ſpirketings, or the firſt ſtreak next to each deck, the next under the beams being called *clamps*; 36, The beams of the middle gun-deck fore and aft; 37, The carlings of the middle gun-deck fore and aft; 38, The fore-bits; 39, The after or main bits; 40, The hatchway to the gunner's and boatſwain's ſtore-rooms; 41, The jeer capſtan.

F, The orlop—42, 43, 44, The gunner's, boatſwain's, and carpenter's ſtore-rooms; 45, The beams of the lower gun-deck; 46, 47, The pillars and the riders, fore and aft; 48, The bulkhead of the ſtore-rooms.

G, The hold—49, 50, 51, The foot-hook rider, the floor rider, and the ſtandard, fore and aft; 52, The pillars; 53, The ſtep of the foremaſt; 54, The kelſon, or falſe keel, and dead riſing; 55, The dead-wood.

H, At midſhips in the hold—56, the floor-timbers; 57, The keel; 58, The well; 59, The chain-pump; 60, The ſtep of the mainmaſt; 61, 62, Beams and carlings of the orlop, fore and aft.

I, The orlop amidſhips—63, The cable tire; 64, The main hatchway.

K, The lower gun-deck amidſhips—65, The ladder leading up to the middle gun-deck; 66, The lower tire of ports.

L, The middle gun-deck amidſhip—67, The middle tire of ports; 68, The entering port; 69, The main jeer bits; 70, Twiſted pillars or ſtanchions; 71, The capſtan; 72, Gratings; 73, The ladder leading to the upper deck.

M, The upper gun-deck amidſhips—74, The main-topſail-ſheet bits; 75, The upper partners of the mainmaſt; 76, The gallows on which ſpare topmaſts, &c. are laid; 77, The fore ſheet blocks; 78, The rennets; 79, The gunwale; 80, The upper gratings; 81, The drift brackets; 82, The piſs dale; 83, The capſtan pall.

N, Abaft the mainmaſt—84, The gangway off the quarterdeck; 85, The bulkhead of the coach; 86, The ſtaircaſe down to the middle gun-deck; 87, The beams of the upper deck; 88, The gratings about the mainmaſt; 89, The coach or council-chamber; 90, The ſtaircaſe up to the quarterdeck.

O, The quarterdeck—91, The beams; 92, The carlings; 93, The partners of the mizenmaſt; 94, The gangway up to the poop; 95, The bulkhead of the cuddy.

P, The poop—96, The trumpeter's cabin; 97, The taffarel.

Q, The captain's cabin.

R, The cuddy, uſually divided for the maſter and ſecretary's officers.

S, The ſtate-room, out of which is made the bed-chamber and other conveniences for the commander in chief; 98, The entrance into the gallery; 99, The bulkhead of the great cabin; 100, The ſtern lights and after galleries.

T, The ward-room, allotted for the lieutenants and marine officers: 101, The lower gallery; 102, The ſteerage and bulkhead of the wardroom; 103, The whipſtaff, commanding the tiller; 104, The after ſtaircaſe leading down to the lower gun-deck.

V, Several officers cabins abaft the mainmaſt, where the ſoldiers generally keep guard.

W, The gun room—105, the tiller commanding the rudder; 106, The rudder; 107, The ſtern-poſt; 108, The tiller tranſom; 109, The ſeveral tranſoms, viz. 1, 2, 3, 4, 5; 110, The gun-room ports, or ſtern-chaſe; 111, The bread room ſcuttle, out of the gun-room; 112, The main capſtan; 113, The pall of the capſtan; 114, The partner; 115, The bulkhead of the bread-room.

X, The bread-room.

Y, The ſteward's room, where all proviſions are weighed and ſerved out.

Z, The cockpit, where are ſubdiviſions for the purſer, the ſurgeon, and his mates.

AA, The platform or orlop, where proviſion is made for the wounded in the time of ſervice; 116, The hold abaft the main-maſt; 117, The ſtep of the mizen-maſt; 118, The kelſon, or falſe keel; 119, The dead wood, or riſing.

Ships of war are fitted out either at the expence of the ſtate or by individuals. Thoſe fitted out at the public expence are called *King's ſhips*, and are divided into *ſhips of the line, frigates, ſloops*, &c. For an account of each of theſe, ſee the reſpective articles. Ships of war fitted out by individuals are called *privateers*. See the article PRIVATEER.

Armed-SHIP. See *ARMED-Ship*.

Bomb-SHIP. See *BOMB Veſſels*.

Double-SHIP. See *SHIP-Building*.

Fire-SHIP. See *FIRE-Ship*.

Hoſpital-SHIP, a veſſel fitted up to attend on a fleet of men of war, and receive their ſick or wounded; for which purpoſe her decks ſhould be high, and her ports ſufficiently large. Her cables ought alſo to run upon the upper deck, to the end that the beds or cradles may be more commodiouſly placed between decks, and admit a free paſſage of the air to diſperſe that which is offenſive or corrupted.

Merchant-SHIP, a veſſel employed in commerce to carry commodities of various ſorts from one port to another.

The largeſt merchant ſhips are thoſe employed by the different companies of merchants who trade to the Eaſt Indies. They are in general larger than our 40 gun ſhips; and are commonly mounted with 20 guns on their upper-deck, which are nine pounders; and ſix on their quarter-deck, which are ſix pounders.

Regiſter-SHIP. See *REGISTER-Ship*.

Store-SHIP, a veſſel employed to carry artillery or naval ſtores for the uſe of a fleet, fortreſs, or garriſon.

Tranſport-SHIP, is generally uſed to conduct troops from one place to another.

Beſides the different kinds of ſhips above mentioned, which are denominated from the purpoſe for which they are employed, veſſels have alſo, in general, been named according to the different manner of rigging them. It would be an endleſs, and at the ſame time an unneceſſary taſk, to enumerate all the different kinds of veſſels with reſpect to their rigging; and therefore a few only are here taken notice of. Fig. 3. is a *ſhip* which would be converted into a *bark* by ſtripping the mizen maſt of its yards and the ſails belonging to them. If each maſt, its correſponding topmaſt and topgallant-maſt, inſtead of being compoſed of ſeparate pieces of wood, were all of one continued piece, then this veſſel with very little alteration would be a *polacre*. Fig. 4. repreſents a *ſnow*; fig. 5. a *bilander*; fig. 6. a *brig*; fig. 7. a *ketch*; fig. 8. a *ſchooner*; fig. 9. a *ſloop*; fig. 10. a *zebec*; fig. 11. a *galliot*; fig. 12. a *dogger*; fig. 13. a *galley* under ſail; fig. 14. ditto rowing.

Plate CCCCLXXXI. fig. 3.

Plate cccclxxxi fig. 6.

Ships are alſo ſometimes named according to the different modes of their conſtruction. Thus we ſay, a *cat-built* ſhip, &c.

To SHIP, is either uſed actively, as to embark any perſon or put any thing aboard ſhip: or paſſively, to receive any thing into a ſhip; as, "we ſhipped a heavy ſea at three o'clock in the morning."

To SHIP, alſo implies to fix any thing in its place; as, to ſhip the oars, that is, to put them in their rowlocks; to ſhip the ſwivel guns, is to fix them in their ſockets; to ſhip the handſpokes, &c.

Machine for drawing Bolts out of SHIPS, an inſtrument invented by Mr William Hill for this purpoſe. His account of which is as follows *.

"Firſt, The uſe of this machine is to draw the kelſon and dead wood bolts out, and to draw the knee of the head bolts.—Secondly, The heads of the kelſon bolts heretofore were all obliged to be driven through the kelſon, floor-timbers, and keel, to get them out; by this means the kelſon is often entirely deſtroyed, and the large hole the head makes materially wounds the floors; and frequently, when the bolt is much corroded, it ſcarfs, and the bolt comes out of the ſide of the keel.—Thirdly, The dead-wood bolts that are driven with two or three drifts, are ſeldom or never got out, by which means the dead wood is condemned, when ſome of it is really ſerviceable.—Fourthly, In drawing the knee of the head-bolts, ſometimes the knee ſtarts off, and cannot be got to again, but furs up, and with this machine may be drawn in; for it has been proved to have more power in ſtarting a bolt than the maul."

Plate cccclxxx fig. 1.

In fig. 1. "A, A, repreſent two ſtrong male ſcrews, working in female ſcrews near the extremities of the cheeks, againſt plates of iron E, E. C C is the bolt to be drawn; which, being held between the chaps of the machine at DD, is, by turning the ſcrews by the lever B, forced upwards out of the wood or plank of the ſhip. F, F, are two dogs, with hooks at their lower extremities; which being driven into the plank, ſerve to ſupport the machine till the chaps have got faſt hold of the bolt. At the upper part of theſe dogs are rings paſſing through holes in a collar, moveable near the heads of the ſcrews. Fig. 2. is a view of the upper ſide of the cheeks when joined together; *a, a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn. Fig. 3. The under ſide of the cheek: *a, a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn, and where the teeth that gripe the bolt are more diſtinctly ſhown. Fig. 4. One of the cheeks ſeparated from the other, the letters referring as in fig. 2. and 3.

Fig. 2.

Fig. 3.

Fig. 4.

This machine was tried in his majeſty's yard at Deptford, and was found of the greateſt utility.—"Firſt, it drew a bolt that was driven down ſo tight as only to go

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* *Tranſac tions of t Society fo the Encou ragement of Arts*, &c. vol.

one inch in ſixteen blows with a double headed maul, and was well clenched below: the bolt drew the ring a conſiderable way into the wood, and wire drew itſelf through, and left the ring behind. Secondly, it drew a bolt out of the Venus's dead wood that could not be got out by the maul. That part of it which went through the keel was bent cloſe up to the lower part of the dead-wood, and the machine drew the bolt ſtraight, and drew it out with eaſe. It alſo drew a kelſon bolt out of the Stanley Weſt Indiaman, in Meſſrs Well's yard, Deptford; which being a bolt of two drifts, could not be driven out.

Management of SHIPS at ſingle anchor, is the method of taking care of a ſhip while riding at ſingle anchor in a tide-way, by preventing her from fouling her anchor, &c. The following rules for this purpoſe, with which we have been favoured by Henry Taylor * of North Shields, will be found of the utmoſt conſequence.

* *Taylor's Inſtructions to Young Mariners Riding at Anchor in moderate Weather.*

Riding in a tide-way, with a freſh-of-wind, the ſhip ſhould have what is called *a ſhort* or *windward ſervice*, ſay 45 or 50 fathoms of cable, and always ſheered to windward (A), not always with the helm hard down, but more or leſs ſo according to the ſtrength or weakneſs of the tide. It is a known fact, that many ſhips ſheer their anchors home, drive on board of other ſhips, and on the ſands near which they rode, before it has been diſcovered that the anchor had been moved from the place where it was let go.

1 When the ſhip will back.

When the wind is croſs, or nearly croſs, off ſhore, or in the oppoſite direction, ſhips will always back. This is done by the mizen-topſail, aſſiſted, if needful, by the mizen-ſtayſail; ſuch as have no mizen-topſail commonly uſe the main-topſail, or if it blows freſh, a topgallant-ſail, or any ſuch ſail at the gaff.

In backing, a ſhip ſhould always wind with a taught cable, that it may be certain the anchor is drawn round. In caſe there is not a ſufficiency of wind for that purpoſe, the ſhip ſhould be hove apeak.

2 How the yards ought to be braced.

Riding with the wind afore the beam, the yards ſhould be braced forward; if abaft the beam, they are to be braced all aback.

3 Riding windward tide in danger of breaking her ſheer.

If the wind is ſo far aft that the ſhip will not back (which ſhould not be attempted, when the tide eaſes, the ſhip forges ahead, and brings the buoy on the lee quarter), ſhe muſt be ſet ahead: if the wind is far aft, and blows freſh, the utmoſt care and attention is neceſſary, as ſhips riding in this ſituation often break their ſheer, and come to windward of their anchors again. It ſhould be obſerved, that when the ſhip lies in this tickliſh ſituation, the after-yards muſt be braced forward, and the fore-yards the contrary way: ſhe will lay ſafe, as the buoy can be kept on the lee quarter, or ſuppoſe the helm is a-port, as long as the buoy is on the larboard quarter. With the helm thus, and the wind right aft, or nearly ſo, the ſtarboard main and fore braces ſhould be hauled in. This ſuppoſes the main braces to lead forward.

4 Tending to leeward when the ſhip muſt be ſet ahead.

When the ſhip begins to tend to leeward, and the buoy comes on the weather-quarter, the firſt thing to be done is to brace about the fore-yard; and when the wind comes near the beam, ſet the fore-ſtayſail, and keep it ſtanding until it ſhakes; then brace all the yards ſharp forward, eſpecially if it is likely to blow ſtrong.

5 How to manage when the ſhip breaks her ſheer.

If laying in the aforeſaid poſition, and ſhe breaks her ſheer, brace about the main-yard immediately; if ſhe recovers and brings the buoy on the lee or larboard quarter, let the main-yard be again braced about; but if ſhe come to a ſheer the other way, by bringing the buoy on the other quarter, change the helm and brace the fore-yard to.

6 When a long ſervice is out, and the ſhip is likely to go to windward.

Riding leeward tide with more cable than the windward ſervice, and expecting the ſhip will go to windward of her anchor, begin as ſoon as the tide eaſes to ſhorten in the cable. This is often hard work; but it is neceſſary to be done, otherwiſe the anchor may be fouled by the great length of cable the ſhip has to draw round; but even if that could be done, the cable would be damaged againſt the bows or cut-water. It is to be obſerved, that when a ſhip rides windward tide, the cable ſhould be cackled from the ſhort ſervice towards the anchor, as far as will prevent the bare part touching the ſhip.

When the ſhip tends to windward and muſt be ſet ahead, hoiſt the fore-ſtayſail as ſoon as it will ſtand, and when the buoy comes on the lee quarter, haul down the fore-ſtayſail, brace to the fore-yard, and put the helm a-lee; for till then the helm muſt be kept a-weather and the yards full.

7 How to manage in a ſtorm.

When the ſhip rides leeward tide, and the wind increaſes, care ſhould be taken to give her more cable in time, otherwiſe the anchor may ſtart, and probably it will be troubleſome to get her brought up again; and this care is the more neceſſary when the ſhip rides in the hauſe of another ſhip. Previous to giving a long ſervice it is uſual to take a weather-bit, that is, a turn of the cable over the windlaſs end, ſo that in veering away the ſhip will be under command. The ſervice ought

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(A) It has been thought by ſome theoriſts, that ſhips ſhould be ſheered to leeward of their anchors; but experience and the common practice of the beſt informed ſeamen are againſt that opinion: for it is found, that when a ſhip rides leeward tide and ſheered to windward, with the wind two or three points upon the bow, and blowing hard in the interval between the ſqualls, the ſheer will draw her towards the wind's eye; ſo that when the next ſquall comes, before ſhe be preſſed aſtream of her anchor, it is probable there will be a lull again, and the ſpring which the cable got by the ſheer will greatly eaſe it during the ſquall.

Every ſeaman knows that no ſhip without a rudder, or the helm left looſe, will wear; they always in ſuch ſituations fly to: this proves that the wind preſſing upon the quarter and the helm a-lee, a ſhip will be leſs liable to break her ſheer than when the helm is a-weather. Beſides, if the helm is a-lee when ſhe breaks her ſheer, it will be a-weather when the wind comes on the other quarter, as it ought to be until ſhe either ſwing to leeward, or bring the buoy on the other quarter. Now if the ſhip breaks her ſheer with the helm a-weather, it throws her head to the wind ſo ſuddenly as ſcarce to give time to brace the yards about, and very probably ſhe will fall over her anchor before the fore-ſtayſail can be got up.

ought to be greaſed, which will prevent its chafing in the hauſe.

If the gale continues to increaſe, the topmaſts ſhould be ſtruck in time; but the fore-yard ſhould ſeldom, if ever, be lowered down, that in caſe of parting the foreſail may be ready to be ſet. At ſuch times there ſhould be more on deck than the common anchor-watch, that no accident may happen from inattention or falling aſleep.

In a tide-way a ſecond anchor ſhould never be let go but when abſolutely neceſſary; for a ſhip will ſometimes ride eaſier and ſafer, eſpecially if the ſea runs high, with a very long ſcope of cable and one anchor, than with leſs length and two cables; however, it is adviſable, as a preventive, when ſhips have not room to drive, and the night is dark, to let fall a ſecond anchor under foot, with a range of cable along the deck. If this is not thought neceſſary to be done, the deep-ſea lead ſhould be thrown overboard, and the line frequently handled by the watch that they may be aſſured ſhe rides faſt.

8
Caution reſpecting the anchor watch.

If at any time the anchor-watch, preſuming on their own knowledge, ſhould wind the ſhip, or ſuffer her to break her ſheer without calling the mate, he ſhould immediately, or the very firſt opportunity, oblige the crew to heave the anchor in ſight; which will prevent the commiſſion of the like fault again; for beſides the ſhare of trouble the watch will have, the reſt of the crew will blame them for neglecting their duty.

9
The particular duty of the chief mate.

Prudent mates ſeldom lie a week in a road-ſtead without heaving their anchor in ſight; even though they have not the leaſt ſuſpicion of its being foul. There are other reaſons why the anchor ſhould be looked at; ſometimes the cable receives damage by ſweeping wrecks or anchors that have been loſt, or from rocks or ſtones; and it is often neceſſary to trip the anchor, in order to take a clearer birth, which ſhould be done as often as any ſhip brings up too near.

Method for the ſafe removal of ſuch SHIPS *as have been driven on ſhore.* For this purpoſe empty caſks are uſually employed to float off the veſſel, eſpecially if ſhe is ſmall, and at the ſame time near the port to which it is propoſed to conduct her. In other caſes, the following method adopted by Mr Barnard* will anſwer.

"On January 1. 1779 (ſays Mr Barnard), in a moſt dreadful ſtorm, the York Eaſt Indiaman, of eight hundred tons, homeward bound, with a pepper cargo, parted her cables in Margate roads, and was driven on ſhore within one hundred feet of the head and thirty feet of the ſide of Margate pier, then drawing twenty-two feet ſix inches water, the flow of a good ſpring tide being only fourteen feet at that place.

"On the third of the ſame month I went down, as a ſhip-builder, to aſſiſt, as much as lay in my power, my worthy friend Sir Richard Hotham, to whom the ſhip belonged. I found her perfectly upright, and her ſheer (or ſide appearance) the ſame as when firſt built, but ſunk to the twelve feet water-mark fore and aft in a bed of chalk mixed with a ſtiff blue clay, exactly the ſhape of her body below that draft of water; and from the rudder being torn from her as ſhe ſtruck coming on ſhore, and the violent agitation of the ſea after her being there, her ſtern was ſo greatly injured as to admit free acceſs thereto, which filled her for four days equal to the flow of the tide. Having fully informed myſelf of her ſituation and the flow of ſpring-tides, and being clearly of opinion ſhe might be again got off, I recommended, as the firſt neceſſary ſtep, the immediate diſcharge of the cargo; and, in the progreſs of that buſineſs, I found the tide always flowed to the ſame height on the ſhip; and when the cargo was half diſcharged, and I knew the remaining part ſhould not make her draw more than eighteen feet water, and while I was obſerving the water at twenty-two feet ſix inches by the ſhip's marks, ſhe inſtantly lifted to ſeventeen feet eight inches; the water and air being before excluded by her preſſure on the clay, and the atmoſphere acting upon her upper part equal to ſix hundred tons, which is the weight of water diſplaced at the difference of theſe two drafts of water.

"The moment the ſhip lifted, I diſcovered ſhe had received more damage than was at firſt apprehended, her leaks being ſuch as filled her from four to eighteen feet water in an hour and a half. As nothing effectual was to be expected from pumping, ſeveral ſcuttles or holes in the ſhip's ſide were made, and valves fixed thereto, to draw off the water at the loweſt ebb of the tide, to facilitate the diſcharge of the remaining part of the cargo; and, after many attempts, I ſucceeded in an external application of ſheep-ſkins ſewed on a ſail and thruſt under the bottom, to ſtop the body of water from ruſhing ſo furiouſly into the ſhip. This buſineſs effected, moderate pumping enabled us to keep the ſhip to about ſix feet water at low water, and by a vigorous effort we could bring the ſhip ſo light as (when the cargo ſhould be all diſcharged) to be eaſily removed into deep water. But as the external application might be diſturbed by ſo doing, or totally removed by the agitation of the ſhip, it was abſolutely neceſſary to provide ſome permanent ſecurity for the lives of thoſe who were to navigate her to the river Thames. I then recommended as the cheapeſt, quickeſt, and moſt effectual plan, to lay a deck in the hold, as low as the water could be pumped to, framed ſo ſolidly and ſecurely, and caulked ſo tight, as to ſwim the ſhip independent of her own leaky bottom.

"Beams of fir-timber twelve inches ſquare were placed in the hold under every lower-deck beam in the ſhip, as low as the water would permit; theſe were in two pieces, for the conveniency of geting them down, and alſo for the better fixing them of an exact length, and well bolted together when in their places. Over theſe were laid long Dantzic deals of two inches and a half thick, well nailed and caulked. Againſt the ſhip's ſides, all fore and aft, was well nailed a piece of fir twelve inches broad and ſix inches thick on the lower and three inches on the upper edge, to prevent the deck from riſing at the ſide. Over the deck, at every beam, was laid a croſs piece of fir timber ſix inches deep and twelve inches broad, reaching from the pillar of the hold to the ſhip's ſide, on which the ſhores were to be placed to reſiſt the preſſure of the water beneath. On each of theſe, and againſt the lower-deck beam, at equal diſtances from the ſide and middle of the ſhip, was placed an upright ſhore, ſix inches by twelve, the lower end let two inches into the croſs piece. From the foot of this ſhore to the ſhip's ſide, under the end of every lower deck beam, was placed a diagonal ſhore ſix inches by twelve, to eaſe the ſhip's deck of part of the ſtrain by throwing it on the ſide. An upright ſhore of three inches by twelve was placed from the end of every croſs piece

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* Philoſophical Tranſactions, vol. lxx. part I.

piece to the lower deck beams at the ſide, and one of three inches by twelve on the midſhip end of every croſs piece to the lower deck beam, and nailed to the pillars in the hold. Two firm tight bulkheads or partitions were made as near the extremes of the ſhip as poſſible. The ceiling or inſide plank of the ſhip was very ſecurely caulked up to the lower deck, and the whole formed a complete ſhip with a flat bottom within ſide, to ſwim the outſide leaky one; and that bottom being depreſſed ſix feet below the external water, reſiſted the ſhip's weight above it equal to five hundred and eighty-one tons, and ſafely conveyed her to the dry-dock at Deptford."

SHIP-BUILDING.

1 Definition. SHIP-BUILDING, or NAVAL ARCHITECTURE, is the art of conſtructing a ſhip ſo as to anſwer a particular purpoſe either of war or merchandiſe.

2 Hiſtory. To whom the world is indebted for the invention of ſhips, is, like all other things of equal antiquity, uncertain.

A very ſmall portion of art or contrivance was ſeen in the firſt ſhips: they were neither ſtrong nor durable; but conſiſted only of a few planks laid together, without beauty or ornament, and juſt ſo compacted as to keep out the water. In ſome places they were only the hulks or ſtocks of trees hollowed, and then conſiſted only of one piece of timber. Nor was wood alone applied to this uſe; but any other buoyant materials, as the Egyptian reed papyrus; or leather, of which the primitive ſhips were frequently compoſed; the bottom and ſides being extended on a frame of thin battens or ſcantlings, of flexible wood, or begirt with wickers, ſuch as we have frequently beheld amongſt the American ſavages. In this manner they were often navigated upon the rivers of Ethiopia, Egypt, and Sabæan Arabia, even in latter times. But in the firſt of them, we find no mention of any thing but leather or hides ſewed together. In a veſſel of this kind, Dardanus ſecured his retreat to the country afterwards called *Troas*, when he was compelled by a terrible deluge to forſake his former habitation of Samothrace. According to Virgil, Charon's infernal boat was of the ſame compoſition.

But as the other arts extended their influence, naval architecture likewiſe began to emerge from the gloom of ignorance and barbariſm; and as the ſhips of thoſe ages were increaſed in bulk, and better proportioned for commerce, the appearance of the floating citadels of unuſual form, full of living men, flying with ſeemingly expanded wings over the ſurface of the untravelled ocean, ſtruck the ignorant people with terror and aſtoniſhment: and hence, as we are told by Ariſtophanes, aroſe the fable of Perſeus flying to the Gorgons, who was actually carried thither in a ſhip! Hence, in all probability, the famous ſtory of Triptolemus riding on a winged dragon is deduced, only becauſe he ſailed from Athens, in the time of great dearth, to a more plentiful country, to ſupply the neceſſities of his people. The fiction of the flying horſe Pegaſus may be joined with thoſe, who, as ſeveral mythologiſts report, was nothing but a ſhip with ſails, and thence ſaid to be the offspring of Neptune the ſovereign of the ſea; nor does there appear any other foundation for the ſtories of griffins, or of ſhips transformed into birds and fiſhes, which we ſo often meet with in the ancient poets. So acceptable to the firſt ages of the world were inventions of this nature, that whoever made any improvements in navigation or naval architecture, building new ſhips better fitted for ſtrength or ſwiftneſs than thoſe uſed before, or rendered the old more commodious by additional contrivances, or diſcovered countries unknown to former travellers, were thought worthy of the greateſt honours, and often aſſociated into the number of their deified heroes. Hence we have in aſtronomy the ſigns of Aries and Taurus, which were no other than two ſhips; the former tranſported Phryxus from Greece to Colchos, and the latter Europa from Phœnicia to Crete. Argo, Pegaſus, and Perſeus, were likewiſe new ſhips of a different ſort from the former, which being greatly admired by the barbarous and uninſtructed people of thoſe times, were tranſlated amongſt the ſtars, in commemoration of their inventors, and metamorphoſed into conſtellations by the poets of their own and of ſucceeding ages.

Hiſtory.

The chief parts, of which ſhips anciently conſiſted, were three, viz. the belly, the prow, and the ſtern: theſe were again compoſed of other ſmaller parts, which ſhall be briefly deſcribed in their order. In the deſcription, we chiefly follow Scheffer, who has ſo copiouſly treated this ſubject, and with ſuch induſtry and learning collected whatever is neceſſary to illuſtrate it, that very little room is left for enlargement by thoſe who incline to purſue this inveſtigation.

1. In the belly, or middle part of the ſhip, there was τροπις, *carina*, or the "keel," which was compoſed of wood: it was placed at the bottom of the ſhip, being deſigned to cut and glide through the waves, and therefore was not broad, but narrow and ſharp; whence it may be perceived that not all ſhips, but only the μακραι, which ſhips of war were called, whoſe bellies were ſtraight, and of a ſmall circumference, were provided with keels, the reſt having uſually flat bottoms. Around the outſide of the keel were fixed pieces of wood, to prevent it from being damaged when the ſhip was firſt launched into the water, or afterwards ſtruck on any rocks; theſe were called χελευσματα, in Latin *cunei*.

Next to the keel was φαλκις, the "pump well, or well-room," within which was contained the αντλιον, or "pump," through which water was conveyed out of the ſhip.

After this, there was δευτερω τροπις, or the "ſecond keel," ſomewhat reſembling what is now called *kelſon*; it was placed beneath the pump, and called λεσβιον, χαλκηνε, κλειτοποδιον; by ſome it is falſely ſuppoſed to be the ſame with φαλκις.

Above the pump was an hollow place, called by Herodotus κοιλη της νηος, by Pollux, κυτος and γαστρα, becauſe large and capacious, after the form of a belly; by the Latins *teſtudo*. This was formed by crooked ribs, with which it was ſurrounded, which were pieces of wood riſing from the keel upwards, and called by Heſychius

νομεις

νομεις, and by others εγκοιλια, the belly of the ſhip being contained within them: in Latin *coſtæ;* and in Engliſh, *timbers*. Upon theſe were placed certain planks, which Ariſtophanes calls εντερωνειας, or εντερωνιδα.

The πλευραι, *latera*, or "ſides" of the ſhip, encompaſſed all the former parts on both hands; theſe were compoſed of large rafters extended from prow to ſtern, and called ζωστηρες, and ζωμιαματα, becauſe by them the whole fabric was begirt or ſurrounded.

In both theſe ſides the rowers had their places, called τοιχοι and εδωλια, in Latin *fori* and *tranſtra*, placed above one another; the loweſt was called θαλαμος, and thoſe that laboured therein θαλαμιοι; the middle, ζολα, and the men ζυλιοι; the uppermoſt θρανοι, whence the rowers were termed θρανιται. In theſe apartments were ſpaces through which the rowers put their oars: theſe were ſometimes one continued vacuity from one end to the other, called τραφηξ, but more uſually diſtinct holes, each of which was deſigned for a ſingle oar; theſe were ſtyled τρηματα, τρυπηματα, as alſo οφθαλμοι, becauſe not unlike the eyes of living creatures. All of them were by a more general name termed εγκωπα, from containing the oars; but εγκωπιν ſeems to have been another thing, ſignifying the ſpaces between the banks of oars on each ſide, where the paſſengers appear to have been placed. On the top of all there was a paſſage or place to walk, called παραδος, and παραθρανος, as joining to the θρανοι, or uppermoſt bank of oars.

2. Πρωρα, the "prow, or fore-deck," whence it is ſometimes called μετωπον, and commonly diſtinguiſhed by other metaphorical titles taken from human faces. In ſome ſhips there is mention of two prows, as alſo two ſterns; ſuch as Danaus's ſhip adorned by Minerva when he fled from Egypt. It was uſual to beautify the prow with gold and various ſorts of paint and colours; in the primitive times red was moſt in uſe; whence Homer's ſhips were generally dignified with the titles of μιλτοπαρηοι, and φοινικοπαρηοι, or "red faced;" the hluc, likewiſe, or ſky-colour, was frequently made uſe of, as bearing a ſtrict reſemblance to the colour of the ſea; whence we find ſhips called by Homer κυανοπρωροι, by Ariſtophanes κυανεμβολοι. Several other colours were alſo made uſe of; nor were they barely varniſhed over with them, but very often annealed by wax melted in the fire, ſo that neither the ſun, winds, nor water, were able to deface them. The art of doing this was called from the wax κηρογραφια, from the fire εγκαυστικη, which is deſcribed by Vitruvius, and mentioned in Ovid.

———————Picta coloribus uſtis
Cœruleam matrem concava puppis habet.

The painted ſhip with melted wax anneal'd
Had Tethys for its deity———————

In theſe colours the various forms of gods, animals, plants, &c. were uſually drawn, which were likewiſe often added as ornaments to other parts of the ſhips, as plainly appears from the ancient monuments preſented to the world by Bayſius.

The ſides of the prow were termed πτερα, or "wings," and παρια, according to Scheffer, or rather παρειαι; for ſince the prow is commonly compared to a human face, it will naturally follow that the ſides ſhould be called *cheeks*. Theſe are now called *bows* by our mariners.

3. Πρυμνη, "the hind-deck or poop," ſometimes called ουρα, the "tail," becauſe the hindmoſt part of the ſhip; it was of a figure more inclining to round than the prow, the extremity of which was ſharp, that it might cut the waters; it was alſo built higher than the prow, and was the place where the pilot ſat to ſteer; the outer-bending part of it was called επισειων, anſwering to our term *quarter*.

They had various ornaments of ſculpture on the prow; as helmets, animals, triumphal wreaths, &c.—The ſtern was more particularly adorned with wings, ſhields, &c. Sometimes a little maſt was erected whereon to hang ribbands of divers colours, which ſerved inſtead of a flag to diſtinguiſh the ſhip; and a weathercock, to ſignify the part from whence the wind blew.

On the extremity of the prow was placed a round piece of wood, called the πτυχις, from its bending; and ſometimes οφθαλμος, the "eye" of the ſhip, becauſe fixed in the fore-deck; on this was inſcribed the name of the ſhip, which was uſually taken from the figure painted on the flag. Hence comes the frequent mention of ſhips called *Pegaſi*, *Scyllæ*, *bulls*, *rams*, *tigers*, &c. which the poets took the liberty to repreſent as living creatures that tranſported their riders from one country to another.

The whole fabric being completed, it was fortified with pitch, and ſometimes a mixture of roſin, to ſecure the wood from the waters; whence it comes that Homer's ſhips are everywhere mentioned with the epithet of μελαιναι, or "black." Pitch was firſt uſed by the inhabitants of Phæacia, ſince called Corſica; ſometimes wax was employed for the ſame purpoſe; whence Ovid,

Cœrulea ceratas accipit unda rates.

The azure waves receive the waxed ſhips.

After all, the ſhip being bedecked with garlands and flowers, the mariners alſo adorned with crowns, ſhe was launched into the ſea with loud acclamations and other expreſſions of joy; and being purified by a prieſt with a lighted torch, an egg and brimſtone, or after ſome other manner, was conſecrated to the god whoſe image ſhe bore.

The ſhips of war of the ancients were diſtinguiſhed from other kinds of veſſels by various turrets and acceſſions of building, ſome to defend their own ſoldiers, and others to annoy the enemy; and from one another, in latter ages, by ſeveral degrees or ranks of oars, the moſt uſual number of which was four or five, which appear not to have been arranged, as ſome imagine, on the ſame level in different parts of the ſhip; nor yet, as others have ſuppoſed, directly above one another's heads; but their ſeats being placed one behind another, aſcended gradually, like ſtairs. Ptolemy Philopater, urged by a vain-glorious deſire of exceeding all the world beſides in naval architecture, is ſaid to have farther enlarged the number of banks to 40; and the ſhip being otherwiſe in equal proportion, this raiſed her to ſuch an enormous bulk, that ſhe appeared at a diſtance like a floating mountain or iſland; and, upon a nearer view, like a prodigious caſtle on the ocean. She was 280 cubits long, 38 broad, and 48 high (each cubit being 1 Engliſh foot $5\frac{1}{2}$ inches), and carried 400 rowers, 400 ſailors, and 3000 ſoldiers. Another which the ſame

ſame prince made to ſail on the Nile, we are told, was half a ſtadium long. Yet theſe were nothing in compariſon of Hiero's ſhip, built under the direction of Archimedes; on the ſtructure of which Moſchion wrote a whole volume. There was wood enough employed in it to make 50 galleys; it had all the variety of apartments of a palace; ſuch as banqueting-rooms, galleries, gardens, fiſh-ponds, ſtables, mills, baths, and a temple to Venus. The floors of the middle apartment were all inlaid, and repreſented in various colours the ſtories of Homer's Iliad. The ceilings, windows, and all other parts, were finiſhed with wonderful art, and embelliſhed with all kinds of ornaments. In the uppermoſt apartment there was a ſpacious gymnaſium, or place for exerciſe, and water was conveyed to the garden by pipes, ſome of hardened clay, and others of lead. The floors of the temple of Venus were inlaid with agates and other precious ſtones; the inſide lined with cypreſs wood; the windows adorned with ivory paintings and ſmall ſtatues. There was likewiſe a library. This veſſel was adorned on all ſides with fine paintings. It had 20 benches of oars, and was encompaſſed with an iron rampart, eight towers, with walls and bulwarks, furniſhed with machines of war, particularly one which threw a ſtone of 300 pounds, or a dart 12 cubits long, the ſpace of half a mile, with many other particulars related by Athenæus. Caligula likewiſe built a veſſel adorned with jewels in the poop, with ſails of many colours, and furniſhed with large porticoes, bagnios, and banqueting-rooms, beſides rows of vines, and fruit-trees of various kinds. But theſe, and all ſuch monſtrous fabrics, ſerved only for ſhow and oſtentation, being rendered by their vaſt bulk unwieldy and unfit for ſervice. Athenæus informs us, the common names they were known by, were *Cyclades*, or *Ætna*, i. e. "iſlands, or mountains," to which they ſeemed nearly equal in bigneſs; conſiſting, as ſome report, of as many materials as would have compoſed 50 triremes, or ſhips of three banks.

The veſſels employed by the northern nations appear to have been ſtill more imperfect than thoſe of the Romans; for a law was enacted in the reign of the emperor Honorius, 24th September, A. D. 418, inflicting capital puniſhment on any who ſhould inſtruct the barbarians in the art of ſhip-building; a proof at once of the great eſtimation in which this ſcience was then held, and of the ignorance of the barbarians with regard to it.

The fleet of Richard I. of England, when he weighed anchor for the holy war from Meſſina, in Sicily, where he had paſſed the winter, A. D. 1190-1, is ſaid to have conſiſted of 150 great ſhips and 53 galleys, beſides barks, tartans, &c. What kinds of ſhips theſe were is not mentioned. To the cruſades, however pernicious in other reſpects, this ſcience ſeems to owe ſome improvements; and to this particular one we are indebted for Richard's marine code, commonly called the *Laws of Oleron*, from the name of a ſmall iſland on the coaſt of France, where he compoſed them, and which moſt of the nations in Europe have made the baſis of their maritime regulations. Thoſe ſhips, if they merited the name of ſhips, were probably very ſmall, as we find that ſo long after as the time of Edward I. anno 1304, 40 men were deemed ſufficient to man the beſt and largeſt veſſels in England; and that Edward the Third, anno 1335, ordained the mayor and ſheriffs of London to "take up all ſhips in their port, and all other ports in the kingdom, of the burden of 40 tons and upwards, and to furniſh the ſame with armed men and other neceſſaries of war, againſt the Scots his enemies, confederated with certain perſons of foreign nations." Edward the Third's fleet before Calais, anno 1347, conſiſted of 738 Engliſh ſhips, carrying 14,956 mariners, being on an average but 20 men to each ſhip; 15 ſhips and 459 mariners, from Bayonne in Guienne, being 30 men to each ſhip; 7 ſhips and 184 men from Spain, which is 26 men to each ſhip; one from Ireland, carrying 25 men; 14 from Flanders, with 133 men, being ſcarcely 10 men to each ſhip; and one from Guelderland, with 24 mariners. Fifteen of theſe were called the king's own ſhips, manned with 419 mariners, being ſomewhat under 17 to each ſhip.

œdera, ol. ii. p. 43.

b. vol. iv. 664.

Hiſtorians repreſent the veſſels of Venice and Genoa as the largeſt and the beſt about this time, but they were ſoon exceeded in ſize by the Spaniſh veſſels called *carricks*, ſome of which carried cannon; and theſe again were exceeded by the veſſels built by the northern people, particularly thoſe belonging to the Hanſe-towns.—In the 14th century, the Hanſeatics were the ſovereigns of the northern ſeas, as well without as within the Baltic; and their ſhips were ſo large, that foreign princes often hired them in their wars. According to Hakluyt, an Engliſh ſhip from Newcaſtle, of 200 tons burden, was ſeized in the Baltic by thoſe of Wiſmar and Roſtock, anno 1394; and another Engliſh veſſel of the ſame burden was violently ſeized in the port of Liſbon, anno 1412.

Fœdera, vol. viii. p. 727.

Soon after ſhips of a much larger ſize were conſtructed. It is mentioned that a very large ſhip was built, anno 1449, by John Taverner of Hull; and in the year 1455, King Henry IV. at the requeſt of Charles king of Sweden, granted a licence for a Swediſh ſhip of the burden of a thouſand tons or under, laden with merchandiſe, and having 120 perſons on board, to come to the ports of England, there to diſpoſe of their lading, and to relade back with Engliſh merchandiſe, paying the uſual cuſtoms. The inſcription on the tomb of William Canning, an eminent merchant, who had been five times mayor of Briſtol, in Ratcliff-church at Briſtol, anno 1474, mentions his having forfeited the king's peace, for which he was condemned to pay 300 marks; in lieu of which ſum, King Edward IV. took of him 2470 tons of ſhipping, amongſt which there was one ſhip of 900 tons burden, another of 500 tons, and one of 400 tons, the reſt being ſmaller.

Ib. vol. xi. p. 258.

Ib. vol. xi. p. 364.

In the year 1506, King James IV. of Scotland built the largeſt ſhip which had hitherto been ſeen, but which was loſt in her way to France in the year 1512, owing probably to a defective conſtruction, and the unſkilfulneſs of the crew in managing ſo large a ſhip.—About this time a very large ſhip was likewiſe built in France. In the fleet fitted out by Henry VIII. anno 1512, there was one ſhip, the Regent, of 1000 tons burden, one of 500, and three of 400 each. A ſhip ſtill larger than the Regent, was built ſoon after, called *Henri Grace Dieu!* In the year 1522 the firſt voyage round the globe was finiſhed.

The Engliſh naval hiſtorians think that ſhips carried cannon on their upper decks only, and had no gunports before the year 1545: and it is certain that many of the largeſt ſhips in former times were fitted out from harbours, where ſhips of a moderate ſize now would not have water enough to float them. In 1575, the whole of the royal navy did not exceed 24 ſhips, and the number of merchant-ſhips belonging to England amounted to no more than 135 veſſels above 100 tons, and 656 between 40 and 100 tons. At Queen Elizabeth's death, anno 1603, there were not above four merchant-ſhips in England of 400 tons burden each.—The largeſt of Queen Elizabeth's ſhips of war was 1000 tons burden, carrying but 340 men, and 40 guns, and the ſmalleſt 600 tons, carrying 150 men and 30 guns. Smaller veſſels were occaſionally hired by her from private owners.

Monſon's Naval Tracts, p. 294.

In the memorable ſea-fight of Lepanto between the Turks and Chriſtians, anno 1571, no veſſels were employed but galleys; and it would appear from the carcaſes of ſome of them, which are ſtill preſerved in the arſenal at Venice, that even theſe were not ſo large or ſo well conſtructed as thoſe of our times. The Invincible Armada, as Spaniſh vanity ſtyled it, once the terror and admiration of nations, in the pompous and exaggerated deſcriptions of which the Spaniſh authors of thoſe times dwelt with ſo much apparent pleaſure, conſiſted of 130 ſhips, near 100 of which were the ſtatelieſt that had yet been ſeen on the ocean. The largeſt of theſe, however, would be no more than a third rate veſſel in our navy, and they were ſo ill conſtructed, that they would neither move eaſily, ſail near the wind, nor be properly worked in tempeſtuous weather. The whole of the naval force collected by Queen Elizabeth to oppoſe this formidable fleet, including hired veſſels, tenders, ſtore-ſhips, &c. amounted to no more than 143.

Ship-building began now to make a conſiderable progreſs in Britain. Both war and trade required an increaſe of ſhipping; ſo that in the year 1670, the annual charge of the navy was reported to be 500,000l.; and in 1678 the navy conſiſted of 83 ſhips, of which 58 were of the line. At this time the exports amounted to ten millions per annum; and the balance of trade was two millions. In 1689 there were 173 ſhips, great and ſmall, in the royal navy, and it has been conſtantly increaſing; ſo that in 1761 the ſhips in the navy amounted to 372, of which 129 were of the line; and in the beginning of the year 1795, the total amount was above 430.

3 Ships of the common form found defective,

4 and improvements propoſed.

As ſhips of the common conſtruction are found to be very defective in many particulars, various methods have therefore from time to time been propoſed to remove ſome of the bad qualities they poſſeſſed. As it would be an endleſs taſk to enumerate the different inventions for this purpoſe, a few of them only will now be mentioned.

5 Double ſhips introduced by Sir William Petty, *European Magazine* for Auguſt 1782.

In 1663 Sir William Petty conſtructed a double ſhip, or rather a ſingle ſhip with a double bottom, which was found to ſail conſiderably faſter than any of the ſhips with which it had an opportunity of being tried. Her firſt voyage was from Dublin to Holyhead; and in her return "ſhe turned into that narrow harbour againſt wind and tide, among rocks and ſhips, with ſuch dexterity as many ancient ſeamen confeſſed they had never ſeen the like." This veſſel with 70 more was loſt in a dreadful tempeſt.

6 and again propoſed by Mr Gordon, p. 54.

The ſubject was again revived by Mr Gordon, in his Principles of Naval Architecture, printed at Aberdeen anno 1784; where, having delivered his ſentiments on the conſtruction of large maſts, he ſays: "Theſe experiments likewiſe point out to us methods by which two veſſels may be laterally connected together, though at a conſiderable diſtance from each other, in a manner ſufficiently ſtrong, with very little increaſe of weight or expence of materials, and without expoſing much ſurface to the action or influence of the wind or the waves, or obſtructing their motion in any conſiderable degree, and conſequently without being much oppoſed by them on that account under any circumſtances; and if veſſels are judiciouſly conſtructed with a view to ſuch a junction, it would be no eaſy matter to enumerate all the advantages that may be obtained by this means." He then enumerates the advantages that double veſſels would have over thoſe of the common conſtruction. Soon after double ſhips were actually built by Mr Miller of Dalſwinton.

7 And lately conſtructed by Mr Miller.

Principles of Naval Architecture, p. 76.

8 Draught of water propoſed to be diminiſhed in order to obtain velocity, &c.

Another plan was propoſed by Mr Gordon to make a ſhip ſail faſt, draw little water, and to keep a good wind. For this purpoſe, "the bottom (he ſays) ſhould be formed quite flat, and the ſides made to riſe perpendicular from it, without any curvature; which would not only render her more ſteady, as being more oppoſed to the water in rolling, but likewiſe more convenient for ſtowage, &c. while the ſimplicity of the form would contribute greatly to the eaſe and expedition with which ſhe might be fabricated. Though diminiſhing the draught of water is, *cæteris paribus*, undoubtedly the moſt effectual method of augmenting the velocity with which veſſels go before the wind; yet, as it proportionally diminiſhes their hold of the water, it renders them extremely liable to be driven to leeward, and altogether incapable of keeping a good wind. This defect may, however, be remedied, in a ſimple and effectual manner, by proportionally augmenting the depth of keel, or, as ſo large a keel would be inconvenient on many accounts, proportionally increaſing their number; as, in place of adding a keel eight feet deep to a veſſel drawing ſix feet water, to affix to different parts of her flat bottom, which would be well adapted for receiving them, ſix different keels of two feet deep each at equal diſtances from each other, with proper intervals between; which will be found equally effectual for preventing theſe pernicious effects. Four ſuch, indeed, would have anſwered the purpoſe as well as the eight feet keel, were it not for the ſuperior preſſure or reſiſtance of the lower water (A).

9 Inconveniency of this plan.

10 Remedied by augmenting the depth of the keel.

11 or by increaſing the number of keels.

Thus

(A) This is frequently repeated on the authority of Mr Gordon and others. Theory ſays otherwiſe; and the experiments of Sir Iſaac Newton ſhow in the moſt unexceptionable manner, that the reſiſtance of a ball deſcending through the water is the ſame at all depths; nay, the heaping up of the water on the bow, occaſioning a hydroſtatical preſſure in addition to the real reſiſtance, will make the whole oppoſition to an equal ſurface, but of greater horizontal dimenſions, greater, becauſe it bears a greater proportion to the reſiſtance.

Thus then it appears, that a veſſel drawing eight feet water only, keels and all, may be made to keep as good a wind, or be as little liable to be driven to leeward, as the ſharpeſt built veſſel of the ſame length drawing 14, nay 20 or upwards, if a few more keels are added, at the ſame time that ſhe would be little more reſiſted in moving in the line of the keels than a veſſel drawing ſix feet water only. Theſe keels, beſides, would ſtrengthen the veſſel conſiderably, would render her more ſteady, and leſs liable to be overſet, and thereby enable her to carry more ſail; and Mr Gordon then enumerates the ſeveral advantages that a ſhip of this conſtruction will poſſeſs.

12 The plan arther im- roved by he adop- ion of ſlid- ng keels.

This plan has been put into execution by Captain Schank, with this difference only, that inſtead of the keels being fixed as propoſed by Mr Gordon, Captain Schank conſtructed them ſo as to ſlide down to a certain depth below the bottom, or to be drawn up within the ſhip as occaſion might require.

13 The utility f ſliding eels pro- ed by ex- eriment.

Captain Schank having communicated his plans to the Navy Board, two veſſels were in conſequence ordered to be built of 13 tons each, and ſimilar in dimenſions, one on the old conſtruction, and the other flat-bottomed, with ſliding keels. In 1790 a comparative trial in preſence of the commiſſioners of the navy was made on the river Thames, each having the ſame quantity of ſail; and although the veſſel on the old conſtruction had leeboards, a greater quantity of ballaſt, and two Thames pilots aboard, yet Captain Schank's veſſel with three ſliding keels beat the other veſſel, to the aſtoniſhment of all preſent, one half of the whole diſtance ſailed; and no doubt ſhe would have beat her much more had ſhe been furniſhed with a Thames pilot.

14 nd actu- lly put in ractice pon a rger ſcale.

This trial gave ſo much ſatiſfaction, that a king's cutter of 120 tons was immediately ordered to be built on the ſame conſtruction, and Captain Schank was requeſted to ſuperintend its building. This veſſel was launched at Plymouth in 1791, and named the *Trial.* The length of this veſſel is 66 feet, breadth 21 feet, and depth of the hold ſeven feet: her bottom is quite flat, and draws only ſix feet water, with all her guns, ſtores, &c. whereas all other veſſels of her tonnage on the old conſtruction draw 14 feet; ſo that ſhe can go with ſafety into almoſt any harbour or creek. She has three ſliding keels incloſed in a caſe or well; they are each 14 feet in length; the fore and the after keels are three feet broad each, and the middle keel is ſix feet broad. The keels are moveable by means of a winch, and may be let down ſeven feet below the real keel; and they work equally well in a ſtorm as in ſtill water. Her hold is divided into ſeveral compartments, all water-tight, and ſo contrived, that ſhould even a plank or two ſtart at ſea in different parts of the veſſel, ſhe may be navigated with the greateſt ſecurity to any place. If ſhe ſhould be driven on ſhore in a gale of wind, ſhe will not ſoon become a wreck, as her keels will be driven up into their caſes, and the ſhip being flat-bottomed, will not be eaſily overſet; and being able to go into ſuch ſhallow water, the crew may all be eaſily ſaved. By means of her ſliding keel ſhe is kept ſteady in the greateſt gale; ſhe is quite eaſy in a great ſea, does not ſtrain in the leaſt, and never takes in water on her deck; and when at anchor, ſhe rides more upright and even than any other ſhip can do: ſhe ſails very faſt either before or upon a wind; no veſſel ſhe has ever been in company with, of equal ſize, has been able, upon many trials, to beat her in ſailing; and yet her ſails ſeem too ſmall.

It has alſo been propoſed to conſtruct veſſels of other materials than wood; and a veſſel was built whoſe bottom, inſtead of being plank, was copper.

BOOK I. *Containing the Method of Delineating the ſeveral Sections of a Ship.*

CHAP. I. *Of the Properties of Ships.*

15 General principles of ſhip-building.

A SHIP ought to be conſtructed ſo as to anſwer the particular purpoſe for which ſhe is intended. It would be an eaſy matter to determine the form of a ſhip intended to ſail by means of oars; but, when ſails are uſed, a ſhip is then acted upon by two elements, the wind and water; and therefore it is much more difficult than is commonly imagined to aſcertain the form of a ſhip ſo as to anſwer in an unfavourable as well as a favourable wind; the ſhip at the ſame time having a cargo of a certain weight and magnitude.

16 Properties that a ſhip muſt poſſeſs to be a good ſailer.

Every ſhip ought to ſail well, but particularly when the wind is upon the beam; for this purpoſe a conſiderable length in proportion to the breadth is neceſſary, and the plane of reſiſtance ſhould be the leaſt poſſible. The main frame ſhould alſo be placed in a proper ſituation; but according to the experiments of Mr Chapman *, its plane is variable with the velocity of the ſhip: the mean place of the main frame has, however, been generally eſtimated to be about one-twelfth of the length of the keel before the middle. Without a ſufficient degree of ſtability a ſhip will not be able to carry a preſs of ſail; a great breadth in proportion to the length and low upper-works will augment the ſtability. The following particulars being attended to, the above property will be gained, and the ſhip will alſo ſteer well. The wing tranſom ſhould be carried pretty high; the faſhion-pieces well formed, and not full below the load water-line: the lower part of the ſtem to be a portion of a circle, and to have a conſiderable rake: the ſternpoſt to be nearly perpendicular to the keel; and all the upper works kept as low as poſſible.

17 To make a ſhip keep a good wind,

Many ſhips from conſtruction are liable to make much leeway. This may in a great meaſure be avoided by giving the ſhip a long keel, little breadth, and a conſiderable depth in the hold: whence the bow will meet with little reſiſtance in compariſon to the ſide, and therefore the ſhip will not fall much to the leeward.

18 and to ſail ſmoothly without pitching hard.

Another very great retardation to the velocity of a ſhip is her pitching. The principal remedy for this is to increaſe the length of the keel and floor, to diminiſh the riſing afore and abaft, and to conſtruct the hull in ſuch a manner that the contents of the fore-body may be duly proportioned to the contents of the after-body.

19 In ſhips of war the lower deck guns to be ſufficiently high above the water.

In a ſhip of war the lower tier of guns ought to be of a ſufficient height above the water, otherwiſe it will be impoſſible to work the lee-guns when it blows hard. This property will be obtained by giving her a long floor-timber, little riſing, a full midſhip frame, light upper works, and the wing-tranſom not too high: And in every ſhip the extreme breadth ought always to be higher afore and abaft than at midſhips.

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* *Traité de la Conſtruction des Vaiſſeaux*, p. 40.

Properties of Ships.

20 Properties of a merchant ſhip,

A merchant ſhip, beſides being a faſt ſailer, ought to carry a conſiderable cargo in proportion to its length, to ſail with little ballaſt, and to be navigated with few hands.

21 to take in a great cargo,

That a ſhip may take in a conſiderable cargo, it ſhould have a great breadth and depth in proportion to its length, a full bottom, and a long and flat floor. But a ſhip of this conſtruction will neither ſail faſt, nor carry much ſail.

22 and to have ſtability.

If a ſhip be filled out much towards the line of floatation, together with low upper works, ſhe will require little ballaſt: and that ſhip which is ſtiff from conſtruction is much better adapted for ſailing faſt than one which, in order to carry the ſame quantity of canvas, is obliged to be loaded with a much greater weight: for the reſiſtance is as the quantity of water to be removed, or nearly as the area of a tranſverſe ſection of the immerſed part of the body at the midſhip frame; and a body that is broad and ſhallow is much ſtiffer than one of the ſame capacity that is narrow and deep.

Principles of Naval Architecture, p. 100.

23 Advantages of a ſhip of a ſmall draught of water,

"The advantages (ſays Mr Gordon) are numerous, important, and obvious. For it is evident, that by enlarging, perhaps doubling, the breadth of veſſels, and forming their bottoms flat and well furniſhed with keels, they muſt, in the *firſt* place, become much ſteadier, roll little, if any, and be enabled to carry greatly more ſail, and that in a better direction, at the ſame time that they would be in no danger of being diſmaſted or overſet, unleſs the maſts were of a moſt extraordinary height indeed. *Secondly*, They would have little or no occaſion for ballaſt, and if any was uſed, could incur leſs danger from its ſhifting. *Thirdly*, That there would be much more room upon deck, as well as accommodation below; the breadth being ſo much increaſed without any diminution of the height above the load-water line. *Fourthly*, That they would deviate much leſs from the intended courſe, and penetrate the water much eaſier in the proper direction; for doubling the breadth, without any increaſe of weight, would diminiſh the depth or draught of water one half; and though the extent of the directly oppoſing ſurface would be the ſame as before, yet the veſſel in moving would meet with half the former reſiſtance only; for ſo great is the difference between the preſſure, force, or reaction, of the upper and the under water. *Fifthly*, That they would by this means be adapted for lying unſupported in docks and harbours when dry, be rendered capable of being navigated in ſhallow water, and of being benefited by all the advantages attending that very important circumſtance: and it is particularly to be obſerved, that making veſſels which may be navigated in ſhallow water, may, in many reſpects, juſtly be regarded as a matter of equal importance with increaſing the number of harbours, and improving them, as having identically the ſame effects with regard to navigation; at the ſame time, that the benefits which would reſult from ſuch circumſtances are obtained by this means without either expence, trouble, or inconvenience: beſides, it would not only enable veſſels to enter many rivers, bays, and creeks, formerly inacceſſible to ſhips of burden, but to proceed to ſuch places as are moſt landlocked, where they can lie or ride moſt ſecure, and with leaſt expence of men and ground tackle. As ſhips of war would carry their guns well by being ſo ſteady, there could be but little occaſion for a high topſide, or much height of hull above water; and as little or no ballaſt would be required, there would be no neceſſity, as in other veſſels, for increaſing their weight on that account, and thereby preſſing them deeper into the water. Theſe are very important circumſtances, and would contribute much to improve the ſailing of ſuch veſſels." From whence it appears, that there would be united, what has hitherto been deemed irreconcileable, the greateſt poſſible ſtability, which is nearly as the area of a tranverſe ſection of the immerſed part of the body at the midſhip frame: and a body that is broad and ſhallow is much ſtiffer than one of the ſame capacity that is narrow and deep. A ſhip of this conſtruction may take in a conſiderable cargo in proportion to her ſize; but if deeply loaded will not ſail faſt, for then the area of a ſection of the immerſed part at the midſhip frame will be very conſiderable; and as the ſails of ſuch a ſhip muſt neceſſarily be large, more hands will therefore be required.

Properti of Ships.

24 and to be navigated with few hands.

Traité du Navire.

The leſs the breadth of a ſhip, the fewer hands will be neceſſary to work her; as in that caſe the quantity of ſail will be leſs, and the anchors alſo of leſs weight. We ſhall gain much (ſays M. Bouguer) by making the extreme breadth no more than the fifth or ſixth part of the length, if, at the ſame time, we diminiſh the depth proportionally; and likewiſe this moſt ſurpriſing circumſtance, that by diminiſhing theſe two dimenſions, or by increaſing the length, a ſhip may be made to go ſometimes as faſt as the wind.

25 Impoſſible to unite a the qualities in the ſame ſhip.

In order to obtain the preceding properties, very oppoſite rules muſt be followed; and hence it appears to be impoſſible to conſtruct a ſhip ſo as to be poſſeſſed of them all. The body, however, muſt be ſo formed, that as many of theſe properties may be retained as poſſible, always obſerving to give the preference to thoſe which are moſt required. If it is known what particular trade the ſhip is to be employed in, thoſe qualities are then principally to be adhered to which are moſt eſſentially neceſſary for that employment.

26 Small ſhip inferior to large ones in point o ſailing, &

It may eaſily be demonſtrated that ſmall ſhips will not have the ſame advantages as large ones of a ſimilar form, when employed in the ſame trade: for a large ſhip will not only ſail faſter than a ſmall one of a ſimilar form, but will alſo require fewer hands to work her. Hence, in order that a ſmall ſhip may poſſeſs the ſame advantages as a large one, the correſponding dimenſions will not be proportional to each other. The reader will ſee in Chapman's *Architectura Navalis Mercatoria* ample tables of the ſeveral dimenſions of ſhips, of different claſſes and ſizes, deduced from theory combined with experiment. Tables of the dimenſions of the principal ſhips of the Britiſh navy, and of other ſhips, are contained in the Ship-builder's Repoſitory, and in Murray's Treatiſe on Ship-building.

Chap. II. *Of the different Plans of a Ship.*

When it is propoſed to build a ſhip, the proportional ſize of every part of her is to be laid down; from whence the form and dimenſions of the timbers, and of every particular piece of wood that enters into the conſtruction, is to be found. As a ſhip has length, breadth, and depth, three different plans at leaſt are neceſſary to exhibit

Different Plans of a Ship.

exhibit the form of the ſeveral parts of a ſhip: theſe are uſually denominated the *ſheer plan*, the *half breadth* and *body plans*.

27
Sheer draught, or elevation.

The *ſheer plan* or *draught*, otherwiſe called the *plan of elevation*, is that ſection of the ſhip which is made by a vertical plane paſſing through the keel. Upon this plan are laid down the length of the keel; the height and rake of the ſtem and ſternpoſt; the ſituation and height of the midſhip and other frames; the place of the maſts and channels; the projection of the head and quarter gallery, and their appendages; and in a ſhip of war the poſition and dimenſions of the gun-ports. Several imaginary lines, namely, the upper and lower height of breadth lines, water lines, &c. are alſo drawn in this plane.

28
Half breadth plan, or horizontal plane.

The *half breadth*, or *floor plan*, or, as it is frequently called the *horizontal* plane, contains the ſeveral half-breadths of every frame of timbers at different heights; ribbands, water lines, &c. are alſo deſcribed on this plane.

29
Body plan, or projection.

The *body* plan, or *plane of projection*, is a ſection of the ſhip at the midſhip frame or broadeſt place, perpendicular to the two former. The ſeveral breadths, and the particular form of every frame of timbers, are deſcribed on this plane. As the two ſides of a ſhip are ſimilar to each other, it is therefore unneceſſary to lay down both; hence the frames contained between the main frame and the ſtem are deſcribed on one ſide of the middle line, commonly on the right hand ſide, and the after frames are deſcribed on the other ſide of that line.

30
The various lines laid down on theſe plans.

Several lines are deſcribed on theſe planes, in order the more readily to aſſiſt in the formation of the timbers; the principal of which are the following:

The *top-timber line*, is a curve limiting the height of the ſhip at each timber.

The *top-timber half breadth line*, is a ſection of the ſhip at the height of the top-timber line, perpendicular to the plane of elevation.

The *height of breadth lines*, are two lines named the *upper* and *lower* heights of breadth. Theſe lines are deſcribed on the plane of elevation to determine the height of the broadeſt part of the ſhip at each timber; and being deſcribed in the body plan, limit the height and breadth of each frame at its broadeſt part.

Main half breadth, is a ſection of the ſhip at the broadeſt part, perpendicular to the ſheer plan, and repreſents the greateſt breadth at the outſide of every timber.

Water lines, are lines ſuppoſed to be deſcribed on the bottom of a ſhip when afloat by the ſurface of water; and the uppermoſt of theſe lines, or that deſcribed by the water on the ſhip's bottom when ſufficiently loaded, is called the *load water line*. According as the ſhip is lightened, ſhe will riſe higher out of the water; and hence new water lines will be formed. If ſhe be lightened in ſuch a manner that the keel may preſerve the ſame inclination to the ſurface of the water, theſe lines will be parallel to each other; and if they are parallel to the keel, they will be repreſented by ſtraight lines parallel to each other in the body plan; otherwiſe by curves. In the half breadth plan, theſe lines are curves limiting the half breadth of the ſhip at the height of the correſponding lines in the ſheer plan. In order to diſtinguiſh theſe lines, they are uſually drawn in green.

Different Plans of a Ship.

Ribband lines, are curves on a ſhip's bottom by the interſection of a plane inclined to the plane of elevation; and are denominated *diagonal* or *horizontal*, according as they are meaſured upon the diagonal, or in a direction perpendicular to the plane of elevation. Both theſe anſwer to the ſame curve on the ſhip's bottom, but give very different curves when deſcribed on the half breadth plan.

31
Frames, compoſed of a floor timber, futtocks, and top timber.

Frames, are circular pieces of timber bolted together, and raiſed upon the keel at certain diſtances, and to which the planks are faſtened. A frame is compoſed of one floor-timber, two or three futtocks, and a top-timber on each ſide: which being united together, form a circular incloſure, and that which incloſes the greateſt ſpace is called the *midſhip* or *main* frame. The arms of the floor-timber of this frame, form a very obtuſe angle; but in the other frames this angle decreaſes with the diſtance of the frame from midſhips. Thoſe floor-timbers which form very acute angles are called *crutches*. The length of the midſhip floor-timber is in general about half the length of the main frame.

32
Sweeps of the ſeveral parts of a frame.

A frame of timbers is commonly formed by arches of circles called *ſweeps*. There are generally five ſweeps: 1ſt, The *floor ſweep*; which is limited by a line in the body plan perpendicular to the plane of elevation, a little above the keel; and the height of this line above the keel at the midſhip frame is called the *dead riſing*. The upper part of this arch forms the head of the floor timber. 2d, The *lower breadth ſweep*; the centre of which is in the line repreſenting the lower height of breadth. 3d, The *reconciling ſweep*. This ſweep joins the two former, without interſecting either; and makes a fair curve from the lower height of breadth to the riſing line. If a ſtraight line is drawn from the upper edge of the keel to touch the back of the floor ſweep, the form of the midſhip frame below the lower height of breadth will be obtained. 4th, The *upper breadth ſweep*; the centre of which is in the line repreſenting the upper height of breadth of the timber. This ſweep deſcribed upwards forms the lower part of the top timber. 5th, The *top-timber ſweep* is that which forms the hollow of the top timber. This hollow is, however, very often formed by a mould, ſo placed as to touch the upper breadth ſweep, and paſs through the point limiting the half breadth of the top timber.

33
Names of frames.

The main frame, or as it is uſually called *dead-flat*, is denoted by the character ⊕. The timbers before dead-flat are marked A, B, C, &c. in order; and thoſe abaft dead-flat by the figures 1, 2, 3, &c. The timbers adjacent to dead-flat, and of the ſame dimenſions nearly, are diſtinguiſhed by the characters (A), (B), &c. and (1), (2), &c. That part of the ſhip abaft the main frame is called the *after body*; and that before it the *fore body*.

All timbers are perpendicular to the half breadth plan. Thoſe timbers whoſe planes are perpendicular to the ſheer plan, are called *ſquare timbers*; and thoſe whoſe planes are inclined to it are called *canted timbers*.

The *riſing line*, is a curve drawn in the ſheer plan, at the heights of the centres of the floor ſweeps in the body plan. As, however, this line, if drawn in this manner, would extend beyond the upper line of the figure, it is therefore uſually ſo drawn that its lower part may touch the upper edge of the keel. This is performed by taking the heights of each of the centres in the

the body plan, from the height of the centre of the ſweep of dead-flat, and ſetting them off on the correſponding timbers in the ſheer plan from the upper edge of the keel.

Half breadth of the riſing, is a curve in the floor plan, which limits the diſtances of the centres of the floor ſweeps from the middle line of the body plan.

The riſing of the floor, is a curve drawn in the ſheer plan, at the height of the ends of the floor timbers. It is limited at the main frame or dead flat by the dead riſing, and in flat ſhips is nearly parallel to the keel for ſome timbers afore and abaft the midſhip frame; for which reaſon theſe timbers are called *flats:* but in ſharp ſhips it riſes gradually from the main frame, and ends on the ſtem and poſt.

Cutting-down line, is a curve drawn on the plane of elevation. It limits the depth of every floor timber at the middle line, and alſo the height of the upper part of the dead wood afore and abaft.

Timber and room, or *room and ſpace*, is the diſtance between the moulding edges of two timbers, which muſt always contain the breadth of two timbers and an interval of about two or three inches between them. In forming the timbers, one mould ſerves for two, the foreſide of the one being ſuppoſed to unite with the aftſide of the other, and ſo make only one line, which is called the *joint of the timbers*.

34 Principal pieces that compoſe a ſhip. Plate ccccIxxxiv. fig. 1.

In order to illuſtrate the above, and to explain more particularly the principal pieces that compoſe a ſhip, it will be neceſſary to give a deſcription of them. Theſe pieces are for the moſt part repreſented according to the order of their diſpoſition in fig. 1.

A, Repreſents the pieces of the keel to be ſecurely bolted together and clinched.

B, The ſternpoſt, which is tenanted into the keel, and connected to it by the knee G.

E, The back of the poſt, which is alſo tenanted into the keel, and ſecurely bolted to the poſt; the intention of it is to give ſufficient breadth to the port, which ſeldom can be got broad enough in one piece. C is the falſe poſt, which is fayed (B) to the fore part of the ſternpoſt.

C, The ſtem, in two pieces, to be ſcarfed together. The ſtem is joined to the fore foot, which makes a part of both.

H, The apron, in two pieces, to be ſcarfed together, and fayed on the inſide of the ſtem, to ſupport the ſcarf thereof; and therefore the ſcarf of the apron muſt be at ſome diſtance from that of the ſtem.

I, The ſtemſon, in two pieces, to ſupport the ſcarf of the apron.

D, The beams which ſupport the decks; and F the knees by which the beams are faſtened to the ſides of the ſhip.

K, The wing tranſom: it is fayed acroſs the ſternpoſt, and bolted to the head of it, and its extremities are faſtened to the faſhion pieces. L, Is the deck tranſom, parallel to the wing tranſom. M, N, Two of the lower tranſoms: theſe are faſtened to the ſternpoſt and faſhion pieces in the ſame manner as the wing tranſom. Q, The knee which faſtens the tranſom to the ſhip's ſide. And, O, The faſhion piece, of which there is one on each ſide. The keel of the faſhion piece is connected with the dead-wood, and the head is faſtened to the wing tranſom.

R, S, Breaſt-hooks; theſe are fayed in the inſide to the ſtem, and to the bow on each ſide of it, to which they are faſtened with proper bolts. There are generally four or five in the hold, in the form of that marked R, and one in the form of that marked S, into which the lower deck planks are rabbeted: There is alſo one immediately under the hauſe holes, and another under the ſecond deck.

T, The rudder, which is joined to the ſternpoſt by the rudder irons, upon which it turns round in the googings, faſtened to the ſternpoſt for that purpoſe. There is a mortiſe cut in the head of the rudder, into which a long bar is fitted called the *tiller*, and by which the rudder is turned.

U, A floor timber: it is laid acroſs the keel, to which it is faſtened by a bolt through the middle. V, V, V, V, The lower, the ſecond, third, and fourth futtocks. W, W, The top timbers. Theſe repreſent the length and ſcarf of the ſeveral timbers in the midſhip frame.

X, The pieces which compoſe the kelſon. They are ſcarfed together in the ſame manner as the keel, and placed over the middle of the floor timbers, being ſcored about an inch and a half down upon each ſide of them, as repreſented in the figure.

Y, The ſeveral pieces of the knee of the head; the lower part of which is fayed to the ſtem, and its keel is ſcarfed to the head of the forefoot. It is faſtened to the bow by two knees, called *cheeks*, in the form of that repreſented by Z; and to the ſtem, by a knee called a *ſtandard*, in the form of that marked ⊕.

a, The cathead, of which there is one on each ſide of the bow, projecting ſo far as to keep the anchor clear of the ſhip when it is hove up.

b, The bits, to which the cable is faſtened when the ſhip is at anchor.

d, The ſide counter-timbers, which terminate the ſhip abaft within the quarter gallery.

e, *e*, Two pieces of dead wood, one afore and the other abaft, fayed on the keel.

Fig. 2.

Fig. 2. is a perſpective repreſentation of a ſhip framed and ready for the planking; in which A, A is the keel; B, the ſternpoſt; C, the ſtem; K, L, M, the tranſoms; F, F, F, F, F, F, the ribbands.

Chap. III. *Containing Preliminary Problems*, &c.

The general dimenſions of a ſhip are the *length*, *breadth*, and *depth*.

35 Proportional dimenſions of a ſhip 36 to be inferred from theory combined with practice;

To aſcertain thoſe dimenſions that will beſt anſwer the intended purpoſe is, no doubt, a problem of conſiderable difficulty; and from theory it may be ſhown that there are no determinate proportions ſubſiſting between the length, breadth, and depth, by which theſe dimenſions may be ſettled; yet, by combining theory and practice, the proportional dimenſions may be approximated to pretty nearly.

As

(B) To *fay*, is to join two pieces of timber cloſe together.

reliminary roblems.

As ſhips are conſtructed for a variety of different purpoſes, their principal dimenſions muſt therefore be altered accordingly, in order to adapt them as nearly as poſſible to the propoſed intention; but ſince there is no fixed ſtandard whereby to regulate theſe dimenſions, the methods therefore introduced are numerous, and in a great meaſure depend upon cuſtom and fancy.

37 ad alſo om the ircle.

With regard, however, to the proportional dimenſions, they perhaps may be inferred from the circle. Thus, if the extreme breadth be made equal to the diameter, the length at the load water line, or the diſtance between the rabbets of the ſtem and poſt at that place, may be made equal to the circumference of the ſame circle; and the depth of the hold equal to the radius, the upper works being continued upwards according to circumſtances. A ſhip formed from theſe dimenſions, with a bottom more or leſs full according as may be judged neceſſary, will no doubt anſwer the propoſed intention. Nevertheleſs, one or other of theſe dimenſions may be varied in order to gain ſome eſſential property, which the trade that the veſſel is intended for may require.

Practical *aman-* *ip*, page 5.

See Book chap. 2.

The following hints are given by Mr Hutchinſon * towards fixing rules for the beſt conſtruction of ſhips bottoms.

1. "I would recommend (ſays he), to prevent ſhips bottoms from hogging † upwards amidſhip, to have the fore and after part of their keels deep enough, that the upper part may be made to admit a rabbet for the garboard ſtreak, that the main body and bearing part of the ſhips bottoms may be made to form an arch downwards in their length, ſuppoſe with the ſame ſheer as their bends, at the rate of about 2 inches for every 30 feet of the extreme length of the keel towards the midſhip or main frame, which may be reckoned the crown of the arch; and the lower part of the keel to be made ſtraight, but laid upon blocks ſo that it may form a regular convex curve downwards at the rate of an inch for every 30 feet of the extreme length of the keel, the loweſt part exactly under the main frame; which curve, I reckon, is only a ſufficient allowance for the keel to become ſtraight below, after they are launched afloat, by the preſſure of the water upward againſt their floors amidſhip, which cauſes their tendency to hog. And certainly a ſtraight keel is a great advantage in ſailing, as well as to ſupport them when laid upon level ground or on ſtraight blocks in a repairing dock, without taking damage.

2. "As ſquare-ſterned ſhips, from experience, are found to anſwer all trades and purpoſes better than round or pink-ſterned ſhips, I would recommend the fore part of the ſternpoſt, on account of drawing the water lines in the draught, only to have a few inches rake, that the after part may ſtand quite upright perpendicular to the keel: and for the rake of the ſtem I would propoſe the rabbet for the hudding ends for the entrance, and bows from the keel upwards, to form the ſame curve as the water line from the ſtem at the harpin towards the main breadth, and the bows at the harpin to be formed by a ſweep of a circle of half the three-fourths of the main breadth; and the main tranſom to be three-fourths of the main breadth; and the buttocks, at the load or ſailing mark aft, to be formed, in the ſame manner as the bows at the harpin, with a ſweep of a circle of half the three-fourths of the main breadth, to extend juſt as far from the ſtem and ſternpoſt as to admit a regular convex curve to the main frame, and from theſe down to the keel to form regular convex water-lines, without any of thoſe unnatural, hollow, concave ones, either in the entrance or run; which rules, in my opinion, will agree with the main body of the ſhip, whether ſhe is deſigned to be built full for burden or ſharp below for ſailing.

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3. "This rule for raking the ſtem will admit all the water lines in the ſhip's entrance to form convex curves all the way from the ſtem to the midſhip or main frame, which anſwers much better for ſailing as well as making a ſhip more eaſy and lively in bad weather. And the bows ſhould flange off, rounding in a circular form from the bends up to the gunwale, in order to meet the main breadth the ſooner, with a ſweep of half the main breadth at the gunwale amidſhips; which will not only prevent them greatly from being plunged under water in bad weather, but ſpread the ſtanding fore-rigging the more, to ſupport theſe material maſts and ſails forward to much greater advantage than in thoſe over ſharp bowed ſhips, as has been mentioned. And as the ſailing trim of ſhips in general is more or leſs by the ſtern, this makes the water lines of the entrance in proportion the ſharper to divide the particles of water the eaſier, ſo that the ſhip may preſs through it with the leaſt reſiſtance.

4. "The run ought to be formed ſhorter or longer, fuller or ſharper, in proportion to the entrance and main body, as the ſhip is deſigned for burden or ſailing faſt. The convex curves of the water lines ſhould leſſen gradually from the load or ſailing mark aft, as has been mentioned, downwards, till a fair ſtraight taper is formed from the after part of the floor to the ſternpoſt below, without any concavity in the water lines; which will not only add buoyancy and burden to the afterbody and run of the ſhip, but, in my opinion, will help both her ſailing and ſteering motions; for the preſſure of the water, as it cloſes and riſes upon it to come to its level again, and fill up that hollow which is made by the fore and main body being preſſed forward with ſail, will impinge, and act with more power to help the ſhip forward in her progreſſive motion, than upon thoſe unnatural concave runs, which have ſo much more flat dead wood, that muſt, in proportion, be a hinderance to the ſtern being turned ſo eaſily by the power of the helm to ſteer the ſhip to the greateſt advantage."

Many and various are the methods which are employed to deſcribe the ſeveral parts of a ſhip. In the following problems, however, thoſe methods only are given which appear to be moſt eaſily applied to practice, and which, at the ſame time, will anſwer any propoſed purpoſe.

Problem I. To deſcribe in the plane of elevation the ſheer or curvature of the top timbers.

Plate cccclxxxv. fig. 3.

38 The place of the main frame about one-twelfth before the middle of the ſhip.

Let QR (fig. 3.) be the length of the ſhip between the wing tranſom and the rabbet of the ſtem. Then ſince it is generally agreed, eſpecially by the French conſtructors, that the broadeſt part of the ſhip ought to be about one-twelfth of the length before the main frame or dead flat; therefore make R⊕ equal to five-twelfths of QR, and ⊕ will be the ſtation of the main frame; ſpace the other frames on the keel, and from theſe points let perpendiculars be drawn to the keel. Let ⊕P be the height of the ſhip at the main frame,

VF

39 Method of deſcribing the top-timber line.

VF the height at the aftermoſt frame, and RK the height at the ſtem. Through P draw EPL parallel to the keel; deſcribe the quadrants PGI, PMN, the radius being P⊕; make PH equal to EF, and PO equal KL, and draw the parallels GH, OM: Divide GH ſimilar to ⊕C, and OM ſimilar to ⊕R. Through theſe points of diviſion draw lines perpendicular to EL, and the ſeveral portions of theſe perpendiculars contained between EL and the arch will be the riſings of the top-timber line above EL. A curve drawn through theſe points will form the top-timber line.

This line is more eaſily drawn by means of a curved or bent ruler, ſo placed that it may touch the three points F, P, and K.

40 The ſtem, Fig. 3.

PROB. II. To deſcribe the ſtem.

Let K (fig. 3.) be the upper part of the ſtem, through which draw KS parallel to the keel, and equal to twice KR: Through the termination of the wales on the ſtem draw TW parallel to QR. Then from the centre S, with the diſtance SK, deſcribe an arch: Take an extent equal to the neareſt diſtance between the parallels WT, QR; and find the point W, ſuch that one point of the compaſs being placed there, the other point will juſt touch the neareſt part of the above arch; and from this point as a centre deſcribe an arch until it meets the keel, and the ſtem will be formed.

41 and poſt. Fig. 3.

PROB. III. To deſcribe the ſternpoſt.

Set off QV (fig. 3.) for the rake of the poſt: draw VX perpendicular to the keel, and equal to the height of the wing tranſom, join QX, and it will repreſent the aft ſide of the poſt.

42 Main half breadth line. Fig. 4.

PROB. IV. To deſcribe the half breadth line.

Let MN (fig. 4.) be the given length: Make N⊕ equal to five-twelfths of MN; draw the line ⊕P perpendicular to MN, and equal to the propoſed extreme half breadth. Let ME be the round aft of the ſtern or wing tranſom; make EO perpendicular to MN, and equal to the given half breadth at the ſtern, which is generally between two-thirds and three-fourths of the main half breadth; and deſcribe the arch MO, the centre of which is in the middle line. Space the frames (A), A, B, &c. and (1), 1, 2, &c. From the centre ⊕, with the radius ⊕P, deſcribe the quadrant PRS; deſcribe alſo the quadrant PCT. Through the point O draw ORU parallel to MN; divide the ſtraight line RU ſimilar to M⊕; and through theſe points of diviſion draw lines perpendicular to MN, and meeting the arch. Transfer theſe lines to the correſpondent frames each to each, and a curve drawn through the extremities will repreſent that part of the ſide contained between the main frame and the ſtern. Again, through Q, the extremity of the foremoſt frame, draw QV parallel to MN. Or make PV a fourth or third part of PU, according as it is intended to make the ſhip more or leſs full towards the bow. Divide VC ſimilar to ⊕C; through theſe points draw lines perpendicular to MN, and terminating in the quadrantal arch: Transfer theſe lines to the correſponding timbers in the fore part, and a curve drawn through the extreme points will limit that part of the ſhip's ſide contained between P and Q. Continue the curve to the next timber at X. From Q draw QZ perpendicular to QX; make the angle ZNQ equal to ZQN, and the point Z will be the centre of the arch forming the bow. Remark, if it is propoſed that the breadth of the ſhip at the frames adjacent to the main frame ſhall be equal to the breadth at the main frame; in this caſe, the centres of the quadrantal arches will be at the points of interſection of theſe frames with the line MN; namely, at (A) and (1). Alſo, if the height of the ſhip at the frames (A) and (1) is to be the ſame as at dead flat, the quadrantal arches in fig. 3. are to be deſcribed from the points of interſection of theſe frames with the line EL.

Theſe rules, it is evident, are variable at pleaſure; and any perſon acquainted with the firſt principles of mathematics may apply calculation to find the radii of the ſeveral ſweeps.

43 Of the m ſhip fram

PROB. V. To deſcribe the main frame or dead flat.

This frame is that which contains the greateſt ſpace, and the particular form of each of the other frames depends very much on it. If the ſhip is intended to carry a great burden in proportion to her principal dimenſions, this frame is made very full; but if ſhe is intended to ſail faſt, it is uſually made ſharp. Hence ariſes diverſity of opinions reſpecting its form; each conſtructor uſing that which to him appears preferable. In order to ſave repetition, it is judged proper to explain certain operations which neceſſarily enter into all the different methods of conſtructing this frame.

44 General precepts deſcribin it. Fig. 5.

In the plane of the upper ſide of the keel produced, draw the line AB (fig. 5.) equal to the propoſed breadth of the ſhip; biſect AB in C, and draw AD, CE, and BF, perpendicular to AB. Then, ſince the two ſides of a ſhip are ſimilar, it is therefore thought ſufficient to deſcribe the half of each frame between the main frame and the ſtern on one ſide of the middle line CE, and the half of each of thoſe before the main frame on the other ſide of it. The firſt half is called the *after-body*, and the other the *fore-body*. The after-body is commonly deſcribed on the left ſide of the middle line; and the fore-body on the right ſide of it: hence the line AD is called the *ſide line* of the *after* body, and BF the ſide line of the *fore* body. Make AD and BF each equal to the height of the ſhip at the main frame. Make AG, BG, and AH, BH, equal to the lower and upper heights of breadth reſpectively, taken from the ſheer plan. Let II be the load water line, or line of floatation when the ſhip is loaded, and KK the height of the riſing line of the floor at this frame. Make CN, CO, each equal to half the length of the floor timber, and N, O, will be the heads of the floor timber, through which draw perpendiculars to AB. Make C *m*, E *m*, each equal to half the thickneſs of the ſternpoſt, and C *n*, E *n*, equal to half the thickneſs of the ſtem, and join *m m*, *n n*.

Method I. *Of deſcribing a main frame.*—From the centre *a* (fig. 5.), in the lower breadth line, deſcribe the lower breadth ſweep G *e*; make N *b* equal to the propoſed radius of the floor ſweep, and from the centre *b* deſcribe the floor ſweep N *f*. Let the radius of the reconciling ſweep be A *g*, equal to about the half of AC; then make A *h* equal to N *b*, and A *m* equal to G *a*. Now from the centre *a*, with an extent equal to *g m*, deſcribe an arch, and from the centre *b*, with the extent *g h*, deſcribe an arch interſecting the former in *c*, which will be the centre of the reconciling ſweep *ef*. Join N *m* by an inverted curve, the centre of which may be in the line *b* N produced downwards; or it may be joined

joined by two curves, or by a ſtraight line if there is little riſing; and hence the lower part of the main frame will be deſcribed.

In order to form the top timber, make F k equal to ſuch part of the half breadth, agreeable to the propoſed round of the ſide, as one-ſeventh; join H k, and make $k\,i$ equal to about two-thirds of H k: make the angle H $i\,l$ equal to i H l; and from the centre l at the diſtance lH deſcribe the arch H i; and from the centre o, the interſection of $l\,i$, and k F produced, deſcribe the arch $i\,k$, and the top timber will be formed.

Fig. 6.

II. *To deſcribe a main frame of an intermediate capacity, that is, neither too flat nor too ſharp.*—Divide the line AX (fig. 6.), which limits the head of the floor timber, into three equal parts; and make $a\,b$ equal to one of them. Divide the line dB, the perpendicular diſtance between the load water line and the plane of the upper ſide of the keel, into ſeven equal parts; and ſet off one of theſe parts from d to c, and from c to m. Let GH be the lower deck, join G m, and produce it to q. Draw the ſtraight line V a, biſect it in n, and from the points n, a, deſcribe arches with the radius G q interſecting each other in P, which will be the centre of the arch $n\,a$. The centre of the arch V n is found by deſcribing arches downwards with the ſame radius.

With an extent equal to once and a half of B e, deſcribe arches from the points b, e, interſecting each other in A, and from this point as a centre deſcribe the arch $e\,b$; make $a\,l$ equal to $d\,m$, and join A m, A l. Then, in order to reconcile two arches ſo as to make a fair curve, the centres of theſe arches and of the points of contact muſt be in the ſame ſtraight line. Hence the point k will be the centre of the arch $d\,m$, and o the centre of the arch $a\,l$. The arch $l\,m$ is deſcribed from the centre A.

To form the top timber, ſet back the tenth part of the half breadth from K to S upon the line of the ſecond deck; then with an extent equal to two-thirds of the whole breadth deſcribe an arch through the points S and H, the upper height of breadth. Again, make MI equal to the fifth part of the half breadth; deſcribe an arch of a circle through the points S and T, taking the diagonal GB for the radius. As this arch is inverted in reſpect of the arch d S, the centre will be without the figure. Hence one-half of the main frame is formed, and the other half is deſcribed by ſimilar operations.

Remark. This frame may be made more or leſs full by altering the ſeveral radii.

Plate cccclxxxvi. fig. 7.

III. *To deſcribe a main frame of a circular form.*—Let the ſeveral lines be drawn as before: Then make O a (fig. 7.) equal to the half breadth G a, and from the centre a, with the radius G a, deſcribe the arch b G c O. Let d be the head of the floor-timber, and $d\,x$ the riſing. Aſſume the point f in the arch, according to the propoſed round of the ſecond futtock, and deſcribe the arch $d\,f$; the centre of which may be found as in the former method: from the centre a, with the diſtance $a\,d$, deſcribe the arch $d\,c$ O; make $d\,c$ equal to one-third of d O, and the angle $d\,c\,h$ equal to $c\,d\,h$, and from the centre h deſcribe the arch $d\,c$. The inverted arch c O may deſcribed as before.

Fig. 8.

IV. *To deſcribe a very full main frame.*—Let the vertical and horizontal lines be drawn as before: let b, fig. 8. be the floor-head, and $b\,x$ the riſing. Divide G c into two equal parts in the point d, and upon $c\,d$ deſcribe the ſquare $d\,b\,a\,c$, in which inſcribe the quadrant $d\,e\,a$. Divide the line $b\,d$ into any number of equal parts in the points O, N, M, L, and draw the lines L m, M e, N n, O b, perpendicular to $d\,b$. Divide the line G C, the depth of the hold, the riſing being deducted, into the ſame number of equal parts in the points E, F, I, K, and make the lines E p, F q, I r, K s, in the frame, equal to the lines O b, N n, M e, L m, in the ſquare, each to each reſpectively; and through the points G, p, q, r, s, b, deſcribe a curve. The remaining part of the frame may be deſcribed by the preceding methods.

Fig. 9.

V. *To deſcribe the main frame of a ſhip intended to be a faſt ſailer.*—The principal lines being drawn as before, let the length of the floor-timber be equal to half the breadth of the ſhip, and the riſing one-fifth or one-ſixth of the whole length of the floor-timber, which lay off from x to E, fig. 9. Through the point E draw the line T x perpendicular to GC, and d E perpendicular to AG. Join T d, which biſect in B, and draw BF perpendicular thereto, and meeting CG produced in F, from the centre F, at the diſtance FT, deſcribe the ſemicircle T d D. Divide GT into any number of parts, VW, &c. and biſect the intervals DV, DW, &c. in the points X, Z, &c.; then, from the centre X, with the extent XV, deſcribe the ſemicircle D b V, interſecting AG in b. Let VP be drawn perpendicular to GT, and b P perpendicular to AG, and the point of interſection P will be one point through which the curve is to paſs. In like manner proceed for the others, and a curve drawn through all the points of interſection will be part of the curve of the main frame. The remaining part of the curve from E to Y will be compoſed of two arches, the one to reconcile with the former part of the curve at E, and the other to paſs through the point Y, the centre of which may be found by any of the preceding methods. In order to find the centre of that which joins with the curve at E, make TR equal to the half of GD, and join ER, in which a proper centre for this arch may be eaſily found.

The portion G b E of the curve is a parabola, whoſe vertex is G and parameter GD.

For $GD : Gb :: Gb : GV$ by conſtruction.

Hence $DG \times GV = Gb^2$, which is the equation for a parabola.

Fig. 10.

VI. *To deſcribe a main frame of a middling capacity.*—Let the length of the floor-timber be equal to one-half of the breadth of the ſhip. Make O d, fig. 10. equal to one-fourth of the length of the floor-timber, and draw the perpendicular $d\,c$ equal to the riſing, and divide it into two equal parts in the point e. Deſcribe an arch through e, and the extremity a of the floor-timber, the radius being equal to the half breadth, or more or leſs according to the propoſed round of the floor-head. Then with the radius O l, half the length of the floor-timber, deſcribe the arch e Y.

Draw $l\,m$ perpendicular to OA: biſect A n in p, and draw the perpendicular $p\,q$. From the middle of A p draw the perpendicular $r\,s$, and from the middle of A r draw the perpendicular $t\,u$. Make $n\,z$, $p\,g$, each equal to $l\,n$: make the diſtances $p\,y$, $r\,b$, each equal to $a\,g$; r F, t E, each equal to $a\,b$; and $t\,x$ equal to a E. Then a curve drawn through the points a, z, y, F, x, T, will form the under part of the midſhip frame.

We ſhall finiſh theſe methods of deſcribing the main

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frame of a ſhip with the following remark from M. Vial du Clairbois*. "It ſeems (ſays he) that they have affected to avoid ſtraight lines in naval architecture; yet, geometrically ſpeaking, it appears that a main frame formed of ſtraight lines will have both the advantage and ſimplicity over others." To illuſtrate this, draw the ſtraight line MN (fig. 9.) in ſuch a manner that the mixtilineal ſpace M *a l* may be equal to the mixtilineal ſpace DNY. Hence the capacity of the main frame formed by the ſtraight lines MN, NY will be equal to that of the frame formed by the curve M *a* DY; and the frame formed by the ſtraight lines will for the moſt part be always more ſuſceptible of receiving a bow that will eaſily divide the fluid. It is alſo evident, that the cargo or ballaſt, being lower in the frame formed of ſtraight lines than in the other, it will therefore be more advantageouſly placed, and will enable the ſhip to carry more ſail (c); ſo that having a bow equally well or better formed, ſhe will ſail faſter.

Traité de Navire de Bouguer, p. 601.

Prob. VI. To deſcribe a ſtern having a ſquare tuck.

Fig. 11.

Let AB (fig. 11.) be the middle line of the poſt, and let CD be drawn parallel thereto at a diſtance equal to half the thickneſs of the poſt. Make CE equal to the height of the lower part of the faſhion-piece above the keel: make CT equal to the height of the extremity G of the tranſom above the plane of the keel produced, and CH equal to the height of the tranſom on the poſt, HT being equal to above one-ninth or one-tenth of GT, and deſcribe the arch GH, the centre of which will be in BA produced: make EK equal to five-twelfths of ET: through K draw KL perpendicular to CD, and equal to EK; and with an extent equal to EL deſcribe the arch EL. Make GI equal to the half of ET, and from the centre I deſcribe the arch GM, and draw the reconciling curve ML.—Let the curve of the faſhion-piece be produced upwards to the point repreſenting the upper height of breadth as at O. Make ON equal to the height of the top-timber, and BN equal to the half breadth at that place, and join ON. Through N and the upper part of the counter, let arches be deſcribed parallel to GH. The tafferel, windows, and remaining part of the ſtern, may be finiſhed agreeable to the fancy of the artiſt.

Fig. 12.

In fig. 12. the projection of the ſtern on the plane of elevation is laid down, the method of doing which is obvious from inſpection.

If the tranſom is to round aft, then ſince the faſhion-pieces are always ſided ſtraight, their planes will interſect the ſheer and floor planes in a ſtraight line. Let G *g* (fig. 14.) be the interſection of the plane of the faſhion-piece with the floor plane. From the point *g* draw *g* W perpendicular to *g* M: make *y k* equal to the height of the tuck, and W *k* being joined will be the interſection of the plane of the faſhion-piece with the ſheer plane. Let the water lines in the ſheer plane produced meet the line *k* W in the points *a*, *s*, *h*, and draw the perpendiculars *aa*, *ſs*, *hh*. From the points *a*, *s*, *h* (fig. 14.) draw lines parallel to G *g* to interſect each correſponding water line in the floor plane in the points 3, 2, 1.

Plate ccccIxxxvii. fig. 14.

From the points G, 3, 2, 1, in the floor-plane draw lines perpendicular to *g* M, interſecting the water lines (fig. 13.) in the points G, 3, 2, 1; and through theſe points deſcribe the curve G 3 2 1 *k*: and WG 3 2, 1 *k* will be the projection of the plane of the faſhion-piece on the ſheer plane. Through the points G, 3, 2, 1 (fig. 13.) draw the lines GF, 3 A, 2 S, 1 H, perpendicular to W *k*; and make the lines WF, *a* A, *s* S, *h* H, equal to the lines *g* G, *a* 3, *s* 2, *h* 1 (fig. 14.) reſpectively, and WFASH *k* will be the true form of the plane of the aft ſide of the faſhion-piece. When it is in its proper poſition, the line WF will be in the ſame plane with the ſheer line; the line *a* A in the ſame plane with the water-line *a* 3; the line *s* S in the ſame plane with the water line *s* 2; and the line *h* H in the ſame plane with the water line *h* 1. If lines be drawn from the ſeveral points of interſection of the water lines with the rabbet of the port (fig. 13.), perpendicular to *g* M, and curved lines being drawn from theſe points to G, 3, 2, 1 (fig. 14.) reſpectively, will give the form and dimenſions of the tuck at the ſeveral water lines.

Fig. 13.

Fig 14.

Prob. VII. To bevel the faſhion-piece of a ſquare tuck by water-lines.

As the faſhion-piece both rakes and cants, the planes of the water-lines will therefore interſect it higher on the aft than on the fore-ſide; but before the heights on the fore-ſide can be found, the breadth of the timber muſt be determined; which let be *b n* (fig. 15.). Then, as it cants, the breadth in the direction of the water-line will exceed the true breadth. In order to find the true breadth, form the aft-ſide of the faſhion-piece as directed in the laſt problem.

Fig. 13.

Let *t* 5 (fig. 13.) be the aft ſide of the rabbet on the outſide of the poſt, WM the common ſection of the plan of the faſhion-piece and the ſheer-plan. Before this laſt line can be determined, the ſeveral water-lines 1, 2, 3, 4, and 5, muſt be drawn parallel to the keel, which may repreſent ſo many tranſoms.—Let theſe water-lines be formed and ended at the aft-ſide of the rabbet, as in fig. 14. where the rounds aft of the ſeveral tranſoms are deſcribed, limiting the curves of the water-lines. Now the line WM muſt rake ſo as to leave room for half the thickneſs of the poſt, at the tuck: in order to which, produce W *g* to *r*; make *r g* half the thickneſs of the poſt; through *r* draw a line parallel to *g* M to interſect *g* G in *b*: then with the radius *r b*, from *x* the point of the tuck as a centre, deſcribe an arch, and draw the line WM juſt to touch the back of that arch.

The line WM being drawn, let any point *k* in it be aſſumed at pleaſure: from *k* draw *k y* perpendicular to *g* M: through *y* draw *y f* (fig. 14.) parallel to *g* G, interſecting the line M *f* drawn perpendicular to *g* M in the point *f*. From M draw M *i* perpendicular to *y f*, and from *y* draw *y n* perpendicular to WM (fig. 13.). Make M *n* (fig. 15.) equal to M *i* (fig. 14.); then MI (fig. 15.) being equal to *y k* (fig. 13.), join *n* 1, and the angle 1 *n* M will be the bevelling to the horizontal plane. Again, make M *z*, M *f* (fig. 15.) reſpectively equal to *y n* (fig. 13.) and M *f* (fig. 14.), and join *z f*; and

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* *Architecture Navale*, p. 22.

(c) It is not a general rule, that lowering the cargo of a ſhip augments her ſtability. This is demonſtrated by the Chevalier de Borda, in a work publiſhed by M. de Goimpy upon this ſubject. See alſo *L'Architecture Novale par M. Vial du Clairbois*, p. 23.

and the angle M *z f* will be the bevelling to the ſheer-plane.

Fig. 15.

The bevelling being now found, draw the line *a b* (fig. 15.) parallel to *z n*, *a z* or *b n* being the ſcantling of the timber. Then *n x* will be the breadth of the timber on the horizontal plane, and *z e* its breadth on the ſheer-plane, and *a c* what is within a ſquare.

Now as the lines *g* G, *a* 3, *s* 2, *h* 1, *y i*, repreſent the aft-ſide of the faſhion-piece on the horizontal plane (fig. 14), dotted lines may be drawn parallel to them to repreſent the fore-ſide, making *n x* (fig. 15.) the perpendicular diſtance between the lines repreſenting fore and aft ſides of the faſhion-piece. By theſe lines form the fore-ſide of the faſhion-piece in the ſame manner as the aft-ſide was formed. The water-lines on the fore-ſide of the plane of the faſhion-piece muſt, however, be firſt drawn in fig. 13. thus: Draw the lines *e b*, *c d* parallel to WM, and whoſe perpendicular diſtances therefrom may be equal to *a c* and *z e* (fig. 15.) reſpectively. Draw a line parallel to *a* A through the point where the line *c d* interſects the fifth water-line. Draw a line parallel to *a* A through the point where the fourth water-line interſects the line *c d*; in like manner proceed with the other water-lines. The fore-ſide of the faſhion-piece is now to be deſcribed by means of theſe new water-lines, obſerving that the diſtances in the floor-plane muſt be ſet off from the line *e b*, and not from WM, as in the former caſe; and a curve deſcribed through the points 5, 3, 2, 1, where theſe diſtances reach to, will repreſent the fore-ſide of the faſhion-piece.

The neareſt diſtance between the points 5, 3, 2, 1, and the aft-ſide of the faſhion-piece is what the bevelling is beyond the ſquare when both ſtock and tongue of the bevel are perpendicular to the timber. Make M *p* (fig. 16.) equal to the breadth of the timber, and M 5 equal to the perpendicular diſtance of the point 5 (fig. 13.) from the aft-ſide of the faſhion-piece, and join 5 *p*. In like manner proceed with the others, and the bevellings at theſe parts will be obtained; but, in order to avoid confuſion, the perpendiculars 4, 3, 2, (fig. 13.), inſtead of being laid off from M (fig. 16.), were ſet off from points as far below M as the other extremities of the lines drawn from theſe points are below the point *p*.

Fig. 16.

PROB. VIII. To deſcribe the tranſoms of a round poop.

The tranſoms are faſtened to the ſtern-poſt in the ſame manner that the floor-timbers are faſtened to the keel, and have a riſing called the *flight* ſimilar to the riſing of the floor-timbers. The upper tranſom is called the *wing* tranſom, the next the *deck* tranſom, and the others the *firſt*, *ſecond*, and *third* tranſoms in order. The wing tranſom has a round aft and a round up: the round up of the deck tranſom is the ſame as that of the beams.

The faſhion-piece of a ſquare tuck muſt be firſt deſcribed, together with the three adjacent frames, by the method to be explained. The part of the ſtern above the wing tranſom is to be deſcribed in the ſame manner as before, and may therefore be omitted in this place. The part below the keel of the faſhion-piece is alſo the ſame in both caſes. Let fig. 17. repreſent the faſhion-piece of a ſquare tuck, and the three adjoining frames. Divide the interval AB into four equal parts in the points C, D, E, and draw the perpendiculars AF, CG, DH, EI, and BK: theſe will be portions of water-lines anſwering to the ſeveral tranſoms.

Plate cccclxxxviii fig. 17.

Fig. 18.

Let theſe water-lines be deſcribed on the floor-plan (fig. 18.), in which ABC repreſents the wing tranſom. Deſcribe the arch *b* C to reconcile the curves A *b* and CE. Let LFG be the water-line anſwering to the lower part of the faſhion-piece, the diſtance between the points L and A being equal to the exceſs of the projection of the point A beyond that of B (fig. 20.). Draw CK (fig. 18.) perpendicular to AM, and make the angle KCM equal to about 25 degrees, and CN will be the projection of the faſhion-piece on the floor-plane. Make AB (fig. 19.) equal to AB (fig. 17.). Divide it into four equal parts, and draw the perpendiculars AF, CH, DI, EK, and BG. Make AF equal to CM, and BG equal to MN, and draw the curve FHIKG, having a leſs curvature than the faſhion-piece of the ſquare tuck *s c p g n*. Make MO, MP, MQ, equal to CH, DI, and EK reſpectively. Divide AL (fig. 18.) into four equal parts, and to theſe points of diviſion draw curves through the points O, P, Q, ſo as to partake partly of the curvature of A *b* CE and partly of that of LNF, but moſt of the curvature of that to which the propoſed curve is neareſt; and hence the form of the ſeveral tranſoms will be obtained.

Fig. 19.

In order to repreſent the curve of the faſhion-piece on the plane of projection, make the lines AF, CG, DH, EI, and BK, (fig. 17.) reſpectively equal to the perpendicular diſtance of the points C, O, P, Q, and N. From the line AN (fig. 18.), and through the extremities of theſe lines, draw the curve FGHIK.

It remains to lay down the projection of the faſhion-piece on the plane of elevation. In order to which, divide the line AB, fig. 20. (equal to AB fig. 17.) into four equal parts, and through the points of diviſion draw the perpendiculars AF, CG, DH, EI, and BK; make AF (fig. 20.) equal to the perpendicular diſtance of the point C from the line BL (fig. 18.). In like manner make the lines CG, DH, EI, and BK (fig. 20) reſpectively equal to the perpendicular diſtances of the points O, P, Q, and N, from the line BL (fig. 18.); and a curve drawn through theſe points will be the projection of the faſhion-piece on the plane of elevation.

Fig. 20.

PROB. IX. To deſcribe the intermediate frames in the after body.

For this purpoſe the midſhip and ſtern frames muſt be drawn in the plane of projection. As the main frame contains the greateſt capacity, and the ſtern frame is that having the leaſt, it hence follows that the form and dimenſions of the intermediate frames will be between theſe; each frame, however, partaking moſt of the form of that to which it is neareſt.

Fig. 21.

Let ACDE (fig. 21.) be the main frame on the plane of projection, and FGH the ſtern frame; and let there be any convenient number of intermediate frames, as *nine*. Draw the floor ribband CF, and the breadth ribband GD. Divide the curves CD, FG, each into the ſame number of equal parts, as three, in the points K, M; L, N; and draw the ſecond and third ribbands KL, MN. In order to divide theſe ribbands ſo as to form fair curves in different ſections, various methods have been propoſed. One of the beſt of theſe, being that which is chiefly employed by the French conſtructors,

tors, is by means of an equilateral triangle, which is conſtructed as follows.

Fig. 22. Draw the line ME (fig. 22.), limited at M, but produced towards E: take M 1 equal to any convenient extent; make 1, 2 equal to thrice that extent, 2, 3 equal to five times, and 3, 4 equal to ſeven times the above extent; and continue this diviſion to E, always increaſing by two, until there be as many points as there are frames, including the main and ſtern frames. Upon ME deſcribe the equilateral triangle MSE, and draw lines from the vertex S to each point of diviſion; then the line SM will be that anſwering to the main frame, and SE that correſponding to the poſt; and the other lines will be thoſe anſwering to the intermediate frames in order.

Fig. 23. Let fig. 23. be the projection of part of the ſtern on the plane of elevation, together with the eighth and ninth frames. From the points L, N, G, (fig. 21.) draw the lines LO, NP, GQ, perpendicular to the plane of the upper edge of the keel. Make AB (fig. 23.) equal to AF (fig. 21.), and draw the water line BCD. Draw the line BC (fig. 22.) ſo that it may be parallel to the baſe of the triangle, and equal to CD (fig. 23.), which produce indefinitely towards H. Make BD equal to BC (fig. 23.), and draw the dotted line SD (fig. 22.). The ribband FC (fig. 21.) is to be applied to the triangle, ſo that it may be parallel to the baſe, and contained between the line MS and the dotted line SD. Let *c f* repreſent this line; then transfer the ſeveral diviſions from *c f* to the ribband CF (fig. 21.), and number them accordingly. Again, make EF (fig. 23.) equal to LO (fig. 21.), and draw the water line FGH; make BF (fig. 22.) equal to FG (fig. 23.), and draw the dotted line SF; apply the ſecond ribband LK to the triangle, ſo that the extremity K may be on the line SM, and the other extremity L on the dotted line SF, and making with SM an angle of about 62½ degrees. Let *k l* be this line, and transfer the diviſions from it to the ribband KL. In like manner make IK (fig. 23.) equal to NP (fig. 21.), and draw the water line KLM. Make BG (fig. 22.) equal to KL (fig. 23.), and draw the dotted line SG; then the ribband MN is to be applied to the triangle in ſuch a manner that its extremities M and N may be upon the lines SM, SG reſpectively, and that it may make an angle of about 68 degrees with the line SM; and the diviſions are to be transferred from it to the ribband MN. The ſame proceſs is to be followed to divide the other ribbands, obſerving to apply the fourth ribband to the triangle, ſo that it may make an angle of 86 degrees with the line SM; the fifth ribband to make an angle of 65 degrees, and the ſixth an angle of 60 degrees with the line SM.

The quantities of theſe angles are, however, far from being preciſely fixed. Some conſtructors, in applying the ribbands to the triangle, make them all parallel to its baſe; and others vary the meaſures of theſe angles according to fancy. It may alſo be remarked, that a different method of dividing the baſe of the triangle is uſed by ſome. It is certainly proper to try different methods; and that is to be preferred which beſt anſwers the intended purpoſe.

Beſide the frames already mentioned, there are other two laid down by ſome conſtructors in the ſeveral plans, called *balance frames*. The after balance frame is placed at one fourth of the length of the ſhip before the ſternpoſt; and the other, commonly called the *loof frame*, at one fourth of the ſhip's length aft of a perpendicular to the keel from the rabbet of the ſtem. Let the dotted line at X, between the fifth and ſixth frames, (fig. 23.) be the place of the after balance frame in the plane of elevation. Then, in order to lay down this frame in the plane of projection, its repreſentation muſt be previouſly drawn in the triangle. To accompliſh this, draw the line SV (fig. 22.) ſo that the interval 5 V may have the ſame ratio to 5 6 (fig. 22.) that 5 X has to 5 6 (fig. 23.) (D). Then the ſeveral points in the ribbands in the plane of projection anſwering to this frame are to be found by means of the triangle in the ſame manner as before.

The loof frame is nearly of the ſame dimenſions as the after balance frame, or rather of a little greater capacity, in order that the centre of gravity of that part of the ſhip may be nearly in the plane of the midſhip frame. Hence the loof frame may be eaſily drawn in the plane of projection, and hence alſo the other frames in the fore body may be readily deſcribed.

Prob. X. To deſcribe the frames in the fore body.

Fig. 24. Draw the middle line of the ſtem AB (fig. 24.); make AC, BD each equal to half the thickneſs of the ſtem, and draw the line CD; deſcribe alſo one half of the main frame CEFGHI. Let *e* E, *f* F, *g* G, *h* H, be water lines at the heights of the ribbands on the main frame; alſo let *a* be the termination of the floor ribband, and *b* that of the breadth ribband on the ſtem. Divide the interval *a b* into three equal parts in the points *c*, *d*, and draw the ribbands *a* E, *c* F, *d* G, and *b* H. Make *e i*, *f k*, *g l*, *h m* (fig. 24.) equal to *e i*, *f k*, *g l*, *h m* (fig. 21.) reſpectively, and draw the curve C*i k l m*, which will be the projection of the loof frame. Or ſince it is neceſſary that the capacity of the loof frame ſhould be a little greater than that of the after balance frame, each of the above lines may be increaſed by a proportional part of itſelf, as one tenth or one twentieth, as may be judged proper.

Fig. 25. Conſtruct the triangle (fig. 25.) in the ſame manner as fig. 22. only obſerving, that as there are fewer frames in the fore than in the after body, its baſe will therefore be divided into fewer parts. Let there be eight frames in the fore body, then there will be eight diviſions in the baſe of the triangle beſide the extremes.

Let fig. 26. repreſent the ſtem and part of the forebody in the plane of elevation, and let O be the place of the loof frame. Divide the interval 4, 5 (fig. 25.) ſo that 4, 5 may be to 4 Z as 4, 5 to 4, 0 (fig. 26.), and draw the dotted line SZ, which will be the line denoting the loof frame in the triangle.

Fig. 26. Draw the lines AB, CD, EF, GH (fig. 26.) parallel to the keel, and whoſe perpendicular diſtances therefrom may be equal to C *a*, C *c*, C *d*, C *b*, (fig. 24.) the interſections

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(D) It is evident, from the method uſed to divide the baſe of the triangle, that this proportion does not agree exactly with the conſtruction: the difference, however, being ſmall, is therefore neglected in practice.

interſections of theſe lines with the rabbet of the ſtem, namely, the points I, K, L, M will be the points of termination of the ſeveral ribbands on the ſtem in the plane of elevation. Divide 8 A (fig. 25.) ſo that 8 B, 8 C, 8 D, and 8 E, may be reſpectively equal to BI, DK, FL, and HM (fig. 26.), and draw the dotted lines SB, SC, SD, SE (fig. 25.). Apply the edge of a ſlip of card to the firſt ribband (fig. 24.), and mark thereon the extremities of the ribband *a*, E, and alſo the point of interſection of the loof frame. Then apply this ſlip of card to the triangle in ſuch a manner that the point *a* may be on the dotted line SB, the point E on the line SM, and the point anſwering to the loof frame on the dotted line SZ; and mark upon the card the ſeveral points of interſection of the lines S 1, S 2, &c. Now apply the card to the ribband *a* E (fig. 24.) as before, and transfer the ſeveral points of diviſion from it to the ribband. In like manner proceed with the other ribbands; and lines drawn through the correſponding points in the ribbands will be the projection of the lower part of the frames in the fore body. The projections of the top-timbers of the ſeveral frames may be taken from the half breadth plan; and hence each top-timber may be eaſily deſcribed.

In large ſhips, particularly in thoſe of the French navy, a different method is employed to form the top-timbers in the fore body, which is as follows:

Plate cccclxxxix. fig. 27.

Let BI (fig. 27.) be one-fourth of the breadth of the ſhip, and draw IK parallel to AB. Take the height of the foremoſt frame from the plane of elevation, and lay it off from A to B: from the point B draw BH perpendicular to AB, and equal to half the length of the wing tranſom. Let E be the place of the breadth ribband on the main frame, and F its place on the ſtem at the height of the wing tranſom. With a radius equal to five-ſixths of half the greateſt breadth of the ſhip deſcribe the quadrant EFG (fig. 28.); Make EH equal to FG (fig. 27.), the point F being at the height of the wing tranſom. Through H draw HO perpendicular to EH, and interſecting the circumference in O; then draw OL parallel to HE, and EL parallel to HO. Divide EL into as many equal parts as there are frames in the fore body, including the main frame, and from theſe points of diviſion draw the perpendiculars 11, 22, &c. meeting the circumference as in the figure. Take the diſtance 11, and lay it off from G (fig. 27.) towards F to the point 1; and from the ſame point G lay off towards F the ſeveral perpendiculars contained between the ſtraight line and the curve to the points 2, 3, &c. and through theſe points draw lines parallel to EG.

ig. 28.

ig. 29.

Take any line AB (fig. 29.) at pleaſure: divide it equally in two in the point 8: divide 8 B in two parts in the point 7, and continue this method of diviſion until there are as many points as there are frames in the fore body, including the main frame. Upon AB conſtruct the equilateral triangle ACB, and draw the line C 8, C 7, &c. Place a ſlip of card on the parallel *a* K 8 (fig. 27.), and mark thereon the points oppoſite to *a*, K, and 8; and let them be denoted accordingly. Then apply this ſlip of card to the triangle, ſo that the point *a*, which is that anſwering to the rabbet of the ſtem, may be on the line AC; that the point anſwering to K may be on C 8, and the extremity 8 on the line CB; and mark on the card the points of interſection of the lines C 7, C 6, &c. and number them accordingly. Now apply this ſlip of card to the ſeventh parallel (fig. 23.), the point *a* being on the line CD, and mark on this parallel the point of interſection 7; ſlide the card down to the ſixth parallel, to which transfer the point N° 6. In like manner proceed with the other parallels.

The point K, at the interſection of the line IK with the eighth parallel, is one point through which the eighth frame paſſes. From this point upwards a curve is to be deſcribed ſo as to reconcile with the lower part of this frame already deſcribed, and the upper part, forming an inverted arch, which is to terminate at H. This top-timber may be formed by two ſweeps, whoſe radii and centres are to be determined partly from circumſtances and partly according to fancy. It however may be more readily formed by hand.

Let LM (fig. 27.) be the line of the ſecond deck at the main frame, and let LN be the difference of the draught of water, if any. Make GN (fig. 28.) equal to LN: draw NM perpendicular to GN, meeting the circle in M; and through the points G and M draw the parallels GV and MV; divide GN as before, and from the ſeveral points of diviſion draw perpendiculars terminating in the curve. Transfer theſe perpendiculars from L upwards (fig. 27.), and through the points thus found draw the lines 11, 22, &c. parallel to LM. Apply a ſlip of card to the eighth parallel, and mark upon it the point anſwering to the ſtem, the eighth and main frames: carry this to the triangle, and place it ſo that theſe points may be on the correſponding lines. Then the points of interſection of the lines C 7, C 6, &c. are to be marked on the card, which is now to be applied firſt to the eighth parallel (fig. 27.), then to the ſeventh, &c. transferring the ſeveral points of diviſion in order as before.

Draw the line HO (fig. 27.); mark its length on a ſlip of card, and apply it to the triangle, ſo that it may be parallel to its baſe, and its extremities one on the eighth and the other on the main frame: mark on the card the points of interſection of the ſeveral intermediate lines as before; then apply the card to HO, and transfer the diviſions.

There are now three points determined through which each top-timber muſt paſs, namely, one in the breadth ribband, one in the fifth, and one in the upper ribband. Through theſe curves are to be deſcribed, ſo as to reconcile with the lower part of the frame, and partake partly of the curvature of the eighth frame, and partly of that of the main frame, but moſt of that of the frame to which it is neareſt: and hence the plane of projection is ſo far finiſhed, that it only remains to prove the ſeveral frames by water lines.

Another method of deſcribing the frames in the body plan is by ſweeps. In this method it is neceſſary, in the firſt place, to deſcribe the height of the breadth lines, and the riſing of the floor, in the plane of elevation. The half breadth lines are next to be deſcribed in the floor plan. The main frame is then to be deſcribed by three or more ſweeps, and giving it ſuch a form as may be moſt ſuitable to the ſervice the ſhip is deſigned for. The lower, upper, and top-timber heights of breadth, and the riſings of the floor, are to be ſet upon the middle line in the body plan, and the ſeveral half breadths are then to be laid off on lines drawn through theſe

Preliminary Problems.

theſe points perpendicular to the middle line. A mould may then be made for the main frame, and laid upon the ſeveral riſings, as in whole mouldings, explained in Chapter V. with this difference, that here an under breadth ſweep is deſcribed to paſs through the point which limits the half breadth of the timber, the centre of which will be in the breadth line of that timber. The proper centres for all the frames being found, and the arches deſcribed, the bend mould muſt be ſo placed on the riſing line of the floor that the back of it may touch the back of the under breadth ſweep. But the general practice is, to deſcribe all the floor ſweeps with compaſſes, as well as the under breadth ſweeps, and to reconcile theſe two by a mould which is an arch of a circle, its radius being the ſame with that of the reconciling ſweep by which the midſhip frame was formed. It is uſual for all the floor ſweeps to be of the ſame radius; and in order to find their centres a line is formed on the floor plan for the half breadth of the floor. As this line cannot be deſcribed on the ſurface of a ſhip, it is therefore only an imaginary line. Inſtead of it ſome make uſe of a diagonal in the body plane to limit the half breadth of the floor upon every riſing line, and to erect perpendiculars at the ſeveral interſections, in the ſame manner as for the midſhip frame.

After the ſweeps are all deſcribed, recourſe is had to moulds, or ſome ſuch contrivance, to form the hollow of the timbers, much in the ſame manner as in whole moulding; and when all the timbers are formed, they muſt be proved by ribband and water lines, and altered, if neceſſary to make fair curves.

The preceding methods of deſcribing the ſeveral planes or ſections of a ſhip being well underſtood, it will be a very eaſy matter to conſtruct draughts for any propoſed ſhip: and as the above planes were deſcribed ſeparately and independent of each other, it is therefore of little conſequence which is firſt deſcribed. In the following application, however, the plane of elevation will be firſt drawn, then part of the floor plan, and laſtly the body plan: and in connecting theſe plans the moſt rational and ſimple methods will be employed.

CHAP. IV. *Application of the foregoing Rules to the Conſtruction of Ships.*

SECT. I. *To conſtruct a Ship intended to carry a conſiderable Burden in Proportion to her general Dimenſions, and to draw little Water.*

DIMENSIONS.

	F.	In.
Length between the wing tranſom and a perpendicular from the rabbet of the ſtem at the height of breadth line -	80	0
Main half breadth moulded -	11	0
Half breadth at the height of breadth line at the ſtern - - -	7	6
Top-timber half breadth - -	10	6
Height of the ſtem above the upper edge of the keel - - -	17	0
Height of the breadth line at the ſtem -	13	6
Height of the breadth line at the ſtern -	12	3
Upper height of breadth at the main frame	7	4
Lower height of breadth - -	5	10
Height of middle line of wales at the ſtem	10	0
Height of middle line of wales at the main frame - - -	6	10
Height of middle line of wales at the ſtern	10	6
Breadth of the wales - -	1	9
Height of top-timber at midſhips -	14	0
——————— at ſtern -	18	0

Application of the foregoing Rules to the Conſtruction of Ships.

Plate CCCCXC. fig. 30.

Draw the line *a b* (fig. 30.) equal to 80 feet, from a convenient ſcale: divide it into as many equal parts plus one as there are to be frames, which let be 16, and through each point of diviſion draw perpendiculars. Make *b c* equal to 17 feet, the perpendicular height of the top of the ſtem above the upper edge of the keel, and deſcribe the ſtem by Prob. II. Make *a d* equal to $10\frac{1}{2}$ feet, the height of the middle line of the wales at the ſtern, and *a e* equal to the propoſed rake of the poſt, which may be about 2 feet: join *d e*; and draw the line *f g* repreſenting the aft-ſide of the poſt. Deſcribe the counter and ſtern by Problem VI. and VII. Make ⊕ *h* equal to 14 feet, the top timber height at the main frame, and *i k* equal to 18 feet, the height at the ſtern; and through the three points *c*, *h*, *k*, deſcribe the curve limiting the top-timbers by Problem I. Make *b d* equal to 10 feet, the height of the middle line of the wales at the ſtem, and ⊕H equal to 6 feet 10 inches, the height at the main frame; and the curve *d* H *d* being deſcribed will repreſent the middle line of the wales. At the diſtance of $10\frac{1}{2}$ inches on each ſide of this line draw two curves parallel thereto, and the wales will be completed in this plan. Make *b l* equal to $13\frac{1}{2}$ feet, the height of the breadth line at the ſtem; *a m* equal to $12\frac{1}{4}$ feet, the height at the ſtern, and I ⊕ K ⊕ equal to 5 feet 10 inches and 7 feet 4 inches reſpectively; and draw the upper breadth line *l* K *m* and lower breadth line *l* I *m*. From the line *a b* lay downwards the breadth of the keel, which may be about one foot, and draw the line L *t* parallel to *a b*.

Fig. 31.

Let the line L *r*, which is the lower edge of the keel, repreſent alſo the middle line of the floor plan. Produce all the perpendiculars repreſenting the frames: make ⊕ M (fig. 31.) equal to 11 feet, the main half breadth at midſhips; through *m* (fig. 30.) draw the line *m* N perpendicular to *a b*, and make *p* N equal to $7\frac{1}{2}$ feet, and draw the main half breadth line NM *r* by Problem IV. Deſcribe alſo the top-timber half breadth line PO *r*, ⊕ O being equal to $10\frac{1}{2}$ feet, and form the projecting part of the ſtem *q r s t*.

In order that the top-timber line may look fair on the bow, and to prevent the foremoſt top-timbers from being too ſhort, it is neceſſary to lift or raiſe the ſheer from the round of the bow to the ſtem. For this purpoſe the following method is uſually employed: Produce the circular ſheer before the ſtem in the plane of elevation at pleaſure; then place a batton to the round of the bow in the half breadth plan, and mark on it the ſtations of the ſquare timbers and the ſide of the ſtem; apply the batton to the ſheer plan, and place it to the ſheer of the ſhip, keeping the ſtations of the timbers on the batton well with thoſe on the ſheer plan for ſeveral timbers before dead-flat, where they will not alter; then mark the other timbers and the ſtem on the ſheer line produced; through theſe points draw lines parallel to the keel, to interſect their correſponding timbers and the ſtem in the ſheer plan: then a curve deſcribed theſe laſt points will be the ſheer of the ſhip round the pplication f the fore- oing Rules the Con- ruction of Ships.

the bow, lifted as required: and the heights of the timbers thus lengthened are to be transferred to the body plan as before.

Plate cccclxxxix. fig. 32.

Draw the line AB (fig. 32.) equal to 22 feet, the whole breadth; from the middle of which draw the perpendicular CD: make CE equal to half the thickneſs of the poſt, and CF equal to half that of the ſtem, and from the points A, E, F, B, draw lines parallel to CD. Make AG, BG each equal to 14 feet, the height at the main frame, and draw the line GG parallel to AB. Make GH, GH each equal to half a foot, the difference between the main and top timber half-breadths. From A and B ſet up the heights of the lower and upper breadth lines to I and K, and draw the ſtraight lines IK, IK. Let CL be the riſing at the main frame, and $\oplus$, $\oplus$ the extremities of the floor timber. Hence, as there are now five points determined in each half of the main frame, it may be very eaſily deſcribed.

Make CM equal to L$\oplus$, join M$\oplus$, and draw the other ribbands NO, PQ. In order, however, to ſimplify this operation, the rectilineal diſtance $\oplus$I was triſected, and through the points of diviſion the lines NO, PQ were drawn parallel to the floor ribband M$\oplus$.

Take the diſtance bc (fig. 30.), and lay it off from F to (fig. 32.); alſo make Fb (fig. 32.) equal to Fu (fig. 30.); through b draw bc parallel to AB, and equal to FR (fig. 31.). In like manner take the heights of each top-timber from fig. 30. and lay them off from C towards D (fig. 32.); through theſe points draw lines parallel to AB, and make them equal each to each, to the correſponding half breadth lines taken from the floor-plan: Then through the ſeveral points a, c, &c. thus found, draw a line acH, which will be the projection of the top-timber line of the fore body in the body plan. Proceed in the ſame manner to find the top-timber line in the after body.

Transfer the height of the main-breadth line on the ſtem bl (fig. 30.), from F to d (fig. 32.). Transfer alſo the heights of the lower and upper breadth lines at timber F (fig. 30.), namely, FW, FX, from F to e and f (fig. 32.); through which draw the parallels eg, fh; make them equal to FS (fig. 31.), and draw the ſtraight line gh. In this manner proceed to lay down the portions of the extreme breadth at each frame, both in the fore and in the after body in the body plan, and draw the upper and lower breadth lines dhK, dgI in the fore body and Ki, Ii in the after body. Hence the portions of the ſeveral top-timbers contained between the top-timber and main breadth lines may be eaſily deſcribed. It was before remarked that their forms were partly arbitrary. The midſhip top-timber has generally a hollow, the form of which is left entirely to the artiſt, though in ſome ſhips, eſpecially ſmall ones, it has none. It is the common practice to make a mould for this hollow, either by a ſweep or ſome other contrivance, which is produced conſiderably above the top-timber line, in a ſtraight line or very near one. The midſhip top-timber is formed by this mould, which is ſo placed that it breaks in four with the back of the upper breadth ſweep. The other top-timbers are formed by the ſame mould, obſerving to place it ſo that the ſtraight part of it may be parallel to the ſtraight part of the midſhip timber, and moved up or down, ſtill keeping it in that direction till it juſt touches the back of the upper breadth ſweep.

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Some conſtructors begin at the after timber, after the mould is made for the midſhip top-timber, becauſe they think it eaſier to keep the ſtraight part of the mould parallel to this than to the midſhip timber; and by this means the top ſide is kept from winding. Others, again, make a mark upon the mould where the breadth line of the midſhip timber croſſes it, and with the ſame mould they form the after timber: this will occaſion the mark that was made on the mould when at the main frame to fall below the breadth line of the after timber, and therefore another mark is made at the height of the breadth line at the after timber; the ſtraight part of the mould is then laid obliquely acroſs the breadth lines of the top-timbers in ſuch a manner that it may interſect the breadth line of the midſhip timber at one of theſe marks and the breadth line of the after timber at the other mark; then the ſeveral interſections of the breadth lines of the timbers are marked upon the mould; which muſt now be ſo placed in forming each timber, that the proper mark may be applied to its proper breadth, and it muſt be turned about ſo as juſt to touch the upper breadth ſweep. Any of theſe methods may make a fair ſide, and they may be eaſily proved by forming another intermediate half breadth line.

The remaining parts of the frames may be deſcribed by either of the methods laid down in Problems IX. and X. In order, however, to illuſtrate this ſtill farther, it is thought proper to ſubjoin another method of forming the intermediate frames, the facility of which will recommend it.

Take FZ (fig. 30.), and lay it from F to k (fig. 32.); then deſcribe the lower part of the foremoſt frame, making it more or leſs full according as propoſed; and interſecting the ribbands in the points l, m, n. Deſcribe alſo the aftermoſt frame o, p, q. Make $\alpha\beta$ (fig. 30.) equal to Fr (fig. 32.), and produce it to a (fig. 31.); alſo draw $\gamma\delta$ and $\varepsilon\zeta$ (fig. 30.) equal to Er and Es (fig. 32.) reſpectively; and produce them to b and c: Make Fe, Ff, FR (fig. 31.) equal to Ml, Nm, Pn (fig. 32.) each to each. Let alſo $\oplus h$, $\oplus i$, $\oplus k$, and 9l, 9m, 9n (fig. 31.) be made equal to M$\oplus$, NO, PQ, and Mo, Nq, Pp (fig. 32.); then through theſe points trace the curves $aenhlb$, $rfimc$, and rRknp, and they will be the projections of the ribbands in the floor plane. Now transfer the ſeveral intervals of the frames contained between the middle line and the ribbands (fig. 31.) to the correſponding ribbands in the body plan (fig. 32.). Hence there will be five points given in each frame, namely, one at the lower breadth line, one at each ribband, and one at the keel; and conſequently theſe frames may be eaſily deſcribed. In order to exemplify this, let it be required to lay down the frame E in the plane of projection. Take the interval En (fig. 31.), and lay it from M to u (fig. 32.). Lay off alſo Ev, Ee (fig. 31.) from N to v and from P to n (fig. 32.); then through the points F, u, v, n and the lower breadth line deſcribe a curve, and it will be the repreſentation of the frame E in the body plan. In like manner the other frames may be deſcribed.

The ribbands may now be transferred from the body plan to the plane of elevation, by taking the ſeveral heights of the interſection of each ribband with the frames, and laying them off on the correſponding frames in the floor plan; and if the line drawn through theſe points

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points make a fair curve, it is preſumed that the curves of the frames are rightly laid down in the body plan. Only one of theſe ribbands, namely, the firſt, is laid down in fig. 30. Theſe curves may alſo be farther proved, by drawing water lines in the plane of elevation, and in the body plan, at equal diſtances from the upper edge of the keel. Then the diſtances between the middle line of the body plan, and the ſeveral points of interſection of theſe lines with the frames, are to be laid off from the middle line in the floor plan upon the correſponding frames; and if the line drawn through theſe points form a fair curve, the frames are truly drawn in the body plan.

In figs. 30. and 32. there are drawn four water lines at any equal diſtances from the keel, and from each other. Theſe lines are then transferred from fig. 32. to fig. 31.; and the lines paſſing through theſe points make fair curves.

The tranſoms are deſcribed by Problem VIII. it is therefore unneceſſary to repeat the proceſs. A riſing line of the floor timbers is commonly drawn in the plane of elevation.

As this is intended only as an introductory example, ſeveral particulars have therefore been omitted; which, however, will be exemplified in the following ſection.

SECT. IV. *To deſcribe the ſeveral Plans of a Ship of War propoſed to carry* 80 *Guns upon two Decks.*

As it is propoſed in this place to ſhow the method of deſcribing the plans of a ſhip of a very conſiderable ſize, it therefore ſeems proper to give the dimenſions of every particular part neceſſary in the delineation of theſe plans. The ſeveral plans of this ſhip are contained in figs. 33. and 34. But as it would very much confuſe the figures to have a reference to every operation, and as the former example is deemed a ſufficient illuſtration, the letters of reference are upon theſe accounts omitted in the figures.

Plate CCCCXCI. Figs. 33. & 34.

PRINCIPAL DIMENSIONS.

Ship Builder's Repoſitory.

		F.	*In.*
Lengths.—Length on the gun or lower deck from the aft part of the rabbit of the ſtem to the aft part of the rabbet of the poſt		182	0
Length from the foremoſt perpendicular to dead flat		63	11¾
Length from the foremoſt perpendicular to timber Y		4	0
Length from after perpendicular to timber 37		3	4
Room and ſpace of the timbers		2	8¾
Length of the quarter-deck from the aft part of the ſtern		95	0
Length of the forecaſtle from the fore part of the beak-head		49	0
Length of round-houſe deck from the aft part of the ſtern		51	8
Heights.—Height of the gun or lower deck from the upper edge of the keel to the under ſide of the plank at dead flat		24	0
Height of the gun or lower deck from the upper edge of the keel to the under ſide of the plank at foremoſt perpendicular		26	
Height of the gun or lower deck from the upper edge of the keel to the under ſide of the plank at after perpendicular		26	3
Height from the upper ſide of the gun-deck plank to the under ſide of the upper deck plank, all fore and aft		7	0
Height from the upper ſide of the upper deck plank to the under ſide of the greater deck plank	afore	6	10
	abaft	6	11
Height to the under ſide of forecaſtle plank, afore and abaft		6	6
Height from the upper ſide of the quarter-deck plank to the under ſide of the round-houſe plank	afore	6	9
	abaft	6	10
Height of the lower edge of the main wales at foremoſt perpendicular		24	6
Height of the lower edge of the main wales at dead flat		20	0
Height of the lower edge of the main wales at after perpendicular		26	6
Height of the lower edge of the channel wales at foremoſt perpendicular		32	6
Height of the lower edge of the channel wales at dead flat		29	0
Height of the lower edge of the channel wales at after perpendicular		34	0
Height of the upper ſide of the wing tranſom		28	4
Height of the touch of the lower counter at the middle line		33	5
Height of the touch of the upper counter at the middle line		36	2
Height of the top-timber line at the after part of the ſtern timber		44	7
Breadths.—Main wales in breadth from lower to upper edge		4	6
Channel wales in breadth from lower to upper edge		3	0
Waiſt rail in breadth		0	7
Diſtance between the upper edge of the channel wales and the under edge of the waiſt rail		2	9
Sheer rail in breadth		0	6
Diſtance between the ſheer rail and the rail above from timber 13 to the ſtern		2	5
Diſtance between the ſheer rail and the rail above from timber 7 to timber 11		1	4
Diſtance between the ſheer rail and the rail above from timber C to the forepart of beak-head		1	2
And the ſaid rail to be in breadth		0	6
Plank ſheer to be in thickneſs		0	2½
Centres of the maſts.—From the foremoſt perpendicular to the centre of the mainmaſt on the gun-deck		103	2
From the foremoſt perpendicular to the centre of the foremaſt on the gun-deck		29	5
From the after perpendicular to the centre of the mizenmaſt on the gun-deck		28	6
Stem.—The centre of the ſweep of the ſtem abaft timber P		0	4
Height of ditto from the upper edge of the keel		26	1
Stem moulded		1	3

Application of the fore going Rule to the Con ſtruction o Ships.

Foremoſt

Application of the foregoing Rules to the Construction of Ships.

	F.	In.
Foremoſt part of the head afore the perpendicular	2	4
Height of ditto from the upper edge of the keel	38	3
Stern-poſt.—Aft part of the rabbet afore the perpendicular on the upper edge of the keel	3	4
Aft part of the port abaft the rabbet at the upper edge of the keel	2	6
Aft part of the port abaft the rabbet at the wing tranſom	1	1
Stern-port fore and aft on the keel	3	1
Ditto ſquare at the head	2	0½
Counters.—The touch of the lower counter at the middle line, abaft the aft part of the wing tranſom	7	6
Round aft of the lower counter	1	4
Round up of the lower counter	0	9
The touch of the upper counter at the middle line, abaft the aft part of the wing tranſom	9	9
Round aft of the upper counter	1	3½
Round up of the upper counter	0	10
Aft part of the ſtern-timber at the middle line, at the height of the top-timber line, abaft the aft part of the wing tranſom	12	6

		F.	In.
Round aft of the wing tranſom		0	6
Round up of the wing tranſom		0	5½
Draught of water.—Load draught of water from the upper edge of the keel	afore	20	5
	abaft	20	5
Channels.—Foremoſt end of the fore channel afore timber R		1	0
The channel to be in length		37	0
And in thickneſs at the outer edge		0	4½
The dead eyes to be 12 in number, and in diameter		1	6
Foremoſt end of the main channel afore timber 9		0	10
The channel to be in length		38	0
And in thickneſs at the outer edge		0	4½
The dead eyes to be 14 in number, and in diameter		1	6
Foremoſt end of the mizen-channel abaft timber 27		2	4
The channel to be in length		20	0
And in thickneſs at the outer edge		0	4
The dead eyes to be 7 in number, and in diameter		1	0

Application of the foregoing Rules to the Construction of Ships.

DIMENSIONS of the ſeveral Parts of the Bodies.

Fore Body.	*Timbers Names.*															
	⊕		C		G		L		P		T		W		Y	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Lower height of breadth	22	6	22	6	22	7	23	0	23	11	25	7	26	10	28	8
Upper height of breadth	24	10	24	10	24	10	24	10½	25	3½	26	4½	27	4½	29	0
Height of the top-timber line	37	5	37	7	38	0	38	5	39	1	39	10	40	4	40	9
Height of the riſing line *	0	0	0	5½	3	10	9	10	18	6						
Height of the cutting down	2	3½	2	3½	2	3½	2	8	3	10	6	4				
Main half breadth	24	5½	24	5½	24	4½	24	0½	23	2½	20	2	17	0	11	0½
Top-timber half breadth	20	11	20	10	20	9	20	6	20	0	18	9½	17	10	16	6
Half breadth of the riſing	8	7	8	4	6	5½	2	9	5	7						
									Outſide							
Length of the lower breadth ſweeps	19	2	18	9	18	3	17	3	15	11	14	1	12	7	12	0
Firſt diagonal line	7	9	7	8¾	7	7	7	1	6	3	3	8				
Second ditto	13	9	13	8½	13	4½	12	1	10	3	7	1½	4	6		
Third ditto	20	0	19	11	19	2	17	7	15	1	11	1	8	3¼	3	4½
Fourth ditto	23	4½	23	4½	23	0	21	8½	18	11	14	8½	11	5	6	0
Fifth ditto	24	8	24	8	24	4½	23	5½	21	2½	17	1	13	8½	7	11
Sixth ditto																
Seventh ditto	24	1½	24	1½	24	0	23	9	22	10	20	10½	18	6½	14	7

* Riſing height 11 feet 10 inches at dead flat, from which all the other riſings muſt be ſet off.

After Body.	*Timbers Names.*																					
	1		5		9		13		17		21		25		29		33		35		37	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft	In.	Ft.	In.	Ft	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Lower height of breadth -	22	6	22	6	22	6	20	7½	22	9	23	0½	27	7½	24	6	25	10¾	26	9¾	28	3
Upper ditto - -	24	10	24	10	24	10	24	11	25	1	25	4	25	8	26	3	27	1	27	9	28	8
Height of the top-timber line	37	5	37	5	37	6	37	10	38	3½	38	11	39	8	40	6	41	5	42	0	42	6
Height of the cutting down -	2	3½	2	3½	2	3½	2	3½	2	4	2	7½	3	5	5	2½	8	7				
Height of the riſing -	0	2½	0	8½	1	9½	3	6½	6	0	10	1	17	0								
Main half breadth - -	24	5¼	24	4¾	24	4¼	24	3¼	24	1	23	8½	23	0½	21	10						
Half breadth of the riſing -	8	6	8	3	7	9	6	10½	5	3½	2	8	2	6	Outſide							
Top-timber half breadth -	20	11	20	10	20	9½	20	9	20	7	20	3	19	5	18	2	16	8	15	10½	15	0¼
Topſides half breadth -											19	7	18	4	17	0	15	10	14	11	14	3
Length of lower breadth ſweeps	19	2	19	2	19	0	18	7	17	1	16	0	14	5	12	5	9	10½	7	11	4	8
Firſt diagonal -	7	9	7	8¼	7	7	7	5	7	2½	6	7	5	9	4	7	2	10	1	8½	0	7
Second ditto - -	13	9	13	8½	13	6	13	1	12	6	11	2	9	7	7	7	4	8¼	3	1	0	11
Third ditto - -	20	0	19	11¼	19	7½	19	0	18	1½	16	6	14	2	11	5½	7	8½	5	5	2	1½
Fourth ditto - -	23	4½	23	3	23	1½	22	6½	21	11	20	3	18	0½	15	3½	11	4	8	7	4	6¼
Fifth ditto - -	24	8	24	7	24	6	24	1½	23	6½	22	3½	20	6½	18	2	14	4	11	5	7	0
Sixth ditto - -																	18	8½	16	0	11	8
Seventh ditto - -											23	9½	23	0	21	8½	20	0	18	11	17	8¾

DIAGONAL LINES for both the FORE and AFTER BODIES.

Fore and After Bodies.	*Names of the Diagonal Lines.*													
	1ſt		2d		3d		4th		5th		6th		7th	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft	In	Ft.	In
Height up the middle line - - -	6	11	11	4	16	5¼	20	8	23	5¾	27	5	43	9
Diſtance from the middle line on the baſe line	4	8	9	1	15	6								
Height up the ſide line - - -							0	9½	6	7	12	7½	32	8½

I. *Of the Sheer Draught or Plane of Elevation.*

Fig. 33. Draw a ſtraight line (fig. 33.) to repreſent the upper edge of the keel, erect a perpendicular on that end to the right, and from thence ſet off 182 feet, the length on the gun-deck, and there erect another perpendicular; that to the right is called the *foremoſt* perpendicular, and the other the *after* one: upon theſe two perpendiculars all the foremoſt and aftermoſt heights muſt be ſet off, which are expreſſed in the dimenſions.

Then ſet off the diſtance of the main frame or dead flat from the foremoſt perpendicular, and at that place erect a third perpendicular, which muſt be diſtinguiſhed by the character ⊕. From dead flat the room and ſpace of all the timbers muſt be ſet off; but it will only be neceſſary to erect a perpendicular at every frame timber; which in the fore body are called *dead flat*, A, C, E, &c. and in the after body (2), 1, 3, 5, &c.: hence the diſtance between the frame perpendiculars will be double the room and ſpace expreſſed in the dimenſions. Then ſet off the heights of the gun-deck afore at midſhip or dead flat, and abaft from the upper ſide of the keel; and a curve deſcribed through theſe three points will be the upper ſide of the gun-deck. Set off the thickneſs of the gun-deck plank below that; and another curve being drawn parallel to the former, the gun-deck will then be deſcribed at the middle line of the ſheer plan.

The centre of the ſtem is then to be laid down by means of the table of dimenſions; from which centre, with an extent equal to the neareſt diſtance of the upper edge of the keel, deſcribe a circle upwards: deſcribe alſo another circle as much without the former as the ſtem is moulded. Then ſet off the height of the head of the ſtem, with the diſtance afore the perpendicular, and there make a point; and within that ſet off the moulding of the ſtem, and there make another point: from this laſt-mentioned point let a line paſs downwards, interſecting the perpendicular at the height of the gun-deck, and breaking in fair with the inner circle, and the after part of the ſtern is drawn. Draw another line from the foremoſt point downwards, parallel to the former, and breaking in fair with the outer circle; then the whole ſtem will be formed, except the after or lower end, which cannot be determined till hereafter.

The ſtern-poſt muſt be next formed. Set off on the upper edge of the keel a ſpot for the aft part of the rabbet taken from the dimenſions, and from that forward ſet off another point at the diſtance of the thickneſs

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neſs of the plank of the bottom, which is four inches and a half; and from this laſt-mentioned point draw a line upwards interſecting the perpendiculars at the height of the lower deck; then ſet up the perpendicular the height of the wing tranſom, and draw a level line, and where that line interſects, the line firſt drawn will be the aft ſide of the wing tranſom; on the upper part of the middle line ſet off from that place the diſtance of the aft ſide of the ſtern-poſt; ſet off alſo the diſtance of the after part from the rabbet on the upper edge of the keel, and a line drawn through theſe two points will be the aft ſide of the poſt. A line drawn parallel to the firſt drawn line at the diſtance of four inches and a half, the thickneſs of the plank on the bottom, will be the aft ſide of the rabbet: and hence the ſtern-poſt is deſcribed, except the head, which will be determined afterwards.

From the dimenſions take the ſeveral heights of the upper deck above the gun-deck, afore, at midſhip, and abaft, and ſet them off accordingly; through theſe points deſcribe a curve, which will be the under ſide of the upper deck; deſcribe alſo another curve parallel thereto, at the diſtance of the thickneſs of the plank, and the upper deck will be then repreſented at the middle line of the ſhip.

Set off the height of the lower counter, at the middle line, from the upper edge of the keel, and draw a horizontal line with a pencil; then on the pencil line ſet off the diſtance the touch of the lower counter is abaft the aft ſide of the wing tranſom: from this point to that where the fore part of the rabbet of the ſtern-poſt interſects the line drawn for the upper part of the wing tranſom, draw a curve at pleaſure, which curve will repreſent the lower counter at the middle line. The height of the upper counter is then to be ſet off from the upper edge of the keel, and a horizontal line is to be drawn as before, ſetting off the diſtance the touch of the upper counter is abaft the aft ſide of the wing tranſom; and a curve deſcribed from thence to the touch of the lower counter will form the upper counter at the middle line.

Both counters being formed at the middle line, the upper part of the ſtern timber above the counters is to be deſcribed as follows: On the level line drawn for the upper ſide of the wing tranſom ſet off the diſtance of the aft ſide of the ſtern timber at the middle line from the aft ſide of the wing tranſom, at the height of the top-timber line, and erect a perpendicular: then upon this perpendicular, from the upper edge of the keel, ſet off the height at the middle line of the top timber line at the after ſide of the ſtern timber; through this point draw a ſtraight line to the touch of the upper counter, and the upper part of the ſtern timber will be deſcribed.

As the ſtern rounds two ways, both up and aft, the ſtern timber at the ſide will conſequently alter from that at the middle line, and therefore remains to be repreſented. Take the round up of the upper counter from the dimenſions, and ſet it below the touch at the middle, and with a pencil draw a level line; take alſo the round aft, and ſet it forward from the touch on the touch line, and ſquare it down to the pencil line laſt drawn, and the point of interſection will be the touch of the upper counter at the ſide. In the ſame manner find the touch of the lower counter; and a curve, ſimilar to that at the middle line, being deſcribed from the one touch to the other, will form the upper counter at the ſide.

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Take the round up of the wing tranſom, and ſet it off below the line before drawn for the height of the wing tranſom, and draw another horizontal line in pencil: then take the round aft of the wing tranſom, and ſet it forward on the upper line from the point repreſenting the aft ſide of the wing tranſom; ſquare it down to the lower line, and the interſection will be the touch of the wing tranſom: then a curve, ſimilar to that at the middle line, being drawn from the touch of the wing tranſom to the touch of the lower counter at the ſide, will be the lower counter at the ſide. Draw a line from the upper counter upwards, and the whole ſtern timber at the ſide will be repreſented. But as the ſtraight line drawn for the upper part of the ſide timber ſhould not be parallel to that at the middle line, its rake is therefore to be determined as follows.

Draw a line at pleaſure, on which ſet off the breadth of the ſtern at the upper counter; at the middle of this line ſet off the round aft of the upper counter; then through this point and the extremities of the ſtern deſcribe a curve. Now take the breadth of the ſtern at the top-timber line, and through the point where that breadth will interſect the curve for the round aft of the ſtern draw a line parallel to that firſt drawn, and the diſtance from the line laſt drawn to the curve at the middle of the line is the diſtance that the ſide timber muſt be from the middle line at the height of the top-timber line.

The ſheer is to be deſcribed, which is done by ſetting off the heights afore, at midſhips and abaft; and a curve deſcribed through theſe three points will be the ſheer. But in order that the ſheer may correſpond exactly with the dimenſions laid down, it will be neceſſary to proceed as follows: The perpendicular repreſenting timber dead flat being already drawn, ſet off from that the diſtances of the other frame timbers, which is double the room and ſpace, as the frames are only every other one; and erect perpendiculars, writing the name under each: then on each of theſe perpendiculars ſet off the correſponding heights of the top-timber line taken from the table of dimenſions for conſtructing the bodies; and through theſe points a curve being deſcribed, will repreſent the ſheer of the ſhip or top-timber line agreeable to the dimenſions.

The quarter-deck and foreceaſtle are next to be deſcribed, which may be done by taking their reſpective heights and lengths from the dimenſions, and deſcribing their curves. In the ſame manner alſo, the round-houſe may be drawn. The decks being deſcribed repreſenting their heights at the middle, it is then neceſſary to repreſent them alſo at the ſide. For this purpoſe take the round of the decks from the dimenſions, and ſet them off below the lower line drawn for the middle; and a curve deſcribed both fore and aft, obſerving to let it be rather quicker than the former, will be the repreſentation of the decks at the ſide.

The ports come next under conſideration. In the placing of them due attention muſt be paid, ſo as to preſerve ſtrength; or that they ſhall be ſo diſpoſed as not to weaken the ſhip in the leaſt, which is often done by cutting off principal timbers, placing them in too large openings, having too ſhort timbers by the ſide of

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them, &c. The frames repreſented by the lines already drawn muſt be firſt conſulted. Then with a pencil draw two curves, for the lower and upper parts of the lower deck poſts, parallel to the line repreſenting the lower deck; the diſtances of theſe lines from the deck are to be taken from the dimenſions, obſerving, however, to add to theſe heights the thickneſs of the deck, as the deck line at the ſide repreſents the under part of the deck.

The foremoſt port is then to be deſcribed, obſerving to place it as far aft as to give ſufficient room for the manger: the moſt convenient place will therefore be to put it between the frames R and T, and equally diſtant from each. It will then be placed in the moſt conſpicuous point of ſtrength, as it will have a long top-timber on the aft ſide and a long fourth futtock on the fore ſide of it. The ſecond port may be placed in like manner between the next two frames, which will be equally well ſituated for ſtrength as the former; and by proceeding in this manner, the ports on the gun deck may alſo be placed, taking care to have two frames between every two ports, all fore and aft.

The upper deck ports are then to be deſcribed; and in order to diſpoſe of them in the ſtrongeſt ſituation poſſible, they muſt be placed over the middle between the gun-deck ports, ſo that every frame in the ſhip will run up to the top of the ſide, by their coming between a gun and upper deck port; and every port will be between the frames, which will in a great meaſure contribute towards the ſtrength of the ſhip. With regard to the ports on the quarter deck, it is not of ſuch material conſequence if they cut the head of the frame, as in placing them the ſituation of the dead eyes muſt be conſidered, placing a port where there is a vacancy between the dead eyes large enough to admit of one; obſerving always to place them as nearly as poſſible at equal diſtances from each other; and where it happens that they do not fall in the wake of a frame, then that frame muſt by all means be carried up to the top of the ſide.

The neceſſary length of the round-houſe being determined in the dimenſions, it may be ſet off; obſerving, however, to let it be no longer than is juſt ſufficient for the neceſſary accommodations, as the ſhorter the round-houſe the works abaft may be kept lower, and a low ſnug ſtern is always accounted the handſomeſt. Then ſet off the round of the deck at the foremoſt end, below the line drawn; the deck at the ſide may be deſcribed by another curve drawn quite aft. Now, from the point for the round of the deck to the ſtern-timber, draw a curve parallel to the top-timber line, and that will be the extreme height of the top of the ſide abaft, which height continues to range fair along to the foremoſt end of the round-houſe, and at that place may have a fall about 14 inches, which may be turned off with a drift ſcroll. At the fore part of the quarter-deck, the topſide may have a riſe of 14 inches, which may alſo be turned off with a ſcroll. But as the raiſing of the topſide only 14 inches at that place will not be ſufficient to unite with the heights abaft, it will therefore be neceſſary to raiſe 14 inches more upon that, and break it off with a ſcroll inverted on the firſt ſcroll, and continue theſe two lines, parallel to the top-timber line, to the diſtance of about ſeven feet aft. At the foremoſt end of the round-houſe there is a break of 14 inches already mentioned; and in order to make that part uniform with the breaks at the foremoſt end of the quarter-deck, there muſt be ſet down 14 inches more below the former; and at theſe two heights continue two curves parallel to the top-timber line, from the aft part of the ſtern to the ends of the two curves already drawn at the foremoſt end of the quarter-deck. If they ſhould happen not to break in fair with them, they muſt be turned off with a round; but to make them appear more handſome, the lower line may be turned off with a ſcroll. Theſe lines being drawn will repreſent the upper edges of the rails.

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The height of the top ſide at the fore part of the ſhip muſt next be conſidered; which, in order to give proper height for the forecaſtle, muſt have a riſe there of 14 inches, the break being at the after end of the forecaſtle, and turned off as before. But as this part of the ſhip is ſtill conſiderably lower than the after part, it will be neceſſary to give another of eight inches upon the former, and turn it off with a ſcroll inverted. Hence this part of the ſhip will appear more uniform to the after part.

The finiſhing parts, namely the wales, ſtern, head, rails, &c. remain to be deſcribed. The wales may be firſt drawn; and as the ſtrength of the ſhip depends very much on the right placing of them, great care muſt therefore be taken that they may be as little as poſſible wounded by the lower-deck ports, and ſo placed that the lower-deck bolts ſhall bolt in them, and alſo that they come as near as poſſible on the broadeſt part of the ſhip. In the firſt place, therefore, the height of breadth lines muſt be choſen for our guide. Theſe heights of breadth are to be taken from the dimenſions, and ſet off on the reſpective frames, and curves drawn through theſe points will be the upper and lower heights of breadth lines. The height of the wales may be now determined; which in general is in ſuch a manner that the upper height of breadth line comes about ſix inches below their upper edge, and the wales are then placed right upon the breadth lines. Take the heights and breadths of the wales afore, at midſhips, and abaft, from the table of dimenſions; draw curves through the points thus found, and the wales will be repreſented.

The channel wales are then to be deſcribed. They are principally intended to ſtrengthen the top ſide, and muſt be placed between the lower and upper deck ports; and the lower end of them at midſhips ſhould be placed as low as poſſible, in order to prevent them from being cut by the upper deck ports afore and abaft. Take their heights and breadths from the dimenſions; lay them off, and deſcribe curves through the correſponding points, and the channel wales will be repreſented.

Lay off the dimenſions of the waſte rail found in the table; and through the points draw a line parallel to the top-timber line all fore and aft. This rail terminates the lower part of the paint work on the top ſide, as all the work above this rail is generally painted, and the work of the top ſide below it payed with a varniſh, except the main wales, which are always payed with pitch.

Take the draught of water from the dimenſions, and draw the load water-line, which is always done in green. Divide the diſtance between the load water-line and the upper edge of the keel into five equal parts, and through theſe points draw four more water-lines.

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Set off the centres of the maſts on the gun-deck; their rake may likewiſe be taken from the dimenſions. Set off alſo the centre of the bowſprit, letting it be four feet from the deck at the after part of the ſtem, which will give ſufficient height for a light and airy figure.

Draw the knight-heads ſo as to be ſufficiently high above the bowſprit to admit of a chock between them for the better ſecurity of the bowſprit. The timber heads may alſo be drawn above the forecaſtle, obſerving to place the moſt convenient for the timbers of the frame, being thoſe which come over the upper deck ports, as they may be allowed long enough to form handſome heads. There ſhould be one placed abaft the cat-head, to which the foremoſt block is to be bolted, and there may be two ports on the forecaſtle formed by them, and placed where it is moſt convenient to the dead eyes.

Deſcribe the channels, taking their lengths and thickneſſes from the dimenſions, and place their upper edges well with the lower edge of the ſheer rail. The dead eyes may then be drawn, obſerving to place them in ſuch a manner that the chains may not interfere with the ports; and the preventer plates muſt all be placed on the channel wales, letting them be of ſuch a length that the preventer bolt at each end may bolt on each edge of the channel wales. It muſt alſo be obſerved to give each of the chains and preventer plates a proper rake, that is, to let them lie in the direction of the ſhrouds, which may be done in the following manner: Produce the maſt upwards, upon which ſet off the length of the maſt to the lower part of the head; theſe ſtraight lines drawn from that point through the centre of each dead eye will give the direction of the chains and preventer braces.

The fenders may be then drawn, obſerving to place them right abreaſt of the main hatchway, in order to prevent the ſhip's ſide from being hurt by whatever may be hoiſted on board. The proper place for them will therefore be at timber 3; and the diſtance between them may be regulated by the diſtance between the ports. The cheſt tree may alſo be drawn, which muſt be placed at a proper diſtance abaft the foremaſt, for the conveniency of hauling home the fore tack. It may therefore be drawn at the aft ſide of timber C from the top of the ſide down to the upper edge of the channel wales; and the fenders may reach from the top of the ſide down to the upper edge of the main wales. As the fenders and cheſt-tree are on the outſide of the planks, wales, &c. the lines repreſenting the wales, &c. ſhould not be drawn through them.

Draw the ſteps on the ſide, which muſt be at the fore part of the main drift or break, making them as long as the diſtance between the upper and lower deck ports will admit of. They may be about ſix inches aſunder, and five inches deep, and continued from the top of the ſide down to the middle of the main wales.

In order to deſcribe the head, the height of the beak-head muſt be firſt determined, which may be about two feet above the upper deck. At that place draw a horizontal line, upon which ſet off the length of the beak-head, which may be 7½ feet abaft the fore part of the ſtem, and from thence ſquare a line up to the forecaſtle deck; which line will repreſent the aft part of the beak-head, and will likewiſe terminate the foremoſt end of the forecaſtle. The length of the head may now be determined, which by the proportions will be found to be 15 feet ſix inches from the fore part of the ſtem. Set it off from the fore part of the ſtem, and erect a perpendicular, which will be the utmoſt limits of the figure forward: then take the breadth of the figure from the proportions, which is four feet four inches, and ſet it off forward; and another perpendicular being drawn will ſhow the utmoſt extent of the hair bracket forward, or aft part of the figure. Then draw the lower cheek, letting the upper edge be well with the upper edge of the main wales, and the after end ranging well with the beak-head line; ſet off the depth of it on the ſtem; which is about 11 inches, and let a curved line paſs from the after end through the point on the ſtem, and to break in fair with the perpendicular firſt drawn for the length of the head, the fore part of the curve will then repreſent the poſition of the figure.

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The upper cheek may next be drawn; but, in order to know the exact place of it on the ſtem, the place of the main rail muſt firſt be ſet off on the ſtem, the upper edge of which may be kept on a level with the beak-head; then ſetting off the depth of it below that, the place for the upper cheek may be determined, letting it be exactly in the middle between that and the lower cheek: then, by drawing curves for the upper and lower edges of the cheek from the after end parallel to the lower cheek, to break in fair with the perpendicular drawn for the back of the figure: then the upper cheek will be formed. The upper part may run in a ſerpentine as high as where the ſhoulder of the figure is ſuppoſed to come, at which place it may be turned off with a ſcroll. The diſtance from the ſcroll to the heel of the figure is called the hair-bracket.

The head of the block may be formed by continuing the line at the breaſt round to the top of the hair-bracket, obſerving to keep the top of it about ſix inches clear of the under ſide of the bowſprit.

Having the diſtance ſet off on the ſtem for placing the main rail, it may next be deſcribed, keeping the bag of it as level as poſſible for the conveniency of the gratings, and letting the foremoſt end riſe gradually according to the riſe of the upper cheek and hair bracket, and may turn off on the round of the ſcroll before drawn for the hair-bracket. To form the after end, ſet off the ſize of the head of the rail abaft the beak-head line, and erect a perpendicular; then deſcribe the arch of a circle from that perpendicular, to break in fair with the lower ſide of the rail in the middle, and alſo another from the beak-head perpendicular, to break in fair with the upper ſide of the rail at the middle, obſerving to continue the head of it ſufficiently high to range with the timber heads above the forecaſtle.

The head timbers are next to be drawn, placing the ſtem timber its own thickneſs abaft the ſtem, and the foremoſt muſt be ſo placed that the fore ſide may be up and down with the heel of the block or figure, which has not yet been ſet off. Take therefore the diſtance from the breaſt to the heel on a ſquare which is ſeven feet, and erect a perpendicular from the lower part of the lower cheek to the lower part of the upper cheek; which perpendicular will terminate the foremoſt end of the lower cheek and the heel of the figure, and will alſo terminate the lower end of the hair-bracket: then, by continuing the ſame perpendicular from the upper part of the

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the lower deck to the under part of the main rail, the fore ſide of the foremoſt head timber will be deſcribed; and by ſetting off its thickneſs aft, the other ſide may be drawn. The middle head timber may be ſpread between the two former ones; and there may alſo be one timber placed abaft the ſtem, at a diſtance from the ſtem, equal to that between the others, and the lower end of it may ſtep on the upper edge of the lower rail.

To deſcribe the middle and lower rails, divide the diſtance between the lower part of the main rail and the upper part of the upper cheek equally at every head timber; and curves being deſcribed through theſe points will form the middle and lower rails. The after end of the lower rail muſt terminate at the after edge of the after head timber.

The cat-head ought to be repreſented in ſuch a manner as to come againſt the aft ſide of the head of the main rail, to rake forward four inches in a foot, and to ſteeve up 5½ inches in a foot, and about one foot ſix inches ſquare. The lower part of it comes on the plank of the deck at the ſide, and the ſupporter under it muſt form a fair curve to break in with the after end of the middle rail.

The hawſe holes muſt come between the cheeks, which is the moſt convenient place for them; but their place fore and aft cannot be exactly determined until they are laid down in the half-breadth plan.

The knee of the head is to project from the breaſt of the figure about two inches; and particular care muſt be taken that in forming it downwards it be not too full, as it is then liable to rub the cable very much: it may therefore have no more ſubſtance under the lower cheek at the heel of the figure than is juſt ſufficient to admit of the bobſtay holes, and may be 3½ feet diſtant from the ſtem at the load-water line, making it run in agreeable ſerpentine line from the breaſt down to the third water line, where it may be 1½ feet from the ſtem. By continuing the ſame line downwards, keeping it more diſtant from the ſtem as it comes down, the *gripe* will be formed. The lower part of it muſt break in fair with the under part of the falſe keel; and the breadth of the gripe at the broadeſt place will be found by the proportions to be 4½ feet. As the aft part of the gripe is terminated by the fore foot, or foremoſt end of the keel, it will now be proper to finiſh that part as follows: From the line repreſenting the upper edge of the keel ſet down the depth of the keel, through which draw a line parallel to the former, and it will be the lower edge of the keel. From that point, where the aft ſide of the ſtem is diſtant from the upper edge of the keel by a quantity equal to the breadth of the keel at midſhips, erect a perpendicular, which will limit the foremoſt end of the keel; and the after or lower end of the ſtem may be repreſented by ſetting off the length of the ſcarf from the foremoſt end of the keel, which may be ſix feet. Set down from the line repreſenting the lower edge of the keel the thickneſs of the falſe keel, which is ſeven inches; and a line drawn through that point parallel to the lower edge of the keel will be the under edge of the falſe keel, the foremoſt end of which may be three inches afore the foremoſt end of the main keel.

The head being now finiſhed, proceed next to the ſtern, the ſide and middle timbers of which are already drawn. From the ſide timber ſet off forward 14 feet, the length of gallery, and draw a pencil line parallel to the ſide timber; draw alſo a line to interſect the touch of the upper counter at the ſide, producing it forwards parallel to the ſheer as far as the pencil line firſt drawn; and this line will repreſent the upper edge of the gallery rim. From which ſet down eight inches, the breadth of the gallery rail, and draw the lower edge of the rail. At the diſtance of eight inches from the fore ſide of the ſide timber draw a line parallel thereto; and from the point of interſection of this line with the upper edge of the gallery rim, draw a curve to the middle timber parallel to the touches of the upper counter, which line will repreſent the upper edge of the upper counter rail as it appears on the ſheer draught. The lower edge of this rail may be formed by ſetting off its depth from the upper edge. In the ſame manner the lower counter rail may be deſcribed: then take the diſtance between that and the upper counter rail, and ſet it off below the rim rail; and hence the rail that comes to the lower ſtool may be drawn, keeping it parallel to the rim rail. Underneath that, the lower finiſhing may be formed, making it as light and agreeable as poſſible.

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Set off from the middle timber on the end of the quarter-deck the projection of the balcony, which may be about two feet, and draw a line with a pencil parallel to the middle timber. On this line ſet off a point 1½ inches below the under ſide of the quarter-deck, rom which draw a curve to the ſide timber parallel to the upper counter rail, which curve will repreſent the lower ſide of the foot ſpace rail of the balcony as it appears in the ſheer draught.

Take the diſtance between the point of interſection of the upper edge of the upper counter with the middle line, and the point of interſection of the under ſide of the foot ſpace rail with the middle line, which ſet up on a perpendicular from the upper edge of the rim rail at the foremoſt end. Through this point draw a line parallel to the rim rail to interſect the lower part of the foot ſpace rail, and this line will repreſent the lower edge of the rail that comes to the middle ſtool, and will anſwer to the foot ſpace rail. Then between this line and the rim rail three lights or ſaſhes may be drawn, having a muntin or pillar between each light of about 14 inches broad, and the lower gallery will be finiſhed. Set off the depth of the middle ſtool rail above the line already drawn for the lower edge, and the upper edge may be drawn. Then ſet off the ſame depth above the curve drawn for the lower edge of the foot ſpace rail, and the upper edge of that rail may then be drawn.

The quarter-piece muſt be next deſcribed, the heel of which muſt ſtep on the after end of the middle ſtool. Draw a line with a pencil parallel to the middle timber, and at a diſtance therefrom, equal to the projection of the balcony. Upon this line ſet up from the roundhouſe deck the height of the upper part of the ſtern or taff rail, which may be four feet above the deck. At that height draw with a pencil a horizontal line, and from its interſection with the line firſt drawn deſcribe a curve to the middle ſtool rail, obſerving to make the lower part of this curve run nearly parallel to the ſide timber, and the lower part about three inches abaft the ſide timber; and this curve will repreſent the aft ſide of the quarter-piece at the outſide. There ſet off the thickneſs

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neſs of the quarter-piece, which is one foot ſix inches, afore the curve already drawn ; and another curve being deſcribed parallel to it from the lower part to the top of the ſheer, and the quarter-piece at the outſide will be repreſented. On the horizontal line drawn for the upper part of the taff-rail ſet off forward the thickneſs of the taff-rail, which is one foot ; then draw a curve down to the head of the quarter-piece parallel to the firſt, and that part of the taff-rail will be deſcribed. Inſtead of a fair curve, it is cuſtomary to form the upper part of the taff-rail with one or two breaks, and their curves inverted. Either way may, however, be uſed according to fancy.

Set off the depth of the taff-rail, which may be about 3½ feet, on the line drawn for the projection ; from the upper part, and from this point, deſcribe a curve as low as the heel of the quarter-piece, and about five inches abaft it at that place ; obſerving to make it run nearly parallel to the after edge of the quarter-piece ; and the after part of the quarter-piece, which comes neareſt to the ſide, will be repreſented.

Set up on the line drawn for the projection of the balcony the height of the upper part of the balcony or breaſt rail, which is 3½ feet from the deck ; ſet off the thickneſs of the rail below that, and deſcribe the balcony, keeping it parallel to the foot ſpace rail, and terminating it at the line drawn for the after part of the quarter-piece neareſt the ſide ; and the whole balcony will then be repreſented.

The upper gallery is then to be deſcribed. In order to this, its length muſt be determined, which may be 11 feet. Set off this diſtance from the ſide timber forward with the ſheer ; and at this point draw a line parallel to the ſide timber, which line will repreſent the fore part of the gallery. Then take the diſtance between the upper part of the foot ſpace rail and the upper part of the breaſt rail on a perpendicular, and ſet it off on a perpendicular from the upper part of the middle ſtool rail on the line drawn for the fore part of the gallery, from which to the fore part of the quarter-piece draw a ſtraight line parallel to the rail below, which line will be the upper edge of the upper rim rail ; and its thickneſs being ſet off, the lower edge may alſo be drawn. From the upper edge of that rail ſet up an extent equal to the diſtance between the lower rim rail and middle ſtool rail, and deſcribe the upper ſtool rail, the after end of which will be determined by the quarter-piece, and the fore end by the line for the length of the gallery. There may be three ſaſhes drawn between theſe two rails as before ; and hence the upper gallery will be formed.

The upper finiſhing ſhould be next drawn, the length of which may be 1½ foot leſs than the upper gallery. Draw a line parallel to the rake of the ſtern for the fore end of it, and let the upper part of the top ſide be the upper part of the upper rail, from which ſet down three inches for the thickneſs of the rail, and deſcribe it. Deſcribe alſo another rail of the ſame length and thickneſs as the former ; and eight inches below ; from the end of which a ſerpentine line may be drawn down to the upper ſtool rail, and the upper finiſhing will be completed.

The ſtern being now finiſhed, the rudder only remains to be drawn. The breadth of the rudder at the lower part is to be determined from the proportions, and ſet off from the line repreſenting the aft part of the ſtern-poſt ; which line alſo repreſents the fore part of the rudder. Then determine on the lower hance, letting it be no higher than is juſt ſufficient, which may be about one foot above the load water-line, and ſet off its breadth at that place taken from the proportions. Then a line drawn from thence to the breadth ſet off at the lower part will be the aft ſide of the rudder below the lower hance. There may alſo be another hance about the height of the lower deck. The uſe of theſe breaks or hances is to reduce the breadth as it riſes toward the head. The aft part may be drawn above the lower hance, the break at the lower hance being about ten inches, and the break at the upper hance ſix inches.—The back may be then drawn. It is of elm, about four inches thick on the aft part. That thickneſs being ſet off, and a line drawn from the lower hance to the lower end, will repreſent the back. The head of the rudder ſhould be as high as to receive a tiller above the upper deck. Therefore ſet off the ſize of the head above the upper deck, and draw a line from thence to the break of the upper hance, and the aft part of the rudder will be repreſented all the way up. The bearding ſhould be drawn, by ſetting off the breadth of it at the keel from the fore ſide of the rudder, which may be nine inches. Set off alſo the breadth at the head of the wing-tranſom, which may be a foot. Then a line being drawn through theſe two points, from the lower part of the rudder to about a foot above the wing-tranſom, and the bearding will be repreſented. As the bearding is a very nice point, and the working of the rudder depending very much upon it, it ſhould always be very particularly conſidered. It has been cuſtomary to beard the rudder to a ſharp edge at the middle line, by which the main piece is reduced more than neceſſary. The rudder ſhould, however, be bearded from the ſide of the pintles, and the fore ſide made to the form of the pintles.

The pintles and braces may next be drawn. In order to which determine the place of the upper one, which muſt be ſo diſpoſed that the ſtraps ſhall come round the head of the ſtandard, which is againſt the head of the ſtern-poſt on the gun-deck, and meet at the middle line. By this means there is double ſecurity both to the brace and ſtandard. To obtain thoſe advantages, it muſt therefore be placed about four inches above the wing-tranſom : the ſecond muſt be placed juſt below the gun-deck ſo as to bolt in the middle of the deck-tranſom, and the reſt may be ſpaced equally between the lower one, which may be about ſix inches above the upper edge of the keel. The number of them is generally ſeven pair upon this claſs of ſhips ; but the number may be regulated by the diſtance between the ſecond and upper one, making the diſtance between the reſt nearly the ſame. The length of all the braces will be found by ſetting off the length of the lower one, which may be eight feet afore the back of the ſtern-poſt, and alſo the length of the third, which is four feet and a half afore the back of the ſtern-poſt ; and a line drawn from the one extremity to the other will limit the intermediate ones, as will appear on the ſheer draught. The braces will ſeem to diminiſh in length very much as they go up ; but when meaſured or viewed on the ſhape of the body, they will be nearly of an equal length. The length of the ſtraps of the pintles which

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come upon the rudder may all be within four inches of the aft ſide of the rudder; and the rudder being a flat ſurface, they will all appear of the proper lengths.

II. *Of the half-breadth and body plans.*—The half-breadth plan muſt be firſt drawn. Then produce the lower edge of the keel both ways, and let it alſo repreſent the middle line of the half-breadth plan. Produce all the frames downwards, and alſo the fore and after perpendiculars. Then from the place in the ſheer-plan, where the height of breadth-lines interſect the ſtem, ſquare down to the middle line the fore and aft part of the rabbet and the fore part of the ſtem. Take from the dimenſions what the ſtem is ſided at that place, and ſet off half of it from the middle line in the half-breadth plan, through which draw a line parallel to the middle line through the three lines ſquared down, and the half breadth of the ſtem will be repreſented in the half-breadth plan. Take the thickneſs of the plank of the bottom which is 4½ inches, and deſcribe the rabbet of the ſtem in the half-breadth plan.

From the points of interſection of the height of breadth lines with the counter timber at the ſide, and with the counter timber at the middle line, draw lines perpendicular to the middle line of the half-breadth plan, from which ſet off the half breadth of the counter on the line firſt drawn; and from this point to the interſection of the line laſt drawn, with the middle line draw a curve, and the half breadth of the counter will be repreſented at the height of breadth, which will be the broadeſt part of the ſtern.

Take the main half breadth of timber dead flat from the dimenſions, and lay it off from the middle line on dead flat in the half-breadth plan. Take alſo from the dimenſions the main half-breadth of every timber, and ſet off each from the middle line on the correſponding timbers in the half-breadth plan. Then a curve drawn from the end of the line repreſenting the half-breadth of the counter through all the points, ſet off on the timbers, and terminating at the aft part of the ſtern, will be the main half-breadth line. Take from the dimenſions the top timber half-breadth, and deſcribe the top-timber half-breadth line in the half-breadth plan, in the ſame manner as the main half-breadth line.

Take from the dimenſions the half-breadth of the riſing, and ſet it off from the middle line on the correſponding timbers, in the half-breadth plan, obſerving, where the word *outſide* is expreſſed in the tables, the half-breadth for that timber muſt be ſet off above or on the outſide of the middle line. Then a curve drawn through theſe points will be the half-breadth of riſing in the half-breadth plan.

Plate ccccxcii. fig. 35.

It will now be neceſſary to proceed to the body plan. Draw a horizontal line (fig. 35.), which is called the *baſe line*, from the right hand extremity of which erect a perpendicular. Then ſet off on the baſe line the main half-breadth at dead flat, and erect another perpendicular, and from that ſet off the main half-breadth again, and erect a third perpendicular. The firſt perpendicular, as already obſerved, is called the ſide line of the fore body; the ſecond the middle line; and the third the ſide line of the after body.

Take from the dimenſions the heights of the diagonals up the middle line, and ſet them from the baſe up the middle line in the body plan. Take alſo their diſtances from the middle line on the baſe, and ſet them off. Set off alſo their heights up the ſide lines, and draw the diagonals. Then take from the ſheer plan the heights of the lower height of breadth-line, and ſet them off upon the middle line in the body plan; through theſe points lines are to be drawn parallel to the baſe, and terminating at the ſide lines. In like manner proceed with the upper height of breadth line.

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The riſing is next to be ſet off on the body plan; it muſt, however, be firſt deſcribed in the ſheer plan: Take, therefore, the heights from the dimenſions, and ſet them off on the correſponding timbers in the ſheer plan, and a curve deſcribed through theſe points will be the riſing line in the ſheer plan. Then take from the dimenſions the riſing heights of dead flat. Set it off in the body plan, and draw a horizontal line. Now take all the riſing heights from the ſheer plan, and ſet them off in the body plan from the line drawn for the riſing height of dead flat, and draw horizontal lines through theſe points. Take from the half-breadth plan the half breadths of the riſing, and ſet them off from the middle line in the body plan, and the centres of the floor ſweeps of the correſponding timbers will be obtained.

From the half-breadth plan take the main half-breadth lines, and ſet them off from the middle line in the body plan on the correſponding lines before drawn for the lower height of breadth; and from the extremities of theſe lines ſet off towards the middle line the lengths of the lower breadth ſweeps reſpectively.

Take from the dimenſions the diſtance of each frame from the middle line on the diagonals, and ſet them off from the middle line on their reſpective diagonal lines. Now theſe diſtances being ſet off, and the lower breadth and floor ſweeps deſcribed, the ſhape of the frames below the breadth line may eaſily be drawn as follows: Place one point of a compaſs in the diſtance ſet off for the length of the lower breadth ſweep, and extend the other to the point which terminates the breadth, and deſcribe an arch of a circle downwards, which will interſect the points ſet off on the upper diagonal lines, letting it paſs as low as convenient. Then fix one point of the compaſſes in the centre of the floor ſweep, and extend the other to the point ſet off on the fourth diagonal, which is the floor head; and deſcribe a circle to interſect as many of the points ſet off on the diagonals as it will. Then draw a curve from the back of the lower breadth ſweep, through the points on the diagonals, to the back of the floor ſweep. Deſcribe alſo another curve from the back of the floor ſweep through the points on the lower diagonals, and terminating at the upper part of the rabbet of the keel, and that part of the frame below the breadth will be formed. In like manner deſcribe the other frames.

Through the extremities of the frames at the lower height of breadth draw lines parallel to the middle line, and terminating at the upper height of breadth line, and from thence ſet off the upper breadth ſweeps; now fix one point of the compaſs in the centres of the upper breadth ſweeps ſucceſſively, and the other point to the extremities of the frames, and deſcribe circles upwards. Then from the ſheer plan take off the heights of the top-timber lines, and ſet them off in the body plan, drawing horizontal lines; upon which ſet off the top-timber half-breadths taken from the correſponding timbers

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bers in the half-breadth plan ; and by deſcribing curves from the back of the upper breadth ſweeps through the points ſet off on the ſeventh or upper diagonal ; and interſecting the top-timber half-breadths, the timbers will then be formed from the keel to the top of the ſide. The upper end of the timbers may be determined by taking the ſeveral heights of the upper part of the top ſide above the top-timber line, and ſetting them off above the top-timber line on the correſponding timbers in the body plan. The lower parts of the timbers are ended at the rabbet of the keel as follows: With an extent of four inches and a half, the thickneſs of the bottom, and one leg of the compaſſes at the place where the line for the thickneſs of the keel interſects the baſe line ; with the other leg deſcribe an arch to interſect the keel line and the baſe. Then fix one point at the interſection of the arch and keel, and from the point of interſection of the keel and baſe deſcribe another arch to interſect the former. Then from the interſection of theſe arches draw one ſtraight line to the interſection of the keel and baſe, and another to the interſection of the lower arch and the keel, and the rabbet of the keel will be deſcribed at the main frame. All the timbers in the middle part of the ſhip which have no riſing terminate at the interſection of the upper edge of the rabbet with the baſe line ; but the lower part of the timbers, having a riſing, end in the centre of the rabbet, that is, where the two circles interſect. Thoſe timbers which are near the after end of the keel muſt be ended by ſetting off the half breadth of the keel at the port in the half breadth plan, and deſcribe the tapering of the keel. Then at the correſponding timbers take off the half breadth of the keel ; ſet it off in the body plan, and deſcribe the rabbet as before, letting every timber end where the two circles for its reſpective rabbet interſect.

To deſcribe the ſide counter or ſtern timber, take the height of the wing tranſom, the lower counter, upper counter, and top-timber line at the ſide ; from the ſheer plan tranſfer them to the body plan, and through theſe points draw horizontal lines. Divide the diſtance between the wing tranſom and lower counter into three equal parts, and through the two points of diviſion draw two horizontal lines. Draw alſo a horizontal line equidiſtant from the upper counter and the top-timber line in the ſheer plan, and tranſfer them to the body plan.

Now, from the point of interſection of the aft ſide of the ſtern timber at the ſide, with the wing tranſom at the ſide in the ſheer plan, draw a line perpendicular to the middle line in the half breadth plan. Draw alſo perpendicular lines from the points where the upper and lower tranſoms touch the ſtern-poſt ; from the points of interſection of the ſtern-timber with the two horizontal lines drawn between, and from the interſection of the ſtern-timber with the horizontal line drawn between the upper counter and top-timber line. Then curves muſt be formed in the half breadth plan for the ſhape of the body at each of theſe heights. In order to which, begin with the horizontal or level line repreſenting the height of the wing tranſom in the body plan. Lay a ſlip of paper to that line, and mark on it the middle line and the timbers 37, 35, 33, and 29 ; tranſfer the ſlip to the half-breadth plan, placing the point marked on it for the middle line exactly on the middle in the half breadth plan, and ſet off the half breadths on the correſponding timbers 37, 35, 33, and 29, and deſcribe a curve through theſe points, and to interſect the perpendicular drawn from the ſheer plan. In like manner proceed with the horizontal lines at the heights of the counters, between the lower counter and wing tranſom, above the upper counter and top-timber line ; and from the interſections of the curve drawn in the half breadth plan, with the perpendicular lines drawn from the ſheer plan, take the diſtances to the middle line, and ſet them off on the correſponding lines in the body plan ; then a curve deſcribed through the ſeveral points thus ſet off will be the repreſentative of the ſtern-timber.

The round-up of the wing tranſom, upper and lower counter, may be taken from the ſheer draught, and ſet off at the middle line above their reſpective level lines in the body plan, by which the round-up of each may be drawn. The round-aft of the wing tranſom may alſo be taken from the ſheer plan, and ſet off at the middle line, abaft the perpendicular for the wing tranſom in the half breadth plan, whence the round-aft of the wing tranſom may be deſcribed.

The after body being now finiſhed, it remains to form the fore body ; but as the operation is nearly the ſame in both, a repetition is therefore unneceſſary, except in thoſe parts which require a different proceſs.

The foremoſt timbers end on the ſtem, and conſequently the method of deſcribing the ending of them differs from that uſed for the timbers uſed in the after body. Draw a line in the body plan parallel to the middle line, at a diſtance equal to the half of what the ſtem is ſided. In the ſheer plan take the height of the point of interſection of the lower part of the rabbet of the ſtem with the timber which is required to be ended, and ſet it off on the line before drawn in the body plan. Then take the extent between the points of interſection of the timber with the lower and upper parts of the rabbet, and with one leg of the compaſſes at the extremity of the diſtance laid off in the body plan deſcribe a circle, and the timbers may then paſs over the back of this circle. Now, by applying a ſmall ſquare to the timber, and letting the back of it interſect the point ſet off for the lower part of the rabbet, the lower part of the rabbet and the ending of the timbers will be deſcribed.

The foremoſt timbers differ alſo very much at the head from thoſe in the after body : For ſince the ſhip carries her breadth ſo far forward at the top-timber line, it therefore occaſions the two foremoſt frames to fall out at the head beyond the breadth, whence they are called *knuckle* timbers. They are thus deſcribed : The height of the top-timber line being ſet off in the body plan, ſet off on it the top half breadth taken from the half breadth plan, and at that place draw a perpendicular ; then from the ſheer plan take the height of the top of the ſide, and ſet it off on the perpendicular in the body plan : Take alſo the breadth of the rail at the top-timber line in the ſheer plan, and ſet it off below the top-timber line at the perpendicular line in the body plan, and the ſtraight part of the knuckle timber to be drawn will be determined. Then from the laſt-mentioned point ſet off deſcribe a curve through the points ſet off for the timber down to the upper breadth, and the whole knuckle timber will be formed. It will hence be ſeen that thoſe timbers forward will fall out beyond the main breadth with a hollow, contrary to the reſt of the top ſide, which falls within the main breadth with a hollow.

The fore and after bodies being now formed, the water lines muſt next be deſcribed in the half-breadth plan, in order to prove the fairneſs of the bodies. In this draught the water lines are all repreſented parallel to the keel; their heights may, therefore, be taken from the ſheer plan, and transferred to the body plan, drawing horizontal lines, and the water lines will be repreſented in the body plan. In ſhips that draw more water abaft than afore, the water lines will not be parallel to the keel; in this caſe, the heights muſt be taken at every timber in the ſheer plan, and ſet off on their correſponding timbers in the body plan; and curves being deſcribed through the ſeveral points, will repreſent the water lines in the body plan.

Take the diſtances from the middle line to the points where the water lines interſect the different timbers in the body plan, and ſet them off on their correſponding timbers in the half-breadth plan. From the points where the water lines in the ſheer plan interſect the aft part of the rabbet of the ſternpoſt draw perpendiculars to the middle line of the half-breadth plan, and upon theſe perpendiculars ſet off from the middle line the half thickneſs of the ſternpoſt at its correſponding water line; which may be taken from the body plan, by ſetting off the ſize of the poſt at the head and the keel, and drawing a line for the tapering of it; and where the line ſo drawn interſects the water lines, that will be the half thickneſs required: then take an extent in the compaſſes equal to the thickneſs of the plank, and fix one point where the half thickneſs of the poſt interſects the perpendicular, and with the other deſcribe a circle, from the back of which the water lines may paſs through their reſpective points ſet off, and end at the fore part of the half-breadth plan, proceeding in the ſame manner as with the after part. A line drawn from the water line to the point ſet off for the half thickneſs of the poſt will repreſent the aft part of the rabbet of the poſt; and in like manner the rabbet of the ſtem may be repreſented. The water lines being all deſcribed, it will be ſeen if the body is fair; and if the timbers require any alteration, it ſhould be complied with.

The cant-timbers of the after body may next be deſcribed in the half-breadth plan; in order to which the cant of the faſhion-piece muſt firſt be repreſented. Having therefore the round aft of the wing tranſom repreſented in the half-breadth plan, and alſo the ſhape of a level line at the height of the wing tranſom; then ſet off the breadth of the wing tranſom at the end, which is one foot four inches, and that will be the place where the head of the faſhion-piece will come: now to determine the cant of it, the ſhape of the body muſt be conſidered; as it muſt be canted in ſuch a manner as to preſerve as great a ſtraightneſs as is poſſible for the ſhape of the timber, by which means the timber will be much ſtronger than if it were crooked; the cant muſt alſo be conſidered, in order to let the timber have as little bevelling as poſſible. Let, therefore, the heel of the timber be ſet off on the middle line, two feet afore timber 35; and then drawing a line from thence to the point ſet off on the level line for the wing tranſom, the cant of the faſhion-piece will be deſcribed, and will be found ſituated in the beſt manner poſſible to anſwer the before-mentioned purpoſes.

The cant of the faſhion-piece being repreſented, the cant of the other timbers may now be eaſily determined. Let timber 29 be the foremoſt cant timber in the after body, and with a pencil draw timber 28; then obſerve how many frames there are between timber 28 and the faſhion-piece, which will be found to be nine, namely, 29, 30, 31, 32, 33, 34, 35, 36, and 37. Now divide the diſtance between timber 28 and the faſhion-piece on the middle line into 10 equal parts: Divide alſo the correſponding portion of the main half-breadth lines into the ſame number of equal parts; and ſtraight lines joining the correſponding points at the middle line with thoſe in the half-breadth line will repreſent the cant timbers in the after body.

The line drawn for the cant of the faſhion-piece repreſents the aft ſide of it, which comes to the end of the tranſoms; but in order to help the converſion with regard to the lower tranſoms, there may be two more faſhion-pieces abaft the former; therefore the foremoſt faſhion piece, or that which is already deſcribed in the half-breadth plan, may only take the ends of the three upper tranſoms, which are, the wing, filling, and deck: the middle faſhion-piece may take the four next, and the after faſhion-piece the lower ones: therefore ſet off in the half-breadth plan the ſiding of the middle and after faſhion-piece, which may be 13 inches each; then by drawing lines parallel to the foremoſt faſhion-piece, at the aforeſaid diſtance from each other, the middle and after faſhion-piece will be repreſented in the half-breadth plan.

The faſhion-piece and tranſoms yet remain to be repreſented in the ſheer plan; in order to which, let the number of tranſoms be determined, which, for ſo large a buttock, may be ſeven below the deck tranſom: draw them with a pencil, beginning with the wing, the upper ſide of which is repreſented by a level line at its height; ſet off its ſiding below that, and draw a level line for the lower edge. The filling tranſom follows; which is merely for the purpoſe of filling the vacancy between the under edge of the wing and the upper part of the deck plank: it may therefore be repreſented by drawing two level lines for the upper and lower edge, leaving about two inches between the upper edge and lower edge of the wing tranſom, and four inches between the lower edge of the gun-deck plank; then the deck tranſom muſt be governed by the gun-deck, letting the under ſide of the gun-deck plank repreſent the upper ſide of it, and ſetting off its ſiding below that; the under edge may alſo be drawn: the tranſoms below the deck may all be ſided equally, which may be 11 inches; they muſt alſo have a ſufficient diſtance between to admit the circulation of the air to preſerve them, which may be about three inches.

The tranſoms being now drawn with a pencil, the faſhion-piece muſt next be deſcribed in the ſheer plan, by which the length of the tranſoms as they appear in that plan will be determined. As the foremoſt faſhion-piece reaches above the upper tranſom, it may therefore be firſt deſcribed: in order to which, draw a ſufficient number of level lines in the ſheer plan; or, as the water lines are level, draw therefore one line between the upper water line and the wing tranſom, and one above the

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the wing tranſom at the intended height of the head of the faſhion-piece, which may be about five feet: then take the height of theſe two level lines, and transfer them to the body plan; and take off two or three timbers and run them in the half-breadth plan, in the ſame manner as the water lines were done; then from the point where the line drawn for the cant of the faſhion-piece, in the half-breadth plan, interſects the level line drawn for the head of the faſhion-piece, draw up a perpendicular to the ſaid line in the ſheer-plan, making a point. Again, from the interſection of the cant line, with the level line for the wing tranſom in the half-breadth plan, draw a perpendicular to the wing tranſom in the ſheer plan. Alſo draw perpendiculars from the points where the cant line in the half-breadth plan interſects the level line below the wing tranſom, and alſo the water lines to the correſponding lines in the ſheer plan; then a curve deſcribed through theſe points will be the repreſentation of the foremoſt faſhion-piece in the ſheer-plan. In the ſame manner the middle and after faſhion-pieces may be deſcribed; obſerving to let the middle one run up no higher than the under part of the deck tranſom, and the after to the under ſide of the fourth tranſom under the deck. The tranſoms may now be drawn with ink, as their lengths are limited by the faſhion-pieces.

Neither the head nor the foreſide of the ſternpoſt are yet deſcribed; take, therefore, from the dimenſions, the breadth of the poſt on the keel, and ſet it off on the upper edge of the keel from the aft ſide of poſt. The head of the poſt muſt next be determined, which muſt juſt be high enough to admit of the helm-poſt tranſom and the tiller coming between it and the upper deck beam; the height therefore that is neceſſary will be one foot nine inches above the wing tranſom. Now draw a level line at that height, upon which ſet off the breadth of the ſternpoſt at that place, taken from the dimenſions, and a line drawn from thence to the point ſet off on the keel will be the foreſide of the ſternpoſt; obſerving, however, not to draw the line through the tranſoms, as it will only appear between them. The inner poſt may be drawn, by ſetting off its thickneſs forward from the ſternpoſt, and drawing a ſtraight line as before, continuing it no higher than the under ſide of the wing tranſom.

The cant timbers in the after body being deſcribed, together with the parts dependent on them, thoſe in the fore body may be next formed; in order to which, the foremoſt and aftermoſt cant timbers muſt be firſt determined, and alſo the cant of the foremoſt ones. The foremoſt cant timber will extend ſo far forward as to be named *&'*; the cant on the middle line may be one foot four inches afore ſquare timber W, and on the main half breadth line one foot nine inches afore timber Y; in which ſituation the line may be drawn for the cant; the aftermoſt may be timber Q. The cant timbers may now be deſcribed in the ſame manner as thoſe in the after body, namely, by ſpacing them equally between the cant timber *&'* and the ſquare timber P, both on the main half-breadth, and middle lines, and drawing ſtraight lines between the correſponding points, obſerving to let them run out to the top-timber half-breadth line, where it comes without the main half-breadth line.

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The hawſe pieces muſt next be laid down in the half-breadth plan; the ſides of which muſt look fore and aft with the ſhip upon account of the round of the bow. Take the ſiding of the apron, which may be about four inches more than the ſtem, and ſet off half of it from the middle line, drawing a line from the main half breadth to the foremoſt cant timber, which will repreſent the foremoſt edge of the knight-head; then from that ſet off the ſiding of the knight-head, which may be one foot four inches, and draw the aft ſide of it. The hawſe pieces may then be drawn, which are four in number, by ſetting off their ſidings, namely, one foot ſix inches parallel from the knight-head and from each other; and ſtraight lines being drawn from the main half-breadth line to the foremoſt cant timber will repreſent them.

The hawſe holes ſhould be deſcribed in ſuch a manner as to wound the hawſe pieces as little as poſſible; they may therefore be placed ſo that the joint of the hawſe pieces ſhall be in the centre of the holes, whence they will only cut half the hawſe pieces. Take the dimenſions of the hawſe holes, which is one foot ſix inches, and ſet off the foremoſt one, or that next the middle line, on the joint between the firſt and ſecond hawſe piece; then ſet off the other on the joint between the third and fourth hawſe piece; and ſmall lines being drawn acroſs the main half-breadth at their reſpective places will repreſent the hawſe holes in the half-breadth plan.

The hawſe holes ſhould next be repreſented in the ſheer plan. In this claſs of ſhips they are always placed in the middle between the cheeks; therefore ſet off their diameter, namely, one foot ſix inches, between the cheeks, and draw lines parallel to the cheeks for their upper and lower part. Then to determine their ſituation agreeable to the half-breadth plan, which is the fore and aft way, draw perpendiculars from their interſections with the main half-breadth line to the lines drawn between the cheeks, and their true ſituations, the fore and aft way, will be obtained; and, by deſcribing them round or circular, according to the points ſet off, they will be repreſented as they appear in the ſheer plan.

The apron may be drawn in the ſheer plan, ſetting off its bigneſs from the ſtem, and letting it come ſo low that the ſcarf may be about two feet higher than the foremoſt end of the fore foot; by which it will give ſhip to the ſcarfs of the ſtem. It may run up to the head of the ſtem.

The cutting down ſhould next be drawn. Take therefore from the tables of dimenſions the different heights there expreſſed, and ſet them off from the upper edge of the keel on the correſponding timbers in the ſheer plan: then a curve deſcribed through the points ſet off, from the inner poſt aft to the apron forward, will be the cutting down. Next ſet off from the cutting down the thickneſs of the timber ſtrake, which is eight inches and a half, and a curve deſcribed parallel to the former will repreſent the timber ſtrake, from which the depth of the hold is always meaſured.

The kelſon is drawn, by taking its depth from the dimenſions, and ſet it off above the cutting down line; and a curve deſcribed parallel to the cutting down will repreſent the kelſon.

The cutting down line being deſcribed, the knee of the dead wood abaft timber 27, being the after floor timber, may then be repreſented. Set off the ſiding of the floor abaft it, and erect a perpendicular in the ſheer plan, which will terminate the foremoſt end of

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the dead wood: then the fore and aſt arm of the knee may be half the length of the whole dead wood, and the up and down arm may reach to the under part of the lower tranſom; and the whole knee may be placed in ſuch a manner that the upper piece of the dead wood ſhall bolt over it, and be of as much ſubſtance as the knee itſelf: therefore the knee muſt conſequently be placed its whole thickneſs below the cutting down line repreſenting the upper part of the dead wood.

The ſheer draught, the body, and half-breadth plan are now finiſhed, from whence the ſhip may be laid down in the mould loft, and alſo the whole frame erected. As, however, the uſe of the diagonal lines in the body plan has not been ſufficiently explained, it is therefore thought proper to ſubjoin the following illuſtration of them.

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Nature and uſe of diagonal lines.

The diagonal lines in the body plan are mentioned in the tables of dimenſions merely for the purpoſe of forming the body therefrom; but after the body is formed, they are of very principal uſe, as at their ſtations the ribbands and harpins which keep the body of the ſhip together while in her frames are all deſcribed, and the heads of the different timbers in the frame likewiſe determined.

The lowermoſt diagonal, or N° 1. which is named the *lower ſirmark*, at which place the bevellings are taken for the hollow of the floors; its ſituation is generally in the middle between the keel and the floor ſirmark.

Second diagonal is placed in the midſhips, about 18 inches below the floor head, and is the ſtation where the floor ribband is placed in midſhips, and likewiſe the floor harpin forward; there is alſo a bevelling taken at this diagonal all the way fore and aft, from which it is termed the *floor ſirmark*.

Third diagonal, terminates the length of the floors, and is therefore called the *floor head*. There are likewiſe bevellings taken at this diagonal as far forward and aft as the floor extends. The placing of this diagonal is of the utmoſt conſequence to the ſtrength of the ſhip, it being ſo near to that part of the bulge which takes the ground, and of conſequence is always liable to the greateſt ſtrain: it ſhould therefore be placed as much above the bearing of the body in midſhips as could be conveniently allowed by converſion of the timber; but afore and abaft it is not of ſo much conſequence.

Fourth diagonal is placed in the middle between the floor head and the fifth diagonal, at which place a ribband and harpin are ſtationed for the ſecurity of the firſt or lower futtock, from whence it is named the *firſt futtock ſirmark*. There are alſo bevellings taken at this diagonal all afore and aft, which being part of the body where the timbers moſt vary, occaſions them to be the greateſt bevellings in the whole body.

Fifth diagonal terminates the heads of the firſt futtocks, and is therefore called the *firſt futtock head*. It ſhould be placed at a convenient diſtance above the floor head, in order to give a ſufficient ſcarf to the lower part of the ſecond futtocks. There are likewiſe bevellings for the timbers taken at this diagonal, all fore and aft.

Sixth diagonal ſhould be placed in the middle between the firſt futtock head and the ſeventh diagonal; at which place the ribband and harpin are ſtationed for the ſupport of the ſecond futtocks. Bevellings are taken at this diagonal all fore and aft. It is named the *ſecond futtock ſirmark*.

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Seventh diagonal terminates the ſecond futtock heads from the fore to the aftermoſt floors, and afore and abaft them it terminates the double futtock heads in the fore and aft cant bodies. It ſhould be placed in midſhips, as much above the firſt futtock head as the firſt futtock is above the floor head: by which it gives the ſame ſcarf to the lower part of the third futtock as the firſt futtock does to the ſecond. There are bevellings taken all fore and aft at this diagonal. It is named the *ſecond futtock head*.

Eighth diagonal is the ſtation for the ribband and harpin which ſupports the third futtocks, and is therefore placed between the ſecond futtock head and ninth diagonal. It is alſo a bevelling place, and is named the *third futtock ſirmark*.

Ninth and laſt diagonal is placed the ſame diſtance above the ſecond futtock head as that is above the firſt, and terminates all the heads of the third futtocks which are in the frames, as they come between the ports; but ſuch as are between the frames, and come under the lower deck ports, muſt run up to the under part of the ports, as no ſhort timbers ſhould by any means be admitted under the ports, which require the greateſt poſſible ſtrength. This diagonal is likewiſe a bevelling place for the heads of the third futtocks, and is therecalled the *third futtock head*.

The fourth futtock heads are terminated by the under part of the upper deck ports all fore and aft, and a ribband is placed fore and aft at the height of the upper breadth line, another between the lower and upper deck ports, and one at the top-timber line; which, with the ribbands and harpins before mentioned, keep the whole body of the ſhip together, and likewiſe in its proper form and ſhape.

It muſt be obſerved, that the diagonal lines laid down in the dimenſions will not correſpond to what has been ſaid above upon diagonals, as they were drawn diſcretionally upon the body for the purpoſe of giving the true dimenſions of it. Therefore, when the body is drawn in fair, the firſt diagonals (which ſhould only be in pencil) are to be rubbed out, and the proper diagonals drawn with red ink, ſtrictly adhering to what has been ſaid above.

SECT. III. *Of the Inboard Works of the Ship deſcribed in the preceding Section.*

DRAUGHTS of the outboard works being now conſtructed, in which every part is deſcribed that is neceſſary to enable the artiſt to put the ſhip in her frames, we muſt now proceed to form another draught of the cavity of the ſhip or inboard works, which muſt be ſo contrived that every thing within the ſhip may be arranged in the moſt commodious manner and to the beſt advantage.

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It is uſual to draw the inboard works in the ſheer-draught; but as this generally occaſions much confuſion, it is therefore the beſt and eaſieſt method to appropriate a draught to this particular purpoſe.

Take from the ſheer-draught the ſtem, ſtern-poſt, counter timbers, and keel, and deſcribe them on another paper; draw in alſo the cutting down, kelſon, apron, tranſoms, faſhion-pieces, and decks, and the upper line of the ſheer all fore and aft, alſo paſs the timbers and ports.

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The beams come firſt under conſideration, and ſhould be ſo diſpoſed as to come one under and one between each port, or as near as can be to anſwer other works of the ſhip; but where it happens that a beam cannot poſſibly be placed under the port, then a beam arm ſhould be introduced to make good the deficiency. Every beam, and alſo the beam arms, ſhould be kneed at each end with one lodging and one hanging knee; and in thoſe parts of the ſhip which require the knees to be very acute, ſuch as the after beams of the gun-deck, and in ſome ſhips, whoſe bodies are very ſharp, the foremoſt beams of the gun-deck, there ſhould be knees of iron. Care ſhould be taken always to let the upper ſide of the knees be below the ſurface of the beams, in large ſhips one inch and a half, and in ſmall ſhips an inch, by which means the air will have a free paſſage between the knees and under part of the deck.

In the converſion of the beams the ſide next the lodging knee ſhould be left as broad at the end of the beam as can poſſibly be allowed by the timber, the beam retaining its proper ſcantling at the end of the lodging knee: by ſo doing the lodging knees will be more without a ſquare, which conſequently makes them the more eaſy to be provided.

In ſhips where the beams can be got in one piece, they ſhould be ſo diſpoſed as to have every other one with the butt end the ſame way; for this reaſon, that the butts will decay before the tops. In large ſhips the beams are made in two or three pieces, and are therefore allowed to be ſtronger than thoſe that are in one piece. The beams in two pieces may have the ſcarf one-third of the length, and thoſe in three pieces ſhould have the middle piece half the length of the whole beam. The cuſtomary way of putting them together is to table them; and the length of the tablings ſhould be one-half more than the depth of the beam. It is very common to divide the tablings in the middle of the beam, and that part which is taken out at the upper ſide to be left at the lower ſide, and then kerſey or flannel is put into the ſcarf: but in this caſe the water is liable to lie in the ſcarf, and muſt be the means of rotting the beams. If, however, the beams were tabled together in dovetails, and taken through from ſide to ſide, putting tar only between them, which hardens the wood; then the water occaſioned by the leaking of the decks would have a free paſſage, and the beam would dry again; and this method would not be found inferior in point of ſtrength to the other. The length of the fore and aft arm of the lodging knee ſhould extend to the ſide of the hanging knee next to it; but there is no neceſſity for that arm to be longer than the other. In faſtening the knees, care would be taken to let one bolt paſs exactly through the middle of the throat, one foot ſix inches from each end, and the reſt divided equally between; obſerving always to have the holes bored ſquare from the knee. The bolts for the thwartſhip arms of both hanging and lodging knees may go through the arms of each knee, and drive every one the other way.

In order to draw the beams in the draught, take the moulding of the lower deck beams, and ſet it off below the line repreſenting the deck at the ſide, and draw a line in pencil parallel thereto, which will repreſent the under ſide of the beams. In like manner repreſent the under ſide of the beams for the upper deck, quarter deck, foreсaſtle, and roundhouſe. Then take the ſiding of the lower-deck beams, and place one under and one between each port, all fore and aft, drawing them in pencil. Determine the dimenſions of the well fore and aft, which is ten feet, and ſet it off abaft the beam under the eighth port, placing the beam under the ninth port at that diſtance: thoſe two beams may then be drawn in ink, and will terminate the extent of the well the fore and aft way; and as a beam cannot go acroſs the ſhip at that place upon account of its being the well and maſt room, there muſt therefore be a beam arm between theſe two beams.

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The main hatchway ſhould then be determined, letting the beam that forms the fore part of the well form the aft part of it, and the beam under the next part may form the fore ſide of it, which beam may alſo be now drawn in ink: there ſhould alſo be another beam arm introduced in the wake of the main hatchway.

The fore hatchway may be next determined; the fore ſide of which ſhould range well up and down with the after end of the forecaſtle, and it may be fore and aft about four-ſevenths of the main hatchway. At the foreſide of the fore hatchway there muſt be a ladderway down to the orlop, which may be as much fore and aft as the beams will allow. The reſt of the beams afore the fore hatchway may remain as firſt placed, there being nothing in the way to alter the ſhip. Then determine on the after hatchway, the foreſide of which comes to the aft ſide of the mainmaſt room.

There ſhould alſo be a hatchway, the foreſide of which may be formed by the aft ſide of the beam under the twelfth port; which is for the conveniency of the ſpirit and fiſh rooms: and there ſhould be a ladderway abaft it to lead down to the cockpit. There may be alſo another hatchway, the foreſide of it to be formed by the aft ſide of the beam under the eleventh port. The ſize of the ladder and hatchways muſt be governed by the beams, as when there is a good ſhift of beams they ſhould not be altered for ladder and hatchways, unleſs it is the three principal hatchways, which muſt always be of a proper ſize, according to the ſize of the ſhip.

The after capſtan muſt be placed between the two hatchways laſt deſcribed, and the beams abaft may ſtand as they are already ſhifted, obſerving only the mizenmaſt. There ſhould be a ſmall ſcuttle placed afore the ſecond beam from aft, for the convenience of the bread room: it muſt be on one ſide of the middle lines, as there is a carling at the middle under the four or five after beams to receive the pillars for the ſupport thereof.

The bits may be placed, letting the foreſide of the after ones come againſt the aft ſide of the beam abaft the third port, and the foreſide of the foremoſt ones againſt the next beam but one forward; then at the foreſide of each bit there ſhould be drawn a ſmall ſcuttle for the conveniency of handing up the powder from the magazine. The breaſt hook ſhould alſo be drawn, which may be three feet the moulding away, and ſided nine-tenths of the beams of the lower deck.

The gun-deck, beams, knees, &c. being deſcribed; in which, as well as all the decks having ports, the ſame precautions are to be uſed as in the gun-deck; and obſerving

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ſerving to keep the beams upon one deck as nearly as poſſible over the beams of the other, for the conveniency of pillaring, as they will then ſupport each other.

The hatchways are to be placed exactly over thoſe on the lower deck, each over each; and therefore, where there is a beam arm in the lower deck there muſt alſo be one above it in the upper deck, and the ſame in the middle deck in three-deck ſhips. It commonly happens in ſhips of the line that there cannot be a whole beam between the deck breaſt hook and the beam that ſupports the ſtep of the bowſprit, becauſe the bowſprit paſſes through that place: in this caſe, there muſt be a beam arm placed, letting the end come equally between the beam and the breaſt hook: but in ſhips that the bowſprit will allow of a whole beam, then the ports and the reſt of the beams muſt be conſulted in order to ſpace it; and when it ſo happens that the fore maſt comes in the wake of a port, then a beam arm muſt be neceſſarily introduced.

Having placed the beams according to the diſpoſition of the other beams below, the ladderways ſhould be contrived: there ſhould be one next abaft the fore hatchway, which is a ſingle ladderway; and one next afore the main hatch, which is a double ladderway; the ladders ſtanding the fore and aft way. There ſhould alſo be another next abaft the after hatch, and one over the cockpit correſponding with that on the lower deck.

The capſtans are next to be conſidered; the after one is already placed on the lower deck, the barrel of which muſt paſs through the upper deck to receive the whelps and drumhead there, it being a double capſtan. In ſhips having three decks, the upper part of each capſtan is in the middle deck; but in ſhips with one deck there is only this one capſtan, the upper part of which is placed on the quarter deck. The foremoſt capſtan ſhould be placed in the moſt convenient ſpot, to admit of its being lowered down to the orlop out of the way of the long boat: it may therefore be placed between the main and fore hatchways; the beam under the ſixth port of the lower deck may form the aft ſide of its room, and the beams on each ſide of it ſhould be placed exactly over or under the beams on the other decks, and they ſhould be at a diſtance from each other ſufficient to let the drumheads paſs between them. The centre of the capſtan ſhould then be placed in the middle between the beams which compoſe its room; and the partners ſhould be fitted in ſuch a manner as to ſhift occaſionally when wanted, which is by letting them be in two pieces fitted together. The partners on the lower deck, wherein the capſtan ſteps, muſt be ſupported by a pillar on the orlop deck, the lower part of which may be fitted in an oak chock; ſo that when the pillar is taken away, and the capſtan lowered down, that chock ſerves as a ſtep for the capſtan. Thoſe two beams on the orlop, by having the pillar and chock upon them, have therefore the whole weight of the capſtan preſſing downwards: for the ſupport of them, there ſhould be a carling placed underneath the fore and aft way, with three pillars, one under each beam, and one between; all of them being ſtept in the kelſon, by which the orlop deck will be well ſupported in the wake of the capſtan, and the other decks will feel no ſtrain from it.

Application of the foregoing Rules to the Conſtruction of Ships.

The fire hearth is next to be diſpoſed; which is placed differently according to the ſize of the ſhip. In three-deckers it is found moſt convenient to place it on the middle deck; whence there is much more room under the forecaſtle than there would have been had it been placed there. In all two-deck ſhips it is placed under the forecaſtle, becauſe on the deck underneath the bits are in the way. It is alſo under the forecaſtle in one-deck ſhips, though confined between the bits: in this caſe it ſhould be kept as near as poſſible to the after bits, that there may be more room between it and the foremoſt bits to make a good galley.

The poſitions of the main-topſail-ſheet bits are next to be determined; the foremoſt of which muſt be ſo placed as to let its foreſide come againſt the aft ſide of the beam abaft the main hatchway, and to paſs down to the lower deck, and there ſtep in the beams: admitting it to be a ſtraight piece, it would come at the aft ſide of the lower deck beam the ſame as it does at the upper deck beam, in conſequence of thoſe two beams ranging well up and down with each other: it muſt therefore have a caſt under the upper deck beam, by which the lower part may be brought forward ſufficient to ſtop in the lower deck beam. The aftermoſt muſt be placed againſt the foreſide of the beam abaft the maſt, and ſtep on the beam below; but there is no neceſſity to provide a crooked piece as before, for the beam of the upper deck may be moved a little farther aft, till it admit of the bit ſtopping on the lower deck beam, unleſs the beam comes under a port, as in that caſe it muſt not by any means be moved. The croſs pieces to the bits ſhould be on the foreſide, and in height from the upper deck about one third of the height between it and the quarter deck. With regard to the heads of the bits, the length of the ſhip's waſte ſhould be conſidered; and if there is length enough from the forecaſtle to the foremoſt bits to admit of the ſpare geer being ſtowed thereon without reaching farther aft, the quarter deck may then run ſo far forward that the head of the foremoſt bits ſhall tenon in the foremoſt beam; this gives the mainmaſt another deck, and admits of the quarter deck being all that the longer: but if there is not the room before mentioned, then the quarter deck muſt run no further forward than the after bits, which will then tenon in the foremoſt beam; and the foremoſt bits muſt have a croſs piece let on their heads, which is termed a *horſe*, and will be for the purpoſe of receiving the ends of the ſpare geer.

The length of the quarter deck being now determined, the beams are then to be placed. For this purpoſe the ſeveral contrivances in the quarter deck muſt be previouſly conſulted. It is neceſſary to obſerve, that there are neither carlings nor lodges, the carlings of the hatches excepted, in the quarter deck, round-houſe, and forecaſtle; as they would weaken inſtead of ſtrengthening the beams, which ſhould be as ſmall as the ſize of the ſhip will permit, in order that the upper works may be as light as poſſible. Hence, as there are to be neither carlings nor lodges, the deck will require a greater number of beams, and a good round up, as on the contrary the deck will be apt to bend with its own weight. The moſt approved rule is therefore to have double the number of beams in the quarter deck as there are in a ſpace of the ſame length in the upper deck.

Then proceed to ſhift the beams to the beſt advantage, pplication f the fore-oing Rules the Con-ruction of Ships.

tage, conſulting the hatchways, ladder-ways, maſts, bits, wheel, &c. With reſpect to the ladder-ways on the quarter decks of all ſhips, there ſhould be one near the fore part of the great cabin for the officers, and another near the foremoſt end of the quarter deck, conſiſting of double ladders for the conveyance of the men up from the other decks in caſes of emergency; and likewiſe one on each ſide of the fore part of the quarter deck from the gangway: and in every ſhip of the line all the beams from the foremoſt ladder-way to the after one ſhould be open with gratings, both for the admiſſion of air, and for the greater expedition of conveying different articles in the time of action.

Two ſcuttles are to be diſpoſed one on each ſide of the mainmaſt, if it happens to come through the quarter deck, for the top tackles to paſs through, to hook to the eye bolts drove in the upper deck for that purpoſe.

The ſteering wheel ſhould be placed under the fore-part of the roundhouſe, and the two beams of the quarter deck, which come under it, ſhould be placed conformable to the two uprights, ſo that they may tenon in them. The quarter deck beams ſhould be kneed at each end with one hanging and one lodging knee; which adds greatly to the ſtrength of the ſide. The hanging knees which come in the great cabin may be of iron; their vertical arms to be two-thirds of the length of that of wood, and to reach the ſpirketing. It ſhould be obſerved, that the beam abaft, which comes under the ſcreen bulkhead, ſhould round aft agreeable to the round of the bulkhead, for the ſupport of the ſame.

The forecaſtle beams ſhould be placed according as the works of the deck will admit. The hatchways are therefore to be conſidered firſt. There ſhould be one for the funnel of the fire hearth to paſs through, and one for the copper to admit of vent for the ſteam; and alſo one or two over the galley as the forecaſtle will admit of. The fore-topſail-ſheet bits ſhould be ſo diſpoſed as to come one pair on the fore and one on the aft ſide of the maſt, to let into the ſide of the forecaſtle beams, and ſtep on the upper deck beams below: there ſhould alſo be a ladder-way at the fore part of the forecaſtle for the conveniency of the fore part of the ſhip.

The beams may now be placed agreeable thereto, their number being four more than there are in a ſpace in the upper deck equal in length to the forecaſtle; and where there happens to be a wide opening between the beams, as in the caſe of a hatchway, maſt room, &c. then half a beam of fir may be introduced to make good the deficiency. The foremoſt beam ſhould be of a breadth ſufficient to take the aft ſide of the inboard arms of the catheads, as they are ſecured upon this beam by being bolted thereto. Every beam of the forecaſtle ſhould be kneed at each end with one hanging and one lodging knee: the vertical arms of the hanging knees ſhould reach the ſpirketing, and the knees well bolted and carefully clenched.

Proceed to the roundhouſe; the ſame things being obſerved with reſpect to the beams as in the quarter deck: for as the roundhouſe beams are ſided very ſmall, it hence follows that they muſt be near to each other. Let therefore the number of beams on the roundhouſe be four more than in the ſame length of the quarter deck; every other beam being of fir for lightneſs, and every oak beam may be kneed at each end with one hanging and one lodging knee; the hanging knees abaft may be of iron, their vertical arms to be in length two thirds of thoſe of wood. The roundhouſe ſhould always have a great round up, both for ſtrength and conveniency. There muſt be on the roundhouſe a ſmall pair of knee-bits on each ſide of the mizenmaſt, turned round and ſcarfed over each other, and bolted through the maſt carlings. There muſt alſo be a companion on the roundhouſe placed over the middle of the coach, in order to give light thereto.

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With regard to placing the roundhouſe beams, the uprights of the ſteering wheel and the mizenmaſt are to be obſerved; as when the beams which interfere with thoſe parts are properly ſpaced, the reſt may be diſpoſed of at diſcretion, or at an equal diſtance from each other, and letting the beam over the ſcreen bulkhead have a proper round aft, agreeable to the quarter deck beam underneath.

The upper parts of the inboard works being now deſcribed, proceed next to the lower parts, or to thoſe which come below the lower deck. Draw in the orlop, by taking the heights afore, at midſhips, and abaft, between that and the gun-deck, from the dimenſions, and a curve deſcribed through theſe points will repreſent the upper part of the deck. Set off the thickneſs of the plank below, and the under ſide of the plank will be repreſented. As this deck does not run quite forward and aft as the other decks, the length of it muſt be therefore determined; for this purpoſe let the after beam be placed at a ſufficient diſtance from aft to admit of the bread rooms being of a proper ſize for the ſhip, which will be under that beam of the gun-deck that comes at the ſecond part from aft. The after beam being drawn in, proceed to ſpace the other beams, placing them exactly under thoſe of the gun-deck; and that which comes under the foremoſt beam of the gun-deck may terminate the fore part of the orlop. Draw the limber ſtrake, by ſetting off its thickneſs above the cutting down line, and a line drawn parallel thereto will repreſent the limber ſtrake. That part of the orlop which is over the after magazine, ſpirit room, and fiſh room, and alſo that which is over the fore magazine, is laid with thicker planks than the reſt of the deck; which is for the better ſecurity of thoſe places, the planks being laid over the beams; but in the midſhips, from the fore part of the ſpirit room to the aft part of the fore magazine, the beams are laid level with the ſurface of the deck, and the planks are rabbeted in from one beam to the other.

In order to repreſent the orlop as juſt deſcribed, the dimenſions of the different apartments above mentioned muſt be determined: Let the aft ſide of the after beam be the aft ſide of the after magazine, and from thence draw the bulkhead down to the limber ſtrake; and the foreſide of the third beam may be the foreſide of the after magazine, drawing that bulkhead likewiſe, which will alſo form the aft ſide of the fiſh room; the foreſide of the fiſh room may be drawn from the aft ſide of the fifth beam, which will alſo repreſent the aft ſide of the ſpirit room; then the foreſide of the ſpirit room may be drawn from the foreſide of the ſixth beam. Hence from the foreſide of the ſixth beam quite aft the deck will

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will be repreſented by the two lines already drawn, and the upper ſide of the beams will be repreſented by the lower line.

Proceed next to the fore part of the orlop, letting the foreſide of the after bits be the aft part of the foremoſt magazine, drawing the bulkhead thereof, which will come to the aft ſide of the ſixth beam; therefore, from the ſixth beam to the foremoſt end of the orlop, the plank and beams will be repreſented juſt in the ſame manner as before mentioned for the after part of the orlop: then the midſhip part of the deck will be repreſented by letting the upper line be the upper ſide of the plank, and likewiſe the upper ſide of the beams; and the lower line will repreſent the lower edge of the plank, only drawing it from beam to beam, and obſerving not to let it paſs through them.

The hatchways, &c. may now be repreſented on the orlop, letting the main, fore, and after hatchway, be exactly under thoſe of the gun deck; there muſt be one over the fiſh room, and one over the ſpirit room. There muſt be two ſcuttles over the after magazine for the paſſage to the magazine and light room. There ſhould alſo be one afore the fourth beam from forward for the paſſage to the fore magazine, and one abaft the ſecond beam for the paſſage to the light room.

The bulkheads for the fore and after parts of the well may be drawn from the lower deck beams to the orlop, and from thence to the limber ſtrake in the hold. The ſhot lockers may alſo be repreſented, having one afore and one abaft the well: there ſhould alſo be one abaft the foremoſt magazine, the ends of which may be formed by the after bits. The ſteps of the maſts may be drawn in by continuing their centres down to the limber ſtrake; and likewiſe two crutches abaft the mizen ſtep divided equally between that and the after part of the cutting down: the breaſt hooks may alſo be drawn, letting them be five in number below the lower deck hook, and all equally divided between that and the foreſtep. Hence every part of the inboard is deſcribed as far as neceſſary.

CHAP. V. *Of the Method of Whole-moulding.*

46 Method of whole-moulding. *Murray's Ship-Building.*

HAVING now finiſhed the methods of laying down the ſeveral plans of a ſhip, any farther addition on this ſubject might appear unneceſſary. We cannot, however, with propriety, omit to deſcribe the method called *whole-moulding*, uſed by the ancients, and which ſtill continues in uſe among thoſe unacquainted with the more proper methods already explained. This method will be illuſtrated by laying down the ſeveral plans of a long-boat; the length of the keel being 29 feet, and breadth moulded nine feet.

47 Applied to a long boat. Plate ccccxciii. fig. 37.

Draw the ſtraight line PO (fig. 37.) equal to 29 feet, the extreme length of the boat, and alſo to repreſent the upper edge of the keel. Let ⊕ be the ſtation of the midſhip frame. From the points, P, ⊕, and O, draw the lines PT, ⊕M, and OS, perpendicular to PO. Make ⊕M, ⊕N, equal to the upper and lower heights of breadth reſpectively at the main frame, PT the height of breadth at the tranſom, and OS the height at the ſtem. Deſcribe the curve TMS to repreſent the ſheer or extreme height of the ſide, which in a ſhip would be called the *upper height of breadth line*, or upper edge of the wale. Through the point N draw a curve parallel to TMS, to repreſent the breadth of the upper ſtrake of a boat, or lower edge of the wale if in a ſhip. The dotted line TNS may alſo be drawn to repreſent the lower height of breadth.

Method of Whole-moulding.

Set off the rake of the port from P to *p*, and draw the line *p t* to repreſent the aft ſide of the port; then T *t* will repreſent the round-up of the tranſom. Set off the breadth of the port from *p* to *r*, and from T to s, and draw the line *r* s to repreſent the foreſide of the port, which may either be a curve or a ſtraight line at pleaſure. Set up the height of the tuck from *p* to *k*. Let *k* X be the thickneſs of the tranſom, and draw the line ZX to repreſent the foreſide of the tranſom.

There is given the point S, the height of the ſheer on the foreſide of the ſtem; now that ſide of the ſtem is to be formed either by ſweeps or ſome other contrivance. Set off the breadth of the ſtem, and form the aft ſide of it.

Set up the dead-riſing from ⊕ to *d*, and form the riſing line r i s. Draw the line KL parallel to PO to repreſent the lower edge of the keel, and another to repreſent the thickneſs of the plank or the rabbet. The rabbet on the poſt and ſtem may alſo be repreſented; and the ſtations of the timbers aſſigned, as ⊕, (1), 1, 2, 3, 4, 5, 6, 7, 8, 9; and ⊕, (A), A, B, C, D, E, F, G, H; and the ſheer plan will be completed.

The half-breadth plan is to be formed next; for this purpoſe the perpendiculars TP, 9, 8, &c. muſt be produced. Upon M⊕ produced ſet off the half breadth from the line KL to R (fig. 38.); ſet off alſo the half breadth at the tranſom from K to *b*, and deſcribe the extreme half breadth line *b* RX, making the forepart of the curve agreeable to the propoſed round of the tranſom.

Fig. 38.

We may next proceed to form the timbers in the body plan. Let AB (fig. 39.) be the breadth moulded at ⊕. Erect the perpendicular CD in the middle of the line AB; draw the line *m n* diſtant therefrom the half thickneſs of the poſt, and *x y* the half thickneſs of the ſtern. Then take off the ſeveral portions of the perpendiculars ⊕, 1, 2, &c. intercepted between the upper edge of the keel and the riſing line in the ſheer plan, and ſet them up from C upon the line CD; through theſe points draw lines parallel to AC; take off alſo the ſeveral lower heights of breadth at ⊕, 1, 2, &c. from the ſheer plan; and ſet them up from C upon the middle line in the body plan; and draw lines parallel to AC through theſe points: Then take off the ſeveral half breadths correſponding to each from the floor plan: and ſet them off on their proper half-breadth lines from the middle line in the body plan.

Fig. 39.

Conſtruct the midſhip frame by Problem V. the form of which will in ſome meaſure determine the form of the reſt. For if a mould be made on any ſide of the middle line to fit the curve part of it, and the riſing line, or that marked *bend mould* (fig. 40.) and laid in ſuch a manner that the lower part of it, which is ſtraight, may be ſet upon the ſeveral riſing lines, and the upper part juſt touch the point of the half breadth in the breadth line correſponding to that riſing upon which the mould is placed, a curve may then be drawn by the mould to the riſing line. In this manner we may proceed ſo far as the riſing line is parallel to the lower height of the breadth line. Then a hollow mould muſt be made, the upper end of which is left ſtraight, as that

Fig. 40.

Method of Whole-moulding.

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that marked *hollow mould* (fig. 40.). This is applied in ſuch a manner, that ſome part of the hollow may touch the ſide of the keel, and the ſtraight part touch the back of the curve before deſcribed by the bend mould; and, beginning abaft, the ſtraight part will always come lower on every timber, till we come to the midſhip timber, when it comes to the ſide of the keel. Having thus formed the timbers, ſo far as the whole mouldings will ſerve, the timbers abaft them are next formed. Their half breadths are determined by the ſheer and floor plans, which are the only fixed points through which the curves of theſe timbers muſt paſs. Some form theſe after timbers before the whole is moulded, and then make the hollow mould, which will be ſtraighter than the hollow of either of theſe timbers. It is indifferent which are firſt formed, or what methods are uſed; for after the timbers are all formed, though every timber may appear very fair when conſidered by itſelf, it is uncertain what the form of the ſide will be. In order to find which, we muſt form ſeveral ribband and water lines; and if theſe do not make fair curves, they muſt be rectified, and the timbers formed from theſe ribband and water lines. In uſing the hollow mould, when it is applied to the curve of each timber, if the ſtraight part is produced to the middle line, we ſhall have as many points of interſection as there are timbers; and if the heights above the baſe be transferred to the correſponding timbers in the ſheer plan, a curve paſſing through theſe points is what is called a *riſing ſtrait*. This may be formed by fixing a point for the aftermoſt timber that is whole moulded, and transferring that height to the ſheer plan. The curve muſt paſs through this point, and fall in with the riſing line ſomewhere abaft dead flat; and if the ſeveral heights of this line be transferred from the ſheer to the middle line in the body plan, theſe points will regulate what is called the *hauling down* of the hollow mould.

The timbers in the after body being all formed, thoſe in the fore body are formed, in the ſame manner, by transferring the ſeveral heights of the riſing and breadth lines from the ſheer to the body plans; the half breadths correſponding to each height muſt alſo be transferred from the floor to the body plan. The ſame hollow mould will ſerve both for the fore and after body; and the level lines, by which the water lines to prove the after body were formed, may be produced into the fore body, and by them the water lines to prove the fore body may be deſcribed.

Another method of proving the body is by ribband lines, which are formed by ſections of planes inclined to the ſheer plan, and interſecting the body plan diagonally, as before obſerved, of which there may be as many as may be judged neceſſary. As this has been already explained, we ſhall therefore lay down only one, repreſented in the body plan by the lines marked d i a. Theſe are drawn in ſuch a manner as to be perpendicular to as many timbers as conveniently may be. After they are drawn in the body plan, the ſeveral portions of the diagonal intercepted between the middle line and each timber muſt be transferred to the floor plan. Thus, fix one foot of the compaſſes in the point where the diagonal interſects the middle line in the body plan; extend the other foot to the point where the diagonal interſects the timber; for example, timber 9: Set off the ſame extent upon the perpendicular repreſenting the plane of timber 9 from the point where it interſects the line KL on the floor plan: in like manner proceed with all the other timbers both in the fore and after body; and theſe ſhall have the points through which the curve muſt paſs. If this ſhould not prove a fair curve, it muſt be altered, obſerving to conform to the points as nearly as the nature of the curve will admit: ſo it may be carried within one point, and without another, according as we find the timbers will allow. For after all the ribband lines are formed, the timbers muſt, if needful, be altered by the ribband lines: this is only the reverſe of forming the ribband lines; for taking the portions of the ſeveral perpendiculars intercepted between the line KL and the curve of the ribband line in the floor plan, and ſetting them off upon the diagonal from the point where it interſects the middle line, we ſhall have the points in the diagonal through which the curves of the timbers muſt paſs. Thus the diſtance between the line KL and the ribband at timber 3 on the floor plan, when transferred to the body plan, will extend on the diagonal from the middle line to the point where the curve of timber 3 interſects that diagonal. The like may be ſaid of all the other timbers; and if ſeveral ribband lines be formed, they may be ſo contrived that their diagonals in the body plan ſhall be at ſuch diſtances, that a point for every timber being given in each diagonal, will be ſufficient to determine the form of all the timbers.

In ſtationing the timbers upon the keel for a boat, there muſt be room for two futtocks in the ſpace before or abaft ⊕; for which reaſon, the diſtance between theſe two timbers will be as much more than that between the other as the timber is broad. Here it is between ⊕ and (A); which contains the diſtances between ⊕ and (1), and the breadth of the timber beſides.

The timbers being now formed, and proved by ribband and water lines, proceed then to form the tranſom, faſhion-pieces, &c. by Problem VI.

This method of whole-moulding will not anſwer for the long timbers afore and abaft. They are generally canted in the ſame manner as thoſe for a ſhip. In order to render this method more complete, we ſhall here deſcribe the manner of moulding the timbers after they are laid down in the mould loft, by a riſing ſquare, bend, and hollow mould.

It was ſhown before how to form the timbers by the bend and hollow moulds on the draught. The ſame method muſt be uſed in the loft; but the moulds muſt be made to their proper ſcantlings in real feet and inches. Now when they are ſet, as before directed, for moulding each timber, let the middle line in the body plan be drawn acroſs the bend mould, and draw a line acroſs the hollow mould at the point where it touches the upper edge of the keel; and let them be marked with the proper name of the timber, as in fig. 40. The graduations of the bend mould will therefore be exactly the ſame as the narrowing of the breadth. Thus, the diſtance between ⊕ and 7 on the bend mould is equal to the difference between the half breadth of timber 7 and that of ⊕. The height of the head of each timber is likewiſe marked on the bend mould, and alſo the floor and breadth ſirmarks. The floor ſirmark is in that point where a ſtraight edged batten touches the

Method of Whole-moulding.

back of the bend mould, the batten being ſo placed as to touch the lower edge of the keel at the ſame time. The ſeveral riſings of the floor and heights of the cutting down line are marked on the riſing ſquare, and the half breadth of the keel is ſet off from the ſide of it.

The moulds being thus prepared, we ſhall apply them to mould timber 7. The timber being firſt properly ſided to its breadth, lay the bend mould upon it, ſo as may beſt anſwer the round according to the grain of the wood; then lay the riſing ſquare to the bottom of the bend mould, ſo that the line drawn acroſs the bend mould at timber 7 may coincide with the line repreſenting the middle of the keel upon the riſing ſquare; and draw a line upon the timber by the ſide of the ſquare, or let the line be ſcored or cut by a tool made for that purpoſe, called a *raſeing knife* (E); this line ſo raſed will be the ſide of the keel. Then the ſquare muſt be moved till the ſide of it comes to 7 on the bend mould, and another line muſt be raſed in by the ſide of it to repreſent the middle of the keel. The other ſide of the keel muſt likewiſe be raſed after the ſame manner, and the point 7 on the riſing ſquare be marked on each ſide of the keel, and a line raſed acroſs at theſe points to repreſent the upper edge of the keel. From this line the height of the cutting-down line at 7 muſt be ſet up, and then the riſing ſquare may be taken away, and the timber may be raſed by the bend mould, both inſide and outſide, from the head to the floor firmark, or it may be carried lower if neceſſary. After the firmarks and head of the timbers are marked, the bend mould may likewiſe be taken away, and then the hollow mould applied to the back of the ſweep in ſuch a manner that the point 7 upon it may interſect the upper ſide of the keel, before ſet off by the riſing ſquare; and when in this poſition the timber may be raſed by it, which will complete the outſide of the timbers. The inſide of the timbers may likewiſe be formed by the hollow mould. The ſcantling at the keel is given by the cutting down before ſet off. The mould muſt be ſo placed as to touch the ſweep of the inſide of the timber formed before by the bend mould, and paſs through the cutting down point.

The uſe of the firmarks is to find the true places of the futtocks; for as they are cut off three or four inches ſhort of the keel, they muſt be ſo placed that the futtock and floor firmarks may be compared and coincide. Notwithſtanding which, if the timbers are not very carefully trimmed, the head of the futtock may be either within or without its proper half breadth; to prevent which a half breadth ſtaff is made uſe of.

The half breadth ſtaff may be one inch ſquare, and of any convenient length. Upon one ſide of it are ſet off from one end the ſeveral half-breadths of all the timbers in the after body, and thoſe of the fore body upon the oppoſite ſide. On the other two ſides are ſet off the ſeveral heights of the ſheer, the after body on one ſide, and the fore body on its oppoſite. Two ſides of the ſtaff are marked *half breadths*, and the other two ſides *heights of the ſheer*.

The ſtaff being thus prepared, and the floor timbers faſtened on the keel, and levelled acroſs, the futtocks muſt next be faſtened to the floor timbers; but they muſt be ſet firſt to their proper half breadth and height. The half breadth ſtaff, with the aſſiſtance of the ramline *, ſerves to ſet them to the half breadth; for as the keel of a boat is generally perpendicular to the horizon, therefore the line at which the plummet is ſuſpended, and which is moveable on the ram line, will be perpendicular to the keel. Whence we may by it ſet the timbers perpendicular to the keel, and then ſet them to their proper half breadths by the ſtaff: and when the two firmarks coincide, the futtock will be at its proper height, and may be nailed to the floor timbers and alſo to the breadth ribband, which may be ſet to the height of the ſheer by a level laid acroſs, taking the height of the ſheer by the ſtaff from the upper ſide of the keel; by which means we ſhall diſcover if the ribband is exactly the height of the ſheer; and if not, the true height may be ſet off by a pair of compaſſes from the level, and marked on the timbers.

Practice of Ship-building.

Chap. VI. *Of the Practice of Ship-Building.*

The elevation, projection, and half-breadth plans, of a propoſed ſhip being laid down on paper, we muſt next proceed to lay down theſe ſeveral plans on the mould loft of the real dimenſions of the ſhip propoſed to be built, and from which moulds for each ſeparate part are to be made. The method of laying down theſe plans, from what has been already ſaid, will, it is preſumed, be no very difficult taſk to accompliſh, as it is no more than enlarging the dimenſions of the original draughts; and with reſpect to the moulds, they are very eaſily formed agreeable to the figure of the ſeveral parts of the ſhip laid down in the mould loft.

Blocks of wood are now to be prepared upon which the keel is to be laid. Theſe blocks are to be placed at nearly equal diſtances, as of five or ſix feet, and in ſuch a manner that their upper ſurfaces may be exactly in the ſame plane, and their middle in the ſame ſtraight line. This laſt is eaſily done by means of a line ſtretched a little more than the propoſed length of the keel; and the upper planes of theſe blocks may be verified by a long and ſtraight rule; and the utmoſt care and precaution muſt be taken to have theſe blocks properly bedded. Each block may be about ſix or eight inches longer than the keel is in thickneſs; their breadth from 12 to 14 inches, and their depth from a foot to a foot and half.

The dimenſions of the keel are to be taken from the mould loft, and the keel is to be prepared accordingly. As, however, it is ſeldom poſſible to procure a piece of wood of ſufficient length for a keel, eſpecially if for a large ſhip, it is, therefore, for the moſt part neceſſary to compoſe it of ſeveral pieces, and theſe pieces are to be ſcarfed together, and ſecurely bolted, ſo as to make one entire piece. It muſt, however, be obſerved, that the pieces which compoſe the keel ought to be of ſuch lengths, that a ſcarf may not be oppoſite to the ſtep of any of the maſts. Rabbets are to be formed on each ſide of the keel to receive the edge of the planks next to

* See next chapter.

(E) The term *raſeing* is uſed when any line is drawn by ſuch an inſtrument inſtead of a pencil.

to it, or garboard ſtrake, and the keel is to be laid on the blocks (F).

The ſtem, and the poſt, and the ſeveral tranſoms belonging to it, are to be prepared from the moulds, and rabbeted in like manner as the keel, to receive the ends of the plank. The tranſoms are to be bolted to the poſt at their middle, each at its reſpective height, taken from the elevation in the mould loft, and the extremities of the tranſoms are to be firmly connected with the faſhion-pieces. Both ſtem and poſt are then to be erected, each at its reſpective extremity of the keel. The tenons at the heel of each being let into mortiſes prepared to receive them, and being ſet to their proper rakes or angles with the keel, are to be ſupported by props or ſhores. Pieces of wood called *dead wood* are to be laid upon and fixed to the upper ſide of the keel towards the fore and aft parts of it; the deepneſs of the dead wood increaſing with its diſtance from the middle, agreeable to the propoſed form of the cutting-down line.

A line is to be ſtretched from the middle of the head of the ſtem to that of the poſt, called the *ram line*, upon which is a moveable line with a plummet affixed to it. The midſhip and other frames are to be erected upon the keel at their proper ſtations. The extremities of each frame are ſet at equal diſtances from the vertical longitudinal ſection of the ſhip, by moving the frame in its own plane until the plumb-line coincides with a mark at the middle between the arms of each frame; and although the keel is inclined to the horizon, yet the frames may alſo be ſet perpendicular to the keel by means of the plumb-line. The ſhores which are ſupporting the frames are now to be ſecurely fixed, that the poſition of the frames may not be altered. The ribbands are now to be nailed to the frames at their proper places, the more effectually to ſecure them; and the intermediate vacancies between the frames filled up with filling timbers. For a perſpective view of a ſhip framed, ſee fig. 2.

Plate cccclxxxxiv. fig. 2.

The frames being now ſtationed, proceed next to fix on the planks, of which the wales are the principal, being much thicker and ſtronger than the reſt. The harpins, which may be conſidered as a continuation of the wales at their fore ends, are fixed acroſs the hawſe pieces, and ſurround the fore part of the ſhip. The planks that incloſe the ſhip's ſides are then brought about the timbers; and the clamps, which are of equal thickneſs with the wales, fixed oppoſite to the wales within the ſhip. Theſe are uſed to ſupport the ends of the beams, and accordingly ſtretch from one end of the ſhip to the other. The thick ſtuff or ſtrong planks of the bottom within board are then placed oppoſite to the ſeveral ſcarfs of the timbers, to reinforce them throughout the ſhip's length. The planks employed to line the ſhip, called the *ceiling* or *foot-waling*, is next fixed in the intervals between the thick ſtuff of the hold. The beams are afterwards laid acroſs the ſhip to ſupport the decks, and are connected to the ſide by lodging and hanging knees: the former of which are exhibited at F, Plate CLXIX. See alſo the article DECK; and the hanging-knees, together with the breadth, thickneſs, and poſition of the keel, floor timbers, futtocks, top-timbers, wales, clamps, thick ſtuff, planks within and without, beams, decks, &c.

The cable bits being next erected, the *carlings* and *ledges*, repreſented in Plate CLXIX. are diſpoſed between the beams to ſtrengthen the deck. The *water-ways* are then laid on the ends of the beams throughout the ſhip's length, and the ſpirketing fixed cloſe above them.—The upper deck is then planked, and the *ſtring* placed under the *gunnel*, or *planſheer*, in the waiſt.

Then proceed next to plank the quarter-deck and foreeaſtle, and to fix the *partners* of the maſts and capſterns with the *coamings* of the hatches. The *breaſt-hooks* are then bolted acroſs the ſtem and bow within-board, the ſtep of the foremaſt placed on the kelſon, and the *riders* fayed to the inſide of the timbers, to reinforce the ſides in different parts of the ſhip's length. The *pointers*, if any, are afterwards fixed acroſs the hold diagonally to ſupport the beams; and the crotches ſtationed in the after hold to unite the half timbers. The *ſteps* of the mainmaſt and capſterns are next placed; the planks of the lower decks and orlop laid; the *navel-hoods* fayed to the hawſe holes; and the *knees of the head*, or cut-water, connected to the ſtem. The figure of the head is then erected, and the *trail-board* and cheeks fixed on the ſide of the knee.

The *taffarel* and *quarter pieces*, which terminate the ſhip abaft, the former above and the latter on each ſide, are then diſpoſed, and the ſtern and quarter galleries framed and ſupported by their brackets. The *pumps*, with their well, are next fixed in the hold; the *limber boards* laid on each ſide of the kelſon, and the *garboard ſtrake* fixed on the ſhip's bottom next to the keel without.

The hull being thus fabricated, proceed to ſeparate the apartments by bulkheads or partitions, to frame the port-lids, to fix the catheads and cheſs-trees; to form the hatchways and ſcuttles, and fit them with proper covers or gratings. Next fix the ladders at the different hatchways, and build the manger on the lower deck, to carry off the water that runs in at the hawſe-holes when the ſhip rides at anchor in a ſea. The bread-room and magazines are then lined; and the gunnel, rails, and gangways fixed on the upper part of the ſhip. The cleats, kevels, and ranges, by which the ropes are faſtened, are afterwards bolted or nailed to the ſides in different places.

The rudder, being fitted with its irons, is next hung to the ſtern-poſt, and the tiller or bar, by which it is managed, let into a mortiſe at its upper end. The *ſcuppers*, or leaden tubes, that carry the water off from the decks, are then placed in holes cut through the ſhip's ſides; and the *ſtandards* bolted to the beams and ſides above the decks to which they belong. The poop lanthorns are laſt fixed upon their cranes over the ſtern, and the *bilge-ways* or *cradles* placed under the bottom to conduct the ſhip ſteadily into the water whilſt launching.

(F) In ſhips of war, which are a long while in building, it has been found that the keel is often apt to rot before they are finiſhed. Upon this account, therefore, ſome builders have begun with the floor timbers, and added the keel afterwards.

Improvements in the Maſts and Rudder.

As the various pieces which have been mentioned above are explained at large in their proper places, it is therefore ſuperfluous to enter into a more particular deſcription of them here.

Chap. VII. *Of Improvements in the Maſts and Rudder.*

48 Improvements in maſts.

49 Of wounded maſts, by Captain Pakenham. Page 209.

An account of a method for reſtoring maſts of ſhips when wounded, or otherwiſe injured, in an eaſy, cheap, and expeditious manner, by Captain Edward Pakenham of the royal navy, has been publiſhed in the tenth volume of the Tranſactions of the Society for the Encouragement of Arts, &c. Captain Pakenham introduces his invention with the following obſervations:

"Among the various accidents which ſhips are liable to at ſea, none call more for the attention and exertion of the officer than the ſpeedy refitting of the maſts; and having obſerved, in the courſe of laſt war, the very great deſtruction made among the lower maſts of our ſhip's from the enemy's mode of fighting, as well as the very great expence and delay in refitting a fleet after an action, particularly acroſs the Atlantic—a very ſimple expedient has ſuggeſted itſelf to me as a reſource in part; which appears ſo very ſpeedy and ſecure, that the capacity of the meaneſt ſailor will at once conceive it. I therefore think it my duty to ſtate my ideas of the advantages likely to reſult from it; and I ſhall feel myſelf exceedingly happy ſhould they in any wiſe contribute to remedy the evil.

"My plan, therefore, is, to have the heels of all lower maſts ſo formed as to become the heads: but it is not the intention of the above plan to have the ſmalleſt alteration made in the heels of the preſent lower maſts; for as all line-of-battle ſhips maſts are nine inches in diameter larger at the heel than at the head, it will follow, that by letting in the treſſel-trees to their proper depth, the maſt will form its own cheeks or hounds; and I flatter myſelf the following advantages will reſult from the above alteration.

"Firſt, I muſt beg to obſerve, that all line-of-battle ſhips bury one-third of their lower maſts, particularly three-deckers; it therefore follows, that if the wounds are in the upper third, by turning the maſt ſo as to make the heel the head, it will be as good as new; for, in eight actions I was preſent in laſt war, I made the following obſervations:

"That in the ſaid actions fifty-eight lower maſts were wounded, and obliged to be ſhifted, thirty-two of which had their wounds in the upper third, and of courſe the ſhips detained until new maſts were made. And when it is conſidered that a lower maſt for a 90 or 74 ſtands government in a ſum not leſs, I am informed, than 2000l. or 2300l. the advantages acroſs the Atlantic reſulting from the aforeſaid plan will be particularly obvious; not to mention the probability of there being no fit ſpars in the country, which was the caſe in the inſtances of the Iſis and Princeſs Royal; and as I was one of the lieutenants of the Iſis at that time, I am more particular in the circumſtance of that ſhip. The Iſis had both her lower maſts wounded above the cathar pins in her action with the Cæſar, a French 74; and as there were no ſpars at New York, the Iſis was detained five weeks at that place.—Now, if her maſts had been fitted on the plan I have propoſed, I am confident ſhe would have been ready for ſea in 48 hours; and as a further proof, I beg leave to add, that the whole fleet, on the glorious 12th of April, had not the leaſt accident of any conſequence except what befel their lower maſts, which detained them between eight and ten weeks at Jamaica.

Improvements in the Maſts and Rudder.

"The delay of a ſhip while a new maſt is making, and probably the fleet being detained for want of that ſhip, which frequently occurred in the courſe of laſt war, the taking of ſhipwrights from other work, with a variety of inconveniences not neceſſary to mention here, muſt be obvious to every officer that has made the ſmalleſt obſervations on ſea-actions.

"You will further obſerve, that this ſubſtitute is formed on the moſt ſimple principle, fitted to the meaneſt capacity, and calculated to benefit all ſhips, from a firſt-rate down to the ſmalleſt merchantman, in caſes of an accident by ſhot, a ſpring, a rottenneſs, particularly as theſe accidents generally happen in the upper third of the maſt and above the cheeks.

"It might probably be objected, that a difficulty and ſome danger might ariſe from the wounded part of the maſt being below; but this will at once be obviated, when it is remembered, that as the wounded part is below the wedges, it may with caſe be both fiſhed, caſed, and ſecured, to any ſize or degree you pleaſe, with the addition of its being wedged on each deck."

Plate ccccxciii. fig. 41.

Fig. 41. repreſents a maſt of a firſt-rate in its proper ſtate, the figures repreſenting its thickneſs at the different diviſions.

Fig. 42.

Fig. 42. the ſame maſt inverted, the heel forming the head, and the treſſel-trees let into their proper depth, the additional thickneſs of the maſt forming its own cheeks.

Fig. 43.

Fig. 43. the propoſed maſt, the figures repreſenting the thickneſs of the maſt in the propoſed alterations; *a*, the heel made ſquare; *b*, the letting in of the treſſel-trees; *c*, the third proportion of thickneſs continued up to where the fourth is in the preſent maſt, or at leaſt ſome little diſtance above the lower part of the cheeks, which is always looked upon as the weakeſt part of the maſt; and by its being ſo proportioned, the maſt, when turned, will be nearly as ſtrong in the partners as before.

Papers on Naval Architecture, part 2.

As the expence of a maſt is much greater than is generally imagined, it is therefore thought proper to ſubjoin the following ſtatement of the ſeveral articles uſed in making a 74 gun ſhip's mainmaſt.

	Value.		
Fiſhes for a ſpindle, 21 inches, 2 nails of two maſts, - -	L. 101	3	11
Two ſide fiſhes, 22 inches, 2 ditto,	133	10	9
Fore and aft fiſhes, 22 inches, 2 nails of one maſt, - - -	66	13	10
Fiſh } On the fore part 21½ inches, 1 nail of half a maſt,	29	8	5
Iron } On the fore part 3 qrs. 19 lbs. - -	1	5	9
Aries load baulk, 2 loads 22 feet, -	12	2	5
Breadthning } Dantzic fir timber. 2 loads 7 feet, -	11	1	7
{ Cheeks } Dantzic fir timber. 4 loads 2 feet, -	20	18	4
{ Iron, 5 cwt. 2 qrs. 24 lb. - -	8	0	0
Knees, elm timber, 13 feet, - -	0	15	2
Iron, 2 qrs. 14 lb. - - -	0	17	6
Carried over	L. 385	17	8

	Value.		
Brought over	L. 385	17	8
Hoops and bolts on the body, 13 cwt. 1 qr. 16 lb.	18	15	0
Treſſel-trees, ſtraight oak timber, ſecond ſort, 2 loads 10 feet,	10	2	4
Iron, 3 qrs. 10 lb.	1	3	6
Croſs trees, ſtraight oak timber, ſecond ſort, 1 load 12 feet,	5	14	0
Iron, 2 qrs. 2 lb.	0	14	6
Cap, elm timber, 1 load 24 feet,	4	6	0
Iron, 2 cwt. 14 lb.	2	19	6
Fullings, bolſters, bollins, and Dantzic fir, 1 load 2 feet,	5	7	8
Workmanſhip,	78	6	0
	L. 513	6	2
Main-topmaſt of a 74 gun ſhip,	50	16	3
Main-top-gallant-maſt,	8	11	0

Principles of Naval Architecture, p. 50.

50
Mr Gordon's plan of building maſts.

In order to leſſen the enormous expence of maſts, a propoſal was made ſome years ago to conſtruct them hollow; and the author having premiſed ſeveral experiments which he had made, proceeds as follows:

“ Galileo taught us, that the reſiſtance or ſtrength of a hollow cylinder is to that of a full cylinder, containing the ſame quantity of matter, as the total diameter of the hollow one is to the diameter of the full one; and theſe experiments ſhow us, that the ſtrength or reſiſtance of two or more pieces of wood, faſtened together at each end, and connected by a pillar, pillars, or framing, increaſes, at leaſt to a certain degree, *cæteris paribus*, as the diſtance between them and number of pillars, provided the force is applied in the line or direction of the pillars.

“ It is ſurpriſing that this diſcovery of Galileo has not been made ſubſervient to more uſeful purpoſes. It is particularly applicable to the conſtruction of maſts, as not requiring that the hollow cylinder ſhould be made of one ſolid piece of wood (G).

Fig. 44. Fig. 45. Fig. 46.

“ However, the foregoing experiments teach us, that the ſame advantages may be obtained by other forms beſides that of a cylinder; and that perhaps not only in a ſuperior degree, but likewiſe with greater facility of execution; as by adopting a ſquare figure, but more particularly by conſtructing them of ſeparate pieces of wood, placed at proper diſtances from each other, in the following or any other manner that may be found moſt convenient. Fig. 44, 45, and 46. exhibit each the tranſverſe ſection of a maſt, in which the ſmall circles repreſent the trees or upright pieces of wood, and the lines the beams or framing of wood, which are employed at proper places and at proper diſtances from each other, for connecting them together. Perhaps ſolid frames of wood, placed at proper diſtances from each other, and filling up the whole dotted ſpace, would anſwer better; in which event, the maſt could be ſtrongly hooped with iron at thoſe places, and the upright-trees formed ſquare, or of any other convenient form.

“ It will be evident to thoſe acquainted with this ſubject, that ſuch maſts would be greatly ſtronger than common ones containing the ſame quantity of materials. It is likewiſe evident that they would be leſs apt to ſpring, as being ſupported on a more extended baſe, and affording many conveniences for being better ſecured; and that they might be conſtructed of ſuch wood as at preſent would be deemed altogether improper for maſts: a circumſtance of importance to Britain at all times, but more particularly now, when there is ſuch difficulty in procuring wood proper for the kind of maſts in common uſe.”

51
An improvement of the rudder.

An improvement in the rudder has lately taken place in ſeveral ſhips, particularly in ſome of thoſe in the ſervice of the Eaſt India Company. It will, however, be neceſſary previouſly to deſcribe the uſual form of the rudder, in order to ſhow the advantages it poſſeſſes when conſtructed agreeable to the improved method.

Papers on Naval Architecture, part I.
Fig. 47.

N° 1. (fig. 47.) repreſents the rudder according to the common method of conſtruction; in which AB is the axis of rotation. It is hence evident that a ſpace conſiderably greater than the tranſverſe ſection of the rudder at the counter muſt be left in the counter for the rudder to revolve in. Thus, let CAB (N° 2.) be the ſection of the rudder at the counter; then there muſt be a ſpace ſimilar to CDE in the counter, in order that the rudder may be moveable as required. Hence, to prevent the water from waſhing up the rudder caſe, a rudder coat, that is, a piece of tarred canvas, is nailed in ſuch a manner to the rudder and counter as to cover the intermediate ſpace: but the canvas being continually waſhed by the ſea, ſoon becomes brittle, and unable to yield to the various turns of the rudder without breaking; in which caſe the ſhip is of courſe left pervious to the waves, even of three or four feet high; in fact, there are few men bred to the ſea who have not been witneſſes to the bad effects of ſuch a ſpace being left ſo ill guarded againſt the ſtroke of the waves; and many ſhips have, with great probability, been ſuppoſed to founder at ſea from the quantity of water ſhipped between the rudder and counter.

Fig. 48.

It was to remedy this defect that the alteration above alluded to took place; which conſiſts in making the upper part AFG (fig. 48. N° 1.) of the rudder ABD cylindrical, and giving that part at the ſame time a caſt forward, ſo that the axis of rotation may by that means be the line AD, paſſing as uſual from E to D, through the centres of the braces which attach the rudder to the ſtern-poſt, and from E to A through the axis of the cylinder AFG, in order that the tranſverſe ſection KH (N° 2.) at the counter may be a circle revolving upon its centre; in which caſe the ſpace of half an inch is more than ſufficient between the rudder and the counter, and conſequently the neceſſity of a rudder coat entirely done away. But as it was foreſeen, that if the rudder

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(G) The ſtrength of theſe cylinders would be ſtill further augmented by having ſolid pieces of wood placed within them at proper diſtances, and ſecurely faſtened to them, in the ſame manner, and on the ſame principles, that nature has furniſhed reeds with joints; and for anſwering, in ſome reſpects, the ſame purpoſe as the pillars in the experiments alluded to.

Load-water Line and Ship's Capacity.

rudder by an accident was unſhipped, this alteration might endanger the tearing away of the counter, the hole is made much larger than the tranſverſe ſection of the cylindric part of the rudder, and the ſpace between filled up with pieces of wood ſo fitted to the counter as to be capable of withſtanding the ſhock of the ſea, but to be eaſily carried away with the rudder, leaving the counter under ſuch circumſtances, in as ſafe a ſtate as it would be agreeable in the preſent form of making rudders in the navy.

Chap. VIII. *Upon the Poſition of the Load-water Line, and the Capacity of a Ship.*

See *Hydrodynamics.*

The weight of the quantity of water diſplaced by the bottom of a ſhip is equal to the weight of the ſhip with its rigging, proviſions, and every thing on board. If, therefore, the exact weight of the ſhip when ready for ſea be calculated, and alſo the number of cubic feet in the ſhip's bottom below the load-water line, and hence the weight of the water ſhe diſplaces; it will be known if the load-water line is properly placed in the draught.

Ship-Builder's Repoſitory.

The poſition of the ſhip in the draught may be either on an even keel, or to draw moſt water abaft; but an even keel is judged to be the beſt poſition in point of velocity, when the ſhip is conſtructed ſuitable thereto, that is, when her natural poſition is ſuch. For when a ſhip is conſtructed to ſwim by the ſtern, and when brought down to her load-water made to ſwim on an even keel (as is the caſe with moſt ſhips that are thus built), her velocity is by that means greatly retarded, and alſo her ſtrength greatly diminiſhed: for the fore-part being brought down lower than it ſhould be, and the middle of the ſhip maintaining its proper depth in the water, the after part is by that means lifted, and the ſhip is then upon an even keel: but in conſequence of her being out of her natural poſition, the after part is always placed downwards with a conſiderable ſtrain, which will continue till the ſhip's ſheer is entirely broken, and in time would fall into its natural poſition again: for which reaſon we ſee ſo many ſhips with broken backs, that is, with their ſheers altered in ſuch a manner that the ſheer rounds up, and the higheſt part is in the midſhips.

Such are the diſadvantages ariſing from not paying a due attention to thoſe points in the conſtruction of a draught; therefore, when the load-water line is found to be ſo ſituated at a proper height on the draught, according to the weight given for ſuch a ſhip, and alſo drawn parallel to the keel, as ſuppoſing that to be the beſt ſailing trim, the next thing is to examine whether the body is conſtructed ſuitable thereto, in order to avoid the above-mentioned ill conſequences.

In the firſt place, therefore, we muſt divide the ſhip equally in two lengthwiſe between the fore and after perpendiculars; and the exact number of cubic feet in the whole bottom beneath the load-water line being known, we muſt find whether the number of cubic feet in each part ſo divided is the ſame; and if they are found to be equal, the body of the ſhip may then be ſaid to be conſtructed in all reſpects ſuitable to her ſwimming on an even keel, let the ſhape of the body be whatever it will; and which will be found to be her natural poſition at the load-water line. But if either of the parts ſhould contain a greater number of cubic feet than the other, that part which contains the greateſt will ſwim the moſt out of the water, and conſequently the other will ſwim deepeſt, ſuppoſing the ſhip in her natural poſition for that conſtruction. In order, therefore, to render the ſhip ſuitably conſtructed to the load-water line in the draught, which is parallel to the keel, the number of cubic feet in the leſs part muſt be ſubtracted from the number contained in the greater part, and that part of the body is to be filled out till it has increaſed half the difference of their quantities, and the other part is to be drawn in as much: hence the two parts will be equal, that is, each will contain the ſame number of cubic feet, and the ſhip's body will be conſtructed in a manner ſuitable to her ſwimming on an even keel.

Load-water Line and Ship's Capacity.

If it is propoſed that the ſhip laid down on the draught ſhall not ſwim on an even keel, but draw more water abaft than afore, then the fore and after parts of the ſhip's body below the load-water line are to be compared; and if theſe parts are unequal, that part which is leaſt is to be filled out by half the difference, and the other part drawn in as much as before.

It will be neceſſary, in the firſt place, to calculate the weight of a ſhip ready equipped for ſea, from the knowledge of the weight of every ſeparate thing in her and belonging to her, as the exact weight of all the timber, iron, lead, maſts, ſails, rigging, and in ſhort all the materials, men, proviſions, and every thing elſe on board of her, from which we ſhall be able afterwards to judge of the truth of the calculation, and whether the load-water line in the draught be placed agreeable thereto. This is indeed a very laborious taſk, upon account of the ſeveral pieces of timber, &c. being of ſo many different figures, and the ſpecific gravity of ſome of the timber entering the conſtruction not being preciſely determined.

In order to aſcertain the weight of the hull, the timber is the firſt thing which comes under conſideration: the number of cubic feet of timber contained in the whole fabric muſt be found; which we ſhall be able to do by help of the draught and the principal dimenſions and ſcantlings; obſerving to diſtinguiſh the different kinds of timber from each other, as they differ conſiderably in weight; then the number of cubic feet contained in the different ſorts of timber being reduced into pounds, and added, will be the weight of the timber. In like manner proceed to find the weight of the iron, lead, paint, &c. and the true weight of the whole will be found.

See *Hydrodynamics.*

In reducing quantity to weight, it may be obſerved that a cubic foot of oak is equal to 66 pounds, and the ſpecific gravity of the other materials is as follows:

Water being	1000	Oak is	891.89
Lead is -	11345	Dry elm	702.70
Iron -	7643	Dry fir	648.64

Load-water Line and Ship's Capacity.

Plates CCCCXC. CCCCXCI.

52 Eſtimate of the weight of the eighty gun ſhip before laid down.

An Eſtimate of the Weight of the Eighty Gun Ship in Plates CCCCXC. and CCCCXCI. *as fitted for Sea, with Six Months Proviſions.*

Weight of the Hull.

	N° of Ft.	N° of lbs.	Tons.	Lbs.
Oak timber at 66 lb. to the cubic foot	48497	3200802	1428	2082
Fir timber at 48 lb. to the cubic foot	4457	213936	95	1136
Elm timber at 52 lb. to the cubic foot	520	27040	12	160
Carve work and lead work		4651	2	171
Iron work, rudder irons, chain-plates, nails, &c.		88254	39	894
Pitch, tar, oakum, and paint		17920	8	
Cook-room fitted with fire hearth		16123	7	443
Sum - -		3568726	1593	406

Weight of the Furniture.

	N° of lbs.	Tons.	Lbs.
Complete ſet of maſts and yards, with the ſpare geer -	161000	71	1960
Anchors with their ſtocks, and maſter's ſtores - -	39996	17	1916
Rigging - -	69128	30	1928
Sails, complete ſet, and ſpare	32008	14	648
Cables and hawſers -	73332	32	1652
Blocks, pumps, and boats	62056	27	1576
Sum - - -	437520	195	720

Weight of the Guns and Ammunition.

Guns with their carriages -	377034	168	714
Powder and ſhot, powder barrels, &c. - - -	116320	51	2080
Implements for the powder	6500	2	2020
Ditto for guns, crows, handſpikes, &c. - - - -	21573	9	1413
Sum - - -	521427	232	1747

Weight of the Officers Stores, &c.

Carpenter's ſtores - -	20187	9	27
Boatſwain's ſtores - -	21112	9	952
Gunner's ſtores - - -	8964	4	4
Caulker's ſtores - -	5200	2	720
Surgeon and chaplain's effects	11096	4	2136
Sum - -	66559	29	1599

Weight of the Proviſions.

Proviſions for ſix months for 700 men, with all their equipage	858970	383	1050
Water, caſks, and captain's table	933900	416	2060
Sum - -	1792870	800	870

Weight of the Men, &c.

	N° of lbs.	Tons.	Lbs.
Seven hundred men with their effects, including the officers and their effects -	316961	141	1121
Ballaſt - - -	1478400	660	
Sum - -	1795361	801	1121

RECAPITULATION.

The hull - -	3568726	1593	406
The furniture - -	437520	195	720
Guns and ammunition -	521427	232	1747
Officers ſtores - -	66559	29	1599
Proviſions - -	1792870	800	870
Weight of the men and ballaſt	1795361	801	1121
Sum - -	8182463	3652	1983

Agreeable to the above eſtimate, we find that the eighty gun ſhip, with every thing on board and fit for ſea, when brought down to the load-water line, weighs 8,182,463 pounds, or nearly 3653 tons. It may now be known if the load-water line in the draught be properly placed, by reducing the immerſed part of the body into cubic feet. For if the eighty gun ſhip, when brought down to the load-water line, weighs 3653 tons, the quantity of water diſplaced muſt alſo be 3653 tons: now a cubic foot of ſalt water being ſuppoſed to weigh 74 pounds, if therefore 8182463 be divided by 74, the quotient is 110573, the number of cubical feet which ſhe muſt diſplace agreeable to her weight.

It is now neceſſary to find the number of cubic feet contained in the ſhip's bottom below the load-water line by calculation. If the bottom was a regular ſolid, this might be very eaſily done; but as it is otherwiſe, we muſt be ſatisfied with the following method by approximation, firſt given by M. Bouguer.

Load-water Line and Ship's Capacity.

53 Method of calculating the contents of the bottom of a ſhip.

Take the lengths of every other of the lines that repreſent the frames in the horizontal plane upon the upper water line; then find the ſum of theſe together, with half the foremoſt and aftermoſt frames. Now multiply that ſum by the diſtance between the frames, and the product is the area of the water line contained between the foremoſt and aftermoſt frames: then find the area of that part abaft the after frame, which forms a trapezium, and alſo the poſt and rudder; find alſo the area of that part afore the foremoſt frame, and alſo of the ſtem and gripe; then theſe areas being added to that firſt found, and the ſum doubled, will be the area of the ſurface of the whole water line. The reaſon of this rule will be obvious to thoſe acquainted with the firſt principles of mathematics.

The areas of the other water line may be found in the ſame manner: then the ſum of all theſe areas, except that of the uppermoſt and lowermoſt, of which only one half of each muſt be taken, being multiplied by the diſtance between the water lines (theſe lines in the plane of elevation being equidiſtant from each other), and the product will be the ſolid content of the ſpace contained between the lower and load-water lines.

Load-water Line and Ship's Capacity.

Add the area of the lower water line to the area of the upper ſide of the keel; multiply half that ſum by the diſtance between them, the product will be the ſolid content of that part between the lower water line and upper edge of the keel, ſuppoſing them parallel to each other. But if the lower water line is not parallel to the keel, the above half ſum is to be multiplied by the diſtance between them at the middle of the ſhip.

The ſolid contents of the keel muſt be next found, by multiplying its length by its depth, and that product by the breadth. Then the ſum of theſe ſolid contents will be the number of cubic feet contained in the immerſed part of the ſhip's bottom, or that part below the load-water line.

Determination of the number of Cubic Feet contained in the Bottom of the Eighty-Gun Ship. See Plates CCCCXC. and CCCCXCI.

54 Applied to the eighty-gun ſhip.

The fore body is divided into five, and the after body into ten, equal parts in the horizontal plane; beſides the parts contained between the foremoſt timber and the ſtem, and the aftermoſt timber and the poſt. The plane of elevation is alſo divided into five equal parts by water lines drawn parallel to the keel. Theſe water lines are alſo deſcribed upon the horizontal plane.

It is to be obſerved that there muſt be five inches added to each line that repreſents a frame in the horizontal plane for the thickneſs of the plank, that being nearly a mean between the thickneſs of the plank next the water and that on the lower part of the bottom.

Upper Water Line abaft Dead Flat.

		Ft.	In.
The breadth at	frame dead flat is 24 feet 10 inches, one-half of which is - -	12	5
	frame (4) - - -	24	10
	frame 3 - - -	24	10
	frame 7 - - -	24	10
	frame 11 - - -	24	10
	frame 15 - - -	24	9½
	frame 19 - - -	24	5
	frame 23 - - -	23	10
	frame 27 - - -	22	9
	frame 31 - - -	20	11
	frame 35 is 16 feet 3 inches, the half of which is - - -	8	1½
Sum - - - - -		236	7
Diſtance between the frames -		10	11
Product - - -		2582	8½
Area of that part abaft frame 35 -		78	0
——— rudder and poſt - -		5	6
Sum - - - -		2666	2½
			2
Area of the load water line from dead flat aft - - - -		5332	5

Second Water Line abaft Dead Flat.

		Ft.	In.
The breadth at	frame dead flat is 23 feet 10½ inches, the half of which is - -	11	11¼
	frame (4) - - -	23	10½
	frame 3 - - -	23	10½
	frame 7 - - -	23	10½
	frame 11 - - -	23	10½
	frame 15 - - -	23	8½
	frame 19 - - -	23	3½
	frame 23 - - -	22	5
	frame 27 - - -	20	10
	frame 31 - - -	17	8
	frame 35 is 8 feet 6 inches, the half of which is - - -	4	3
Sum - - - - -		219	7¼
Diſtance between the frames -		10	11
Product - - -		2397	4
Area of that part abaft frame 35 -		31	7
rudder and poſt - -		5	5
Sum - - - -		2434	4
			2
Area of the 2d water line from dead flat aft		4868	8

Third Water Line abaft Dead Flat.

The breadth at	frame dead flat is 22 feet 1½ inches—half	11	0¾
	frame (4) - - -	22	1½
	frame 3 - - -	22	1½
	frame 7 - - -	22	1½
	frame 11 - - -	22	1
	frame 15 - - -	21	5
	frame 19 - - -	20	8½
	frame 23 - - -	19	3½
	frame 27 - - -	16	5
	frame 31 - - -	11	2½
	frame 35 is 4 feet 3 inches—half	2	1½
		190	8¼
		10	11
		2081	8
Area of that part abaft frame 35 -		14	5½
rudder and poſt - -		5	6
		2101	7½
			2
Area of the 3d water line from dead flat aft		4203	3

Fourth Water Line abaft Dead Flat.

The breadth at	frame dead flat is 20 feet 1 inch—half	10	0½
	frame (4) - - -	20	1
	frame 3 - - -	20	1
	frame 7 - - -	19	11
	frame 11 - - -	19	7½
	frame 15 - - -	19	0
Carry over - -		108	9

Brought

Load-water Line and Ship's Capacity.

		Ft.	In.
	Brought over	108	9
Breadth at	frame 19	17	7½
	frame 23	14	10
	frame 27	10	11
	frame 31	5	11
	frame 35 is 1 foot 11½ inches—half	0	11½
		159	0
		10	11
		1735	9
	Area of that part abaft frame 35	9	9
	rudder and poſt	5	0
		1750	6
			2
	Area of the 4th water line from dead flat aft	3501	0

Fifth or Lower Water Line abaft Dead Flat.

The breadth at	frame dead flat is 17 feet 2 inches—half	8	7
	frame (4)	17	2
	frame 3	17	2
	frame 7	17	1
	frame 11	16	4
	frame 15	15	4
	frame 19	13	1
	frame 23	8	9
	frame 27	4	10
	frame 31	2	11
	frame 35 is 1 foot 2½ inches—half	0	7¼
		121	10¼
		10	11
		1330	2
	Area of that part abaft frame 35	4	8½
	rudder and poſt	4	6½
		1339	5
			2

Area of the 5th or lower water line from dead flat aft			2678	10
Half the area of the load water line			2666	2½
Area of the ſecond water line			4868	8
Area of the third water line			4203	3
Area of the fourth water line			3501	0
Half the area of the lower water line			1339	5
Sum			16578	6½
Diſtance between the water lines			4	1
Content in cubic feet between the lower and load-water lines			67695	8½
Area of the lower water line	2678	10		
Area of the upper ſide of the keel	206	4		
Sum	2885	2		
Half	1442	7		
Diſtance between the lower water line and the keel	4	1		
Cub. feet contained between lower water line and the keel	5890	6½	5890	6½
Content of the keel, lower part of rudder, and falſe keel			464	3
Cubic feet abaft the midſhip frame under water when loaded			74050	6

Upper or Load Water Line afore Dead Flat.

Load-water Line and Ship's Capacity.

		Ft.	In.
The breadth at	frame dead flat is 24 feet 10 inches—half	12	5
	frame E	24	10
	frame I	24	8½
	frame N	24	0
	frame Q	21	10½
	frame W is 15 feet 1 inch—half	7	6½
	Sum	115	4½
	Diſtance between the frames	10	11
	Product	1259	6
	Area of the part afore frame W	80	3
	ſtem and knee	4	0
	Sum	1343	9
	Multiply by		2
	Area of the load water line from dead flat forward	2687	6

Second Water Line afore Dead Flat.

The breadth at	frame dead flat is 23 feet 10½ inches—half	11	11¼
	frame E	23	10
	frame I	23	5
	frame N	22	5
	frame Q	19	11
	frame W is 11 feet 11 inches—half	5	11½
	Sum	107	5¾
	Diſtance between the frames	10	11
	Product	1173	9
	Area of the part afore frame W, with the ſtem and knee	43	9
	Sum	1217	6
			2
	Area of the ſecond water line from dead flat forward	2435	0

Third Water Line afore Dead Flat.

The breadth at	frame dead flat is 22 feet 1½ inch—half	11	0¾
	frame E	22	1
	frame I	21	8
	frame N	20	1
	frame Q	16	1½
	frame W is 7 feet—half	3	6
	Sum	94	6¼
	Diſtance between the frames	10	11
	Product	1031	10
	Area of the part afore W, with the ſtem and gripe	25	10
	Sum	1057	8
			2
	Area of the third water line from dead flat forward	2115	4

Load water Line and Ship's Capacity.

Fourth Water Line afore Dead Flat.

		Ft.	In.
The breadth at	frame dead flat is 20 feet 1 inch—half	10	0½
	frame E - - -	20	0½
	frame I - - -	19	3
	frame N - - -	16	5
	frame Q - - -	11	2
	frame W is 2 feet nine inches—half	1	4½
Sum - - - -		78	3½
Diſtance between the frames - -		10	11
Product - - -		854	8
Area of part before W, with the ſtem and gripe - - - - - -		8	10¾
Sum - - - -		863	6¾
			2
Area of fourth water line from dead flat forward - - -		1727	1½

Fifth Water Line afore Dead Flat.

		Ft.	In.
Breadth at	frame dead flat is 17 feet 2 inches—half	8	7
	frame E - - -	16	9
	frame I - - -	14	10
	frame N - - -	10	9½
	frame Q is 5 feet—half - -	2	6
Sum - - - -		53	5½
Diſtance between the frame - -		10	11
Product - - -		583	7
Area of part afore Q - -		26	$2\frac{2}{1}$
ſtem and knee - -		5	11
Sum - - - -		615	9
			2
Area of the fifth or lower water line from dead flat forward - -		1231	6
Area of the upper ſide of the keel -		87	4
Sum - - - - -		1318	10
Half - - - - -		659	5
Diſtance between the lower water line and keel - - - -		4	1
Content of the part contained between the lower water line and the keel in cub. feet		2692	7¼
Half of the area of the load water line		1343	9
Area of the ſecond water line -		2435	0
third water line -		2115	4
fourth water line -		1727	1½
Half the area of the fifth or lower water line		615	9
Sum - - - -		8236	11½
Diſtance between the water lines -		4	1

Tonnage of a Ship.

	Ft.	In.
Cubic feet contained between the lower and load water lines - - -	33634	2¾
Cubic feet contained between lower water line and keel - - - -	2692	7½
Content of the keel and falſe keel -	196	6
Content afore midſhip frame under water when loaded - -	36523	4
Content abaft midſhip frame -	74050	6
Content under water - -	110573	10
Weight of a cubic foot of ſalt water		74lbs.
Weight of the whole ſhip with every thing on board - - -	8182463.8lbs.	

As the weight of the ſhip, with every thing on board, found by this calculation, is equal to that found by eſtimate; it hence appears that the water line is properly placed in the draught. It now only remains to find whether the body is conſtructed ſuitably thereto, that is, whether the ſhip will be in her natural poſition when brought down to that line. For this purpoſe a perpendicular muſt be erected 27 feet ¼ inch. abaft dead flat, which will be the middle between the two perpendiculars and the place where the centre of gravity ſhould fall, that the ſhip may ſwim on an even keel. The ſolidity of that part of the bottom contained between the ſaid perpendicular and dead flat is then to be calculated, which will be found to be 25846 feet 7 inches.

Solidity of the bottom afore dead flat	36523 f.	4 in.
——— between the middle and dead flat	25846	7
Solid content of the fore part of the bottom - - -	62369	11
Solidity of the bottom abaft dead flat	74050	6
——— between the middle and dead flat	25846	7
Solid content of the aft. part of the bot.	48203	11
——————— fore part of the bottom	62369	11
Difference - - -	14166	
Half - - -	7083	

Hence the after part of the ſhip's bottom is too lean by 7083 cubic feet, and the fore part as much too full. The after part muſt therefore be filled out until it has received an addition of 7083 feet, and the fore part muſt be drawn in till it has loſt the ſame quantity, and the bottom will then be conſtructed ſuitable to the ſhip's ſwimming on an even keel.

CHAP. IX. *Of the Tonnage of a Ship.*

55 Proper method of calculating the tonnage of a ſhip.

THIS is a queſtion of equal importance and difficulty. By the tonnage of a ſhip is meant the weight of every thing that can with ſafety and expediency be taken on board that ſhip for the purpoſe of conveyance; it is alſo called the *ſhip's burthen*; and it is totally different from the weight of the whole as ſhe floats in the water. It is perhaps beſt expreſſed by calling it the *weight of the cargo*. It is of importance, becauſe it is by this that the merchant or freighter judges of the fitneſs of of the ſhip for his purpoſe. By this government judge of the ſhips requiſite for tranſport ſervice, and by this are all revenue charges on the ſhip computed. It is no leſs difficult to anſwer this queſtion by any general rule which ſhall be very exact, becauſe it depends not only on the cubical dimenſions of the ſhip's bottom, but alſo on the ſcantling of her whole frame, and in ſhort on the weight of every thing which properly makes part of a ſhip ready to receive on board her cargo. The weight of timber is variable; the ſcantling of the frame is no leſs ſo. We muſt therefore be contented with an average value which is not very remote from the truth; and this average is to be obtained, not by any mathematical diſcuſſion, but by obſervation of the burthen or cargo actually received, in a great variety of caſes. But ſome ſort of rule of calculation muſt be made out. This is and muſt be done by perſons not mathematicians. We may therefore expect to find it incapable of being reduced to any principle, and that every builder will have a different rule. Accordingly the rules given for this purpoſe are in general very whimſical, meaſures being uſed and combined in a way that ſeems quite unconnected with ſtereometry or the meaſurement of ſolids. The rules for calculation are even affected by the intereſts of the two parties oppoſitely concerned in the reſult. The calculation for the tonnage by which the cuſtoms are to be exacted by government are quite different from the rule by which the tonnage of a tranſport hired by government is computed; and the ſame ſhip hired as a tranſport will be computed near one half bigger than when paying importation duties.

Yet the whole of this might be made a very ſimple buſineſs and very exact. When the ſhip is launched, let her light water line be marked, and this with the cubical contents of the immerſed part be noted down, and be ingroſſed in the deed by which the property of the ſhip is conveyed from hand to hand. The weight of her maſts, ſails, rigging, and ſea-ſtores, is moſt eaſily obtained; and every builder can compute the cubical contents of the body when immerſed to the load water line. The difference of theſe is unqueſtionably the burthen of the ſhip.

It is evident from what has been already ſaid in the laſt chapter, that if the number of cubic feet of water which the ſhip diſplaces when light, or, which is the ſame, the number of cubic feet below the light water line, found by the preceding method of calculation, be ſubtracted from the number of cubic feet contained in the bottom below the load water line, and the remainder reduced to tons by multiplying by 74, the number of pounds in a cubic foot of ſea water, and divided by 2240, the number of pounds in a ton, the quotient will be the tonnage.

But as this method is very troubleſome, the following rule for this purpoſe is that which is uſed in the king's and merchants ſervice.

56
Common rule.

Let fall a perpendicular from the foreſide of the ſtem at the height of the hawſe holes (H), and another perpendicular from the back of the main poſt at the height of the wing tranſom. From the length between theſe two perpendiculars deduct three-fifths of the extreme breadth (I), and alſo as many times 2½ inches as there are feet in the height of the wing tranſom above the upper edge of the keel; the remainder is the length of the keel for tonnage. Now multiply this length by the extreme breadth, and the product by half the extreme breadth, and this laſt product divided by 94 is the tonnage required.

Or, multiply the length of the keel for tonnage by the ſquare of the extreme breadth, and the product divided by 188 will give the tonnage.

Calculation of the Tonnage of an Eighty Gun Ship.

57
Calculation of the tonnage of the eighty gun ſhip.

I. According to the true method.

	Tons.	lbs
The weight of the ſhip at her launching draught of water - -	1593	406
The weight of the furniture -	195	720
The weight of the ſhip at her light water mark - - -	1788	1126
The weight of the ſhip at the load water mark - - -	3652	1983
Real burthen - -	1864	857

II. By the common rule.

			Ft.	Inch.
Length from the foreſide of the ſtem at the height of the hawſe holes, to the aft ſide of the main poſt, at the height of the wing tranſom -			185	10
Three-fifths of the extreme breadth is - -	29 f.	9½ in.		
Height of the wing tranſom is 28 f. 4 in. which multiplied by 2½ inches is	6	8½		
Sum -	36	6	36	6
Length of the keel for tonnage -			149	4
Extreme breadth - -			49	8
Product - - -			7416	10½
Half the extreme breadth -			24	10
			94)184185	8¾
Burthen according to the common rule - -			1959	929
Real burthen - -			1864	857
Difference - -			95	72

58
The common rule gives the tonnage of ſhips of war greater, and of merchant ſhips leſs, than the truth.

Hence an eighty gun ſhip will not carry the tonnage ſhe is rated at by about 95 tons. As the body of this ſhip is fuller than in ſhips of war in general, there is therefore a nearer agreement between the tonnages found by the two different methods. It may be obſerved that ſhips of war carry leſs tonnage than they are rated at by the common rule, and that moſt merchant ſhips carry

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(H) In the merchant ſervice this perpendicular is let fall from the fore ſide of the ſtem at the height of the wing tranſom, by reaſon of the hawſe-holes being generally ſo very high in merchant ſhips, and their ſtems alſo having a great rake forward.

(I) The breadth underſtood in this place is the breadth from outſide to outſide of the plank.

a great deal more. In confirmation of this, it is thought proper to ſubjoin the dimenſions of ſeveral ſhips, with the tonnage calculated therefrom.

1. *Audacious of ſeventy-four guns.*

Length on the gun deck		168 f.	0 in.
Length of the keel for tonnage		138	0
Extreme breadth		46	9
Depth of the hold		19	9
Launching draught of water	afore	12	0
	abaft	17	4
Load draught of water	afore	20	6
	abaft	21	6
The weight of the ſhip at her launching draught of water		1509 t.	678lbs.
The weight of the furniture		120	1500
Weight of the ſhip at her light water mark		1629	2178
Weight of the ſhip at her load water mark		2776	498
Real burthen		1146	560

By the common rule.

Length of the keel for tonnage	138 f.	0 in.
Extreme breadth	46	9
Product	6451	6
Half the extreme breadth	23	4½
	94)150803	
Tonnage according to the common rule	1604	643
Real burthen	1146	560
Difference	458	83

2. *An Eaſt Indiaman.*

Length between the perpendiculars forward and aft		132 f.	8 in.
Length of the keel for tonnage		105	0
Extreme breadth		38	0
Depth in hold		16	0
Launching draught of water	afore	7	10
	abaft	11	10
Load draught of water	afore	19	8
	abaft	20	8
The weight of the ſhip at her launching draught of water		602 t.	2116lbs.
The weight of the furniture		50	124
Weight of the ſhip at her light water mark		653	
Weight of the ſhip at her load water mark		1637	1670
Real burthen		984	1670

By the common rule.

Keel for tonnage	105 f.	
Extreme breadth	38	
Product	3999	
Half extreme breadth	19	
	94)75810	
Tonnage	806	1096
Real tonnage	984	1670
Difference	178	574

3. *A Cutter.*

Length of the keel for tonnage		58 f.	0 in.
Extreme breadth		29	0
Lauching draught of water	afore	5	10
	abaft	9	8
Load draught of water	afore	9	0
	abaft	12	0
The weight of the cutter at her launching		147 t.	640lbs.
Weight of the furniture		9	199
Weight of the cutter at her light water mark		156	839
Weight of the cutter at her load water mark		266	1970
Real burthen		110	1131

By the common rule.

Keel for tonnage	58 f.	
Extreme breadth	29	
Product	1682	
Half extreme breadth	14½	
	94)24389	
Tonnage by the common rule	259	1024
Real tonnage	110	1131
Difference	148	2133

The impropriety of the common rule is hence manifeſt, as there can be no dependence on it for aſcertaining the tonnage of veſſels.

We ſhall now ſubjoin the following experimental method of finding the tonnage of a ſhip.

59 Experimental method of determining the tonnage of veſſels.

Conſtruct a model agreeable to the draught of the propoſed ſhip, to a ſcale of about one-fourth of an inch to a foot, and let the light and load water lines be marked on it. Then put the model in water, and load it until the ſurface of the water is exactly at the light water line; and let it be ſuſpended until the water drains off, and then weighed. Now ſince the weights of ſimilar bodies are in the triplicate ratio of their homologous dimenſions, the weight of the ſhip when light is, therefore, equal to the product of the cube of the number of times the ſhip exceeds the model by the weight of the model, which is to be reduced to tons. Hence, if the model is conſtructed to a quarter of an inch ſcale, and its weight expreſſed in ounces; then to the conſtant logarithm 0.4893556, add the logarithm of the weight of the model in ounces, and the ſum will be the logarithm of the weight of the ſhip in tons.

Again, the model is to be loaded until the ſurface of the water coincides with the load water line. Now the model being weighed, the weight of the ſhip is to be found by the preceding rule: then the difference between the weights of the ſhip when light and loaded is the tonnage required.

nnage of
a Ship.

It will alſo be worth while to add the following exact rule of Mr Parkins, who was many years foreman of the ſhipwrights in Chatham dockyard.

1. *For Men of War.*

Take the length of the gun-deck from the rabbet of the ſtem to the rabbet of the ſtern poſt. $\frac{23}{24}$ of this is to be aſſumed as the *length for tonnage*, = L.

Take the extreme breadth from outſide to outſide of the plank; add this to the length, and take $\frac{1}{23}$ of the ſum; call this the *depth for tonnage*, = D.

Set up this height from the limber ſtrake, and at that height take a breadth alſo from outſide to outſide of plank in the timber when the extreme breadth is found, and another breadth in the middle between that and the limber ſtrake; add together the extreme breadth and theſe two breadths, and take $\frac{1}{3}$ of the ſum for the breadth for tonnage, = D.

Multiply L, D, and B together, and divide by 49. The quotient is the burthen in tons.

The following proof may be given of the accuracy of this rule. Column 1. is the tonnage or burthen by the king's meaſurement; col. 2. is the tonnage by this rule; and, col. 3. is the weight actually received on board theſe ſhips at Blackſtakes:

Victory	100 guns.	2162	1839	1840
London	90	1845	1575	1677
Arrogant	74	1614	1308	1314
Diadem	64	1369	1141	965
Adamant	50	1044	870	886
Dolphin	44	879	737	758
Amphion	32	667	554	549
Daphne	20	429	329	374

2. *For Ships of Burthen.*

Take the length of the lower deck from the rabbet of the ſtem to the rabbet of the ſtern-poſt; then $\frac{31}{32}$ of this is the length for tonnage, = L.

Add the length of the lower deck to the extreme breadth from outſide to outſide of plank; and take $\frac{3}{35}$ of the ſum for the depth for tonnage, = D..

Set up that depth from the limber ſtrake, and at this height take a breadth from outſide to outſide. Take another at $\frac{2}{3}$ of this height, and another at $\frac{1}{3}$ of the height. Add the extreme breadth and theſe three breadths, and take the 4th of the ſum for the breadth for tonnage, = B.

Multiply L, D, and B, and divide by $36\frac{2}{3}$. The quotient is the burthen in tons.

This rule reſts on the authority of many ſuch trials, as the following:

	King's Meaſm.	Rule.	Actually recd. on bd.
Northington Indiaman	676	1053	1064
Granby Indiaman	786	1179	1179
Union coallier	193	266	289
Another coallier	182	254	277

CHAP. X. *Of the Scale of Solidity.*

Scale of
Solidity.

BY this ſcale the quantity of water diſplaced by the bottom of the ſhip, for which it is conſtructed, anſwering to a given draught of water, is eaſily obtained; and alſo the additional weight neceſſary to bring her down to the load water line.

In order to conſtruct this ſcale for a given ſhip, it is neceſſary to calculate the quantity of water diſplaced by the keel, and by that part of the bottom below each water line in the draught. Since the areas of the ſeveral water lines are already computed for the eighty-gun ſhip laid down in Plates CCCCXC. and CCCCXCI. the contents of theſe parts may hence be eaſily found for that ſhip, and are as follow.

Draught of Water.			*Water diſplaced in*		
			Cubic feet.	*tons.*	*lbs.*
Keel and falſe keel	2 f.	3 in.	660.9	21	1855
Diſt. bet. keel and 5th w. line	4	1	8583.1$\frac{3}{4}$	283	1233
Sum	6	4	9243.10$\frac{3}{4}$	305	848
Diſt. 5th and 4th w. line	4	1	18657.8$\frac{11}{48}$	616	828
Sum	10	5	27901.7$\frac{47}{48}$	921	1676
Diſt. 4th and 3d w. line	4	1	23574.6$\frac{17}{48}$	778	1795
Sum	14	6	51476.2$\frac{1}{4}$	1700	1231
Diſt. 3d and 2d w. line	4	1	27812.1$\frac{3}{24}$	918	1775
Sum	18	7	79288.3$\frac{21}{24}$	2619	766
Diſt. 2d and 1ſt w. line	4	1	31285.7$\frac{19}{24}$	1033	1218
Sum	22	8	110573.11$\frac{1}{4}$	3652	1984

Conſtruct any convenient ſcale of equal parts to repreſent tons, as ſcale N° 1. and another to repreſent feet as N° 2.

Plate
CCCCXCII.
60
Conſtruction of the ſcale of ſolidity for the ſhip of eighty guns.

Draw the line AB (fig. 36.) limited at A, but produced indefinitely towards B. Make AC equal to the depth of the keel, 2 feet 3 inches from ſcale N° 2. and through C draw a line parallel to AB, which will repreſent the upper edge of the keel; upon which ſet off C *c* equal to 21 tons 1855 lbs. taken from ſcale N° 1. Again, make AD equal to the diſtance between the lower edge of the keel and the fifth water line, namely, 6 feet 4 inches, and a line drawn through D parallel to AB will be the repreſentation of the lower water line; and make D *b* equal to 305 tons 848 lbs. the correſponding tonnage. In like manner draw the other water lines, and lay off the correſponding tonnages accordingly: then through the points A, *c*, *b*, *e*, *f*, *g*, *h*, draw the curve A*c b e f g h*. Through *h* draw *h* B perpendicular to AB, and it will be the greateſt limit of the quantity of water expreſſed in tons diſplaced by the bottom of the ſhip, or that when ſhe is brought down to the load water line. And ſince the ſhip diſplaces 1788 tons at her light water-mark, take therefore that quantity from the ſcale N° 1. which being laid upon AB from A to K, and KL drawn perpendicular to AB, will be the repreſentation of the light water

water line for tonnage. Hence the ſcale will be completed.

61 Uſe of the above ſcale.

Let it now be required to find the number of cubic feet diſplaced when the draught of water is 17 feet, and the number of additional tons neceſſary to bring her down to the load water mark.

Take the given draught of water 17 feet from the ſcale N° 2, which laid from it will reach to I; through which draw the lime IMN parallel to AB, and interſecting the curve in AC; then the diſtance IM applied to the ſcale N° 1, will meaſure about 2248 tons, the diſplacement anſwerable to that draught of water; and MN applied to the ſame ſcale will meaſure about 1405 tons, the additional weight neceſſary to bring her down to the load water mark. Alſo the neareſt diſtance between M and the line KL will meaſure about 460 tons, the weight already on board.

It will conduce very much to facilitate this operation to divide KB into a ſcale of tons taken from the ſcale N° 1, beginning at B, and alſo *h* L, beginning at *h*. Then when the draught of water is taken from the ſcale N° 2, and laid from it to I, as in the former example, and IMN drawn parallel to AB, and interſecting the curve in M. Now through M draw a line perpendicular to AB, and it will meet KB in a point repreſenting the number of tons aboard, and alſo *h* L in a point denoting the additional weight neceſſary to load her.

Again, if the weight on board be given, the correſponding draught of water is obtained as follows.

Find the given number of tons in the ſeale KB, through which draw a line perpendicular to AB; then through the point of interſection of this line with the curve draw another line parallel to AB. Now the diſtance between A and the point where the parallel interſected AH being applied to the ſcale N° 2, will give the draught of water required.

Any other caſe to which this ſcale may be applied will be obvious.

BOOK II. *Containing the Properties of Ships*, &c.

CHAP. I. *Of the Equilibrium of Ships.*

SINCE the preſſure of fluids is equal in every direction, the bottom of a ſhip is therefore acted upon by the fluid in which it is immerſed; which preſſure, for any given portion of ſurface, is equal to the product of that portion by the depth and denſity of the fluid: or it is equal to the weight of a column of the fluid whoſe baſe is the given ſurface, and the altitude equal to the diſtance between the ſurface of the fluid and the centre of gravity of the ſurface preſſed. Hence a floating body is in equilibrio between two forces, namely, its gravity and the vertical preſſure of the fluid; the horizontal preſſure being deſtroyed.

Plate CCCCXCIV.

Let ABC (fig. 49.) be any body immerſed in a fluid whoſe line of floatation is GH: hence the preſſure of the fluid is exerted on every portion of the ſurface of the immerſed part AFCH. Let EF, CD be any two ſmall portions contained between the lines ED, FC, parallel to each other, and to the line of floatation GH: then the preſſure exerted upon EF is expreſſed by $EF \times IK$, IK being the depth of EF or CD; the denſity of the fluid being ſuppoſed equal to 1. In like manner the preſſure upon CD is equal to $CD \times IK$. Now ſince the preſſure is in a direction perpendicular to the ſurface, draw therefore the line EL perpendicular to EF, and DM perpendicular to DC, and make each equal to the depth IK, below the ſurface. Now the effort or preſſure of the fluid upon EF will be expreſſed by $EF \times EL$, and that upon CD by $CD \times DM$. Complete the parallelograms ON, QS, and the preſſure in the direction EL is reſolved into EN, EO, the firſt in a horizontal, and the ſecond in a vertical direction. In like manner, the preſſure in the direction DM is reſolved into the preſſures DS, DQ. Hence the joint effect of the preſſures in the horizontal and vertical directions, namely, $EF \times EN$, and $EF \times EO$, will be equal to $EF \times EL$: For the ſame reaſon, $CD \times DP + CD \times DQ = CD \times DM$. But the parts of the preſſures in a horizontal direction $EF \times EN$, and $CD \times DP$, are equal. For, becauſe of the ſimilar triangles ENL, ERF, and DPM, DSC, we have $\frac{EL}{EN}=\frac{EF}{FR}$ and $\frac{DM}{DP}=\frac{DC}{CS}$: Hence $DM \times CS = DP \times DC$, and $EL \times FR = EN \times EF$. Now ſince $EL = DM$, and $FR = CS$, therefore $EL \times FR = DM \times CS = DP \times DC = EN \times EF$. Hence ſince $EF \times EN = DP \times CD$, the effects of the preſſures in a horizontal direction are therefore equal and contrary, and conſequently deſtroy each other.

The preſſure in a vertical direction is repreſented by $EO \times EF$, $DQ \times DC$, &c. which, becauſe of the ſimilar triangles EOL, ERF, and DLM, DSC, become $EL \times ER$, $DM \times DS$, &c. or $IK \times ER$, $IK \times DS$, &c. By applying the ſame reaſoning to every other portion of the ſurface of the immerſed part of the body, it is hence evident that the ſum of the vertical preſſures is equal to the ſum of the correſponding diſplaced columns of the fluid.

62 The weight of a ſhip equal to that of the quantity of water diſplaced.

Hence a floating body is preſſed upwards by a force equal to the weight of the quantity of water diſplaced; and ſince there is an equilibrium between this force and the weight of the body, therefore the weight of a floating body is equal to the weight of the diſplaced fluid (K). Hence alſo the centre of gravity of the body and the centre of gravity of the diſplaced fluid are in the ſame vertical, otherwiſe the body would not be at reſt.

63 And the centre of gravity of both are in the ſame vertical.

CHAP. II. *Upon the Efforts of the Water to bend a Veſſel.*

Theorie complette, &c. *par Euler*, tranſlated by Watſon.

WHEN it is ſaid that the preſſure of the water upon the immerſed part of a veſſel counterbalances its weight, it is ſuppoſed that the different parts of the veſſel are ſo cloſely connected together, that the forces which act upon its ſurface are not capable of producing any change. For we may eaſily conceive, if the connection of the parts were not ſufficiently ſtrong, the veſſel would run the riſk either of being broken in pieces, or of ſuffering ſome alteration in its figure.

The veſſel is in a ſituation ſimilar to that of a rod AB

(K) Upon this principle the weight and tonnage of the 80 gun ſhip laid down were calculated.

ſforts of
e Water
o bend a
Veſſel.

AB (fig. 50.), which being acted upon by the forces A a, C c, D d, B b, may be maintained in equilibrio, provided it has a ſufficient degree of ſtiffneſs: but as ſoon as it begins to give way, it is evident it muſt bend in a convex manner, ſince its middle would obey the forces C c and D d, while its extremities would be actually drawn downwards by the forces A a and B b.

The veſſel is generally found in ſuch a ſituation; and ſince ſimilar efforts continually act whilſt the veſſel is immerſed in the water, it happens but too often that the keel experiences the bad effect of a ſtrain. It is therefore very important to inquire into the true cauſe of this accident.

Plate
cccxcv.
fig. 51.

For this purpoſe, let us conceive the veſſel to be divided into two parts by a tranſverſe ſection through the vertical axis of the veſſel, in which both the centre of gravity G (fig. 51.) of the whole veſſel and that of the immerſed part are ſituated: ſo that one of them will repreſent the head part, and the other that of the ſtern, each of which will be conſidered ſeparately. Let g be the centre of gravity of the entire weight of the firſt, and o that of the immerſed part correſponding. In like manner, let γ be the centre of gravity of the whole after part, and w that of its immediate portion.

64
e cauſe
a ſhip's
gging,
65
d ſag-
g.

Now it is plain, that the head will be acted upon by the two forces $g\,m$ and $o\,n$, of which the firſt will preſs it down, and the latter puſh it up. In the ſame manner, the ſtern will be preſſed down by the force $\gamma\,\mu$, and puſhed by the force $\omega\,\nu$. But theſe four forces will maintain themſelves in equilibrium, as well as the total forces reunited in the points G and O, which are equivalent to them; but whilſt neither the forces before nor thoſe behind fall in the ſame direction, the veſſel will evidently ſuſtain efforts tending to bend the keel upwards, if the two points $o\,\omega$ are nearer the middle than the two other forces $g\,m$ and $\gamma\,\mu$. A contrary effect would happen if the points o and ω were more diſtant from the middle than the points g and γ.

But the firſt of theſe two cauſes uſually takes place almoſt in all veſſels, ſince they have a greater breadth towards the middle, and become more and more narrow towards the extremities; whilſt the weight of the veſſel is in proportion much more conſiderable towards the extremities than at the middle. From whence we ſee, that the greater this difference becomes, the more alſo will the veſſel be ſubject to the forces which tend to bend its keel upwards. It is therefore from thence that we muſt judge how much ſtrength it is neceſſary to give to this part of the veſſel, in order to avoid ſuch a conſequence.

If other circumſtances would permit either to load the veſſel more in the middle, or to give to the part immerſed a greater capacity towards the head and ſtern, ſuch an effect would no longer be apprehended. But the deſtination of moſt veſſels is entirely oppoſite to ſuch an arrangement: by which means we are obliged to ſtrengthen the kneel as much as may be neceſſary, in order to avoid ſuch a diſaſter.

We ſhall conclude this chapter with the following practical obſervations on the hogging and ſagging of ſhips by Mr Hutchinſon of Liverpool:

ctical
man-
, p. 13.

"When ſhips with long floors happen to be laid adry upon mud or ſand, which makes a ſolid reſiſtance againſt the long ſtraight floors amidſhips, in compariſon with the two ſharp ends, the entrance and run meet with little ſupport, but are preſſed down lower than the flat of the floor, and in proportion hogs the ſhip amidſhips; which is too well known from experience to occaſion many total loſſes, or do ſo much damage by hogging them, as to require a vaſt deal of trouble and expence to ſave and repair them, ſo as to get the hog taken out and brought to their proper ſheer again: and to do this the more effectually, the owners have often been induced to go to the expence of lengthening them; and by the common method, in proportion as they add to the burden of theſe ſhips, by lengthening their too long ſtraight floors in their main bodies amidſhips, ſo much do they add to their general weakneſs to bear hardſhips either on the ground or afloat; for the ſcantling of their old timber and plank is not proportionable to bear the additional burden that is added to them.

Efforts of
the Water
to bend a
Veſſel.

"But defects of this kind are beſt proved from real and inconteſtable facts in common practice. At the very time I was writing upon this ſubject, I was called upon for my advice by the commander of one of thoſe ſtrong, long, ſtraight floored ſhips, who was in much trouble and diſtraction of mind for the damage his ſhip had taken by the pilot laying her on a hard, gentle ſloping ſand, at the outſide of our docks at Liverpool, where it is common for ſhips that will take the ground to lie for a tide, when it proves too late to get into our wet docks. After recommending a proper ſhip carpenter, I went to the ſhip, which lay with only a ſmall keel, yet was greatly hogged, and the butts of her upper works ſtrained greatly on the lee ſide; and the ſeams of her bottom, at the lower futtock heads, vaſtly opened on the weather ſide: all which ſtrained parts were agreed upon not to be caulked, but filled with tallow, putty, or clay, &c. with raw bullocks hides, or canvas, nailed with battons on her bottom, which prevented her ſinking with the flow of the tide, without hindering the preſſure of water from righting and cloſing the ſeams again as ſhe floated, ſo as to enable them to keep her free with pumping. This veſſel, like many other inſtances of ſhips of this conſtruction that I have known, was ſaved and repaired at a very great expence in our dry repairing docks. And that their bottoms not only hog upwards, but ſag (or curve) downwards, to dangerous and fatal degrees, according to the ſtrain or preſſure that prevails upon them, will be proved from the following facts:

"It has been long known from experience, that when ſhips load deep with very heavy cargoes or materials that are ſtowed too low, it makes them ſo very labourſome at ſea, when the waves run high, as to roll away their maſts; and after that misfortune cauſes them to labour and roll the more, ſo as to endanger their working and ſtraining themſelves to pieces: to prevent which, it has been long a common practice to leave a great part of their fore and after holds empty, and to ſtow them as high as poſſible in the main body at midſhips, which cauſes the bottoms of theſe long ſtraight-floored ſhips to ſag downwards, in proportion as the weight of the cargo ſtowed there exceeds the preſſure of the water upwards, ſo much as to make them dangerouſly and fatally leaky.

"I have known many inſtances of thoſe ſtrong ſhips of 500 or 600 tons burdens built with long ſtraight floors, on the eaſt coaſt of England, for the coal and timber trade, come loaded with timber from the Baltic to

Efforts of the Water to bend a Veſſel.

to Liverpool, where they commonly load deep with rock ſalt, which is too heavy to fill their holds, ſo that for the above reaſons they ſtowed it high amidſhips, and left large empty ſpaces in their fore and after holds, which cauſed their long ſtraight floors to ſag downwards, ſo much as to make their hold ſtaunchions amidſhips, at the main hatchway, ſettle from the beams three or four inches, and their mainmaſts ſettle ſo much as to oblige them to ſet up the main rigging when rolling hard at ſea, to prevent the maſts being rolled away; and they were rendered ſo leaky as to be obliged to return to Liverpool to get their leaks ſtopped at great expence. And in order to ſave the time and expence in diſcharging them, endeavours were made to find out and ſtop their leaks, by laying them aſhore dry on a level ſand; but without effect: for though their bottoms were thus ſagged down by their cargoes when afloat, yet when they came a-dry upon the ſand, ſome of their bottoms hogged upwards ſo much as to raiſe their mainmaſts and pumps ſo high as to tear their coats from their decks; ſo that they have been obliged to diſcharge their cargoes, and give them a repair in the repairing dock, and in ſome to double their bottoms, to enable them to carry their cargoes with ſafety, ſtowed in this manner. From this cauſe I have known one of theſe ſtrong ſhips to founder.

"Among the many inſtances of ſhips that have been diſtreſſed by carrying cargoes of lead, one ſailed from hence bound to Marſeilles, which was ſoon obliged to put back again in great diſtreſs, having had four feet water in the hold, by the commander's account, owing to the ſhip's bottom ſagging down to ſuch a degree as made the hold ſtaunchions ſettle ſix inches from the lower deck beams amidſhips; yet it is common with theſe long ſtraight floored ſhips, when theſe heavy cargoes are diſcharged that make their bottoms ſag down, then to hog upwards: ſo that when they are put into a dry repairing dock, with empty holds, upon ſtraight blocks, they commonly either ſplit the blocks cloſe fore and aft, or damage their keels there, by the whole weight of the ſhip lying upon them, when none lies upon the blocks under the flat of their floors amidſhips, that being hogged upwards; which was the caſe of this ſhip's bottom; though ſagged downwards ſix inches by her cargo, it was now found hogged ſo much that her keel did not touch the blocks amidſhips, which occaſioned ſo much damage to the after part of the keel, as to oblige them to repair it; which is commonly the caſe with theſe ſhips, and therefore deſerving particular notice."

In order to prevent theſe defects in ſhips, "they ſhould all be built with their floors or bottoms lengthwiſe, to form an arch with the projecting part downwards, which will naturally not only contribute greatly to prevent their taking damage by their bottoms hogging and ſtraining upwards, either aground or afloat, as has been mentioned, but will, among other advantages, be a help to their ſailing, ſteering, ſtaying, and waring."

Chap. III. *Of the Stability of Ships.*

Stability of Ships.

When a veſſel receives an impulſe or preſſure in a horizontal direction, ſo as to be inclined in a ſmall degree, the veſſel will then either regain its former poſition as the preſſure is taken off, and is in this caſe ſaid to be poſſeſſed of ſtability; or it will continue in its inclined ſtate; or, laſtly, the inclination will increaſe until the veſſel is overturned. With regard to the firſt caſe, it is evident that a ſufficient degree of ſtability is neceſſary in order to ſuſtain the efforts of the wind; but neither of the other two caſes muſt be permitted to have place in veſſels.

Fig. 52.

Let CED (fig. 52.) be the ſection of a ſhip paſſing through its centre of gravity, and perpendicular to the ſheer and floor plans; which let be in equilibrium in a fluid; AB being the water line, G the centre of gravity of the whole body, and g that of the immerſed part AEB. Let the body receive now a very ſmall inclination, ſo that a E b becomes the immerſed part, and γ its centre of gravity. From γ draw γ M perpendicular to $a\,b$, and meeting g G, produced, if neceſſary, in M. If, then, the point M thus found is higher than G the centre of gravity of the whole body, the body will, in this caſe, return to its former poſition, the preſſure being taken off. If the point M coincides with G, the veſſel will remain in its inclined ſtate; but if M be below G, the inclination of the veſſel will continually increaſe until it is entirely overſet.

The point of interſection M is called the *metacenter*, and is the limit of the altitude of the centre of gravity of the whole veſſel. Whence it is evident, from what has already been ſaid, that the ſtability of the veſſel increaſes with the altitude of the metacenter above the centre of gravity: But when the metacenter coincides with the centre of gravity, the veſſel has no tendency whatever to move out of the ſituation into which it may be put. Thus, if the veſſel be inclined either to the right or left ſide, it will remain in that poſition until a new force is impreſſed upon it: in this caſe, therefore, the veſſel would not be able to carry ſail, and is hence unfit for the purpoſes of navigation. If the metacenter is below the common centre of gravity, the veſſel will inſtantly overſet.

As the determination of the metacenter is of the utmoſt importance in the conſtruction of ſhips, it is therefore thought neceſſary to illuſtrate this ſubject more particularly.

Let AEB (fig. 52.) be a ſection of a ſhip perpendicular to the keel, and alſo to the plane of elevation, and paſſing through the centre of gravity of the ſhip, and alſo through the centre of gravity of the immerſed part, which let be g.

Now let the ſhip be ſuppoſed to receive a very ſmall inclination, ſo that the line of floatation is a, b, and γ the centre of gravity of the immerſed part a E b. From γ draw γ M perpendicular to $a\,b$, and interſecting GM in M, the metacenter, as before. Hence the preſſure of the water will be in the direction γ M.

In order to determine the point M, the metacenter, the poſition of γ with reſpect to the lines AB and g G, muſt be previouſly aſcertained. For this purpoſe, let the ſhip be ſuppoſed to be divided into a great number of ſections by planes perpendicular to the keel, and parallel to each other, and to that formerly drawn, theſe planes being ſuppoſed equidiſtant. Let AEB (fig. 53.) be one of theſe ſections, g the centre of gravity of the immerſed part before inclination, and γ the centre of gravity of the immerſed part when the ſhip is in its inclined ſtate; the diſtance $g\,\gamma$ between the two centres of

Fig. 53.

tability of Ships.

of gravity in each ſection is to be found. Let AB be the line of floatation of the ſhip when in an upright ſtate, and ab the water line when inclined. Then, becauſe the weight of the ſhip remains the ſame, the quantity of water diſplaced will alſo be the ſame in both caſes, and therefore $AEB = aEb$, each ſuſtaining the ſame part of the whole weight of the ſhip. From each of theſe take the part AEb, which is common to both, and the remainders AOa, BOb will be equal; and which, becauſe the inclination is ſuppoſed very ſmall, may be conſidered as rectilineal triangles, and the point O the middle of AB.

Now, let H, I, K, be the centres of gravity of the ſpaces AOa, AEb, and BOb, reſpectively. From theſe points draw the lines Hh, Ii, and Kk, perpendicular to AB, and let IL be drawn perpendicular to EO. Now to aſcertain the diſtance γq of the centre of gravity γ of the part aEb from the line AB, the momentum of aEb with reſpect to this line muſt be put equal to the difference of the momentums of the parts AEb, AOa, which are upon different ſides of AB [*]. Hence $aEb \times \gamma q$, or $AEB \times \gamma q = AEb \times Ii - AOa \times Hh$. But ſince g is the common centre of gravity of the two parts AEb, BOb, we have therefore $AEB \times gO = AEb \times Ii + BOb \times Kk$. Hence by expunging the term $AEb \times Ii$ from each of theſe equations, and comparing them, we obtain $AEB \times \gamma q = AEB \times gO - BOb \times Kk - AOa \times Hh$.

[*] Bezout's Mecha- ique, art. 63.

Now, ſince the triangles AOa, BOb, are ſuppoſed infinitely ſmall, their momentums or products, by the infinitely little lines Hh, Kk, will alſo be infinitely ſmall with reſpect to $AEB \times gO$; which therefore being rejected, the former equation becomes $AB \times \gamma q = AEB \times gO$, and hence $\gamma q = gO$. Whence the centres of gravity γ, g, being at equal diſtances below AB, the infinitely little line γg is therefore perpendicular to EO. For the ſame reaſon $g\gamma$, fig. 52. may be conſidered as an arch of a circle whoſe centre is M.

To determine the value of $g\gamma$, the momentum of aEb with reſpect to EO muſt be taken, for the ſame reaſon as before, and put equal to the momentums of the two parts AOa, AEb; and we ſhall then have $aEb \times g\gamma$, or $AEB \times g\gamma = AEB \times IL + AOa \times Oh$. But ſince g is the common centre of gravity of the two ſpaces AEb, BOb, we ſhall have $AEb \times IL - BOb \times Ok = 0$, or $AEb \times IL = BOb \times Ok$. Hence $AEB \times g\gamma = BOb \times Ok + AOa \times Oh = 2BOb \times Ok$; becauſe the two triangles AOa, BOb are equal, and that the diſtances Ok, Oh, are alſo evidently equal.

Let x be the thickneſs of the ſection repreſented by ABC. Then the momentum of this ſection will be $2BOb \times x \times Ok$, which equation will alſo ſerve for each particular ſection.

Now let ſ repreſent the ſum of the momentums of all the ſections. Hence $\int, AEB \times x \times g\gamma = \int, 2BOb \times x \times Ok$. Now the firſt member being the ſum of the momentums of each ſection, in proportion to a plane paſſing through the keel, ought therefore to be equal to the ſum of all the ſections, or to the volume of the immerſed part of the bottom multiplied by the diſtance $g\gamma$. Hence V repreſenting the volume, we ſhall have $V \times g\gamma = \int, 2BOb \times x \times Ok$.

In order to determine the value of the ſecond member of this equation, it may be remarked, that when the ſhip is inclined, the original plane of floatation CBPQ (fig. 54.) becomes $CbpQ$. Now the triangles NIn, BOb, being the ſame as thoſe in figures 52. and 53.; and as each of theſe triangles has one angle equal, they may, upon account of their infinite ſmallneſs, be conſidered as ſimilar; and hence $BOb : NIn :: \overline{OB}|^2 : \overline{IN}|^2$; whence $BOb = \frac{\overline{OB}|^2}{\overline{IN}|^2} \times NIn$. Moreover, we have (fig. 53.) $Ok = \frac{2}{3}OB$, for the points K and k may be conſidered as equidiſtant from the point O: whence $BOb \times Ok = \frac{\overline{\frac{2}{3}OB}|}{\overline{IN}^2} \times NIn$.

Stability of Ships.

Fig. 54.

Hence $V \times g\gamma = \int, \frac{\overline{\frac{3}{4}OB}|^3}{\overline{IN}|^2} \times x \times NIn$. From this equation the value of $g\gamma$ is obtained.

Fig. 55.

To find the altitude gM (fig. 55.) of the metacenter above the centre of gravity of the immerſed part of the bottom, let the arc NS be deſcribed from the centre I with the radius IN; then $NIn = \frac{IN \times NS}{2}$. Now ſince the two ſtraight lines γM, gM are perpendicular to an and AN reſpectively, the angles M and NIn are therefore equal: and the infinitely little portion $g\gamma$, which is perpendicular to gM, may be conſidered as an arch deſcribed from the centre M. Hence the two ſectors NIS, $gM\gamma$ are ſimilar; and therefore $gM : g\gamma :: IN : NS$. Hence $NS = \frac{IN \times g\gamma}{gM}$; and conſequently $NIn = \frac{\overline{IN}|^2 \times g\gamma}{2gM}$. Now this being ſubſtituted in the former equation, and reduced, we have $V \times g\gamma = \int \frac{\frac{2}{3}\overline{OB}|^3 \times x \times g\gamma}{gM}$. But ſince gM and $g\gamma$ are the ſame, whatever ſection may be under conſideration, the equation may therefore be expreſſed thus, $V \times g\gamma = \frac{\frac{2}{3}g\gamma}{gM} \cdot \int, \overline{OB}|^3 \times x$. Hence $gM = \frac{\frac{2}{3}\int, \overline{OB}|^3 \times x}{V}$. Let $y = OB$, and the equation becomes $gM = \frac{\frac{2}{3}\int, y^3 x}{V}$. Whence to have the altitude of the metacenter above the centre of gravity of the immerſed part of the bottom, the length of the ſection at the water-line muſt be divided by lines perpendicular to the middle line of this ſection into a great number of equal parts, ſo that the portion of the curve contained between any two adjacent perpendiculars may be conſidered as a ſtraight line. Then the ſum of the cubes of the half perpendiculars or ordinates is to be multiplied by the diſtance between the perpendiculars, and two-thirds of the product is to be divided by the volume of the immerſed part of the bottom of the ſhip.

It is hence evident, that while the ſector at the water line is the ſame, and the volume of the immerſed part of the bottom remains alſo the ſame, the altitude of the metacenter will remain the ſame, whatever may be the figure of the bottom.

CHAP. IV. *Of the Centre of Gravity of the immerſed Part of the Bottom of a Ship.*

THE centre of gravity [*] of a ſhip, ſuppoſed homogeneous, and in an upright poſition in the water, is in a

[*] See Mechanics.

vertical ſection paſſing through the keel, and dividing the ſhip into two equal and ſimilar parts, at a certain diſtance from the ſtern, and altitude above the keel.

In order to determine the centre of gravity of the immerſed part of a ſhip's bottom, we muſt begin with determining the centre of gravity of a ſection of the ſhip parallel to the keel, as ANDFPB (fig. 56.), bounded by the parallel lines AB, DF, and by the equal and ſimilar curves AND, BPF.

Fig. 56.

66 Diſtance of the centre of gravity from the ſtem or ſtern.

If the equation of this curve were known, its centre of gravity would be eaſily found: but as this is not the caſe, let therefore the line CE be drawn through the middle C, E, of the lines AB, DF, and let this line CE be divided into ſo great a number of equal parts by the perpendiculars TH, KM, &c. that the arches of the curves contained between the extremities of any two adjacent perpendiculars may be conſidered as ſtraight lines. The momentums of the trapeziums DTHF, TKMH, &c. relative to the point E, are then to be found, and the ſum of theſe momentums is to be divided by the ſum of the trapeziums, that is, by the ſurface ANDFPB.

The diſtance of the centre of gravity of the trapezium THFD from the point E is $=\frac{\frac{1}{3}IE\times(DF+2TH)}{DF+TH}$*. For the ſame reaſon, and becauſe of the equality of the lines IE, IL, the diſtance of the centre of gravity of the trapezium TKMH from the ſame point E will be $\frac{\frac{1}{3}IE\times(TH+2KM)}{TH+KM}+IE$, or $=\frac{\frac{1}{3}IE\times(4TH+5KM)}{TH+KM}$. In like manner, the diſtance of the centre of gravity of the trapezium NKMP from the point E will be $\frac{\frac{1}{3}IE\times(KM+2NP)}{KM+NP}+2IE$, or $\frac{\frac{1}{3}IE\times(7KM+8NP)}{KM+NP}$ &c.

Now, if each diſtance be multiplied by the ſurface of the correſponding trapezium, that is, by the product of half the ſum of the two oppoſite ſides of the trapezium into the common altitude IE, we ſhall have the momentums of theſe trapeziums, namely, $\frac{1}{6}\overline{IE}|^2\times(DF+2TH)$, $\frac{1}{6}\overline{IE}|^2\times(4TH+5KM)$ $\frac{1}{6}\overline{IE}|^2\times(7KM+8NP)$, &c. Hence the ſum of theſe momentums will be $\frac{1}{6}\overline{IE}|^2\times(DF+6TH+12KM+18NP+24QS+14AB)$. Whence it may be remarked, that if the line CE be divided into a great number of equal parts, the factor or coefficient of the laſt term, which is here 14, will be $=2+3(n-2)$ or $3n-4$, *n* being the number of perpendiculars. Thus the general expreſſion of the ſum of the momentums is reduced to $\overline{IE}|^2\times(\frac{1}{6}DF+TH+2KM+3NP+4QS+$, &c. $-+\frac{3n-4}{6}\times AB$.

The area of the figure ANDFPB is equal to $IE\times(\frac{1}{2}DF+TH+KM+NP+$, &c..... $+\frac{1}{2}AB)$; hence the diſtance EG of the centre of gravity G from one of the extreme ordinates DF is equal to

67 Rule for the diſtance of the centre of gravity from one of the extreme ordinates.

$$\frac{IE\times(\frac{1}{6}DF+TH+2KM+3NP+,\&c.\frac{3n-4}{6}\times AB)}{\frac{1}{2}DF+TH+KM+NP+,\&c.+\frac{1}{2}AB}$$

Whence the following rule to find the diſtance of the centre of gravity G from one of the extreme ordinates DF. To the ſixth of the firſt ordinate add the ſixth of the laſt ordinate multiplied by three times the number of ordinates minus four; then the ſecond ordinate, twice the third, three times the fourth, &c. the ſum will be a firſt term. Then to half the ſum of the extreme ordinates add all the intermediate ones, and the ſum will be a ſecond term. Now the firſt term divided by the ſecond, and the quotient multiplied by the interval between two adjacent perpendiculars, will be the diſtance ſought.

Thus, let there be ſeven perpendiculars, whoſe values are 18, 23, 28, 30, 30, 21, 0, feet reſpectively, and the common interval between the perpendiculars 20 feet. Now the ſixth of the firſt term 18 is 3; and as the laſt term is 0, therefore to 3 add 23, twice 28 or 56, thrice 30 or 90, four times 30 or 120, five times 21 or 105; and the ſum is 397. Then to the half of 18+0, or 9, add the intermediate ordinates, and the ſum will be 141. Now $\frac{397\times 20}{141}$, or $\frac{7940}{141}$, $=59$ feet four inches nearly, the diſtance of the centre of gravity from the firſt ordinate.

Now, when the centre of gravity of any ſection is determined, it is eaſy from thence to find the centre of gravity of the ſolid, and conſequently that of the bottom of a ſhip.

68 Height of the centre of gravity above the keel.

Fig. 57, 58.

The next ſtep is to find the height of the centre of gravity of the bottom above the keel. For this purpoſe the bottom muſt be imagined to be divided into ſections by planes parallel to the keel or water-line, (figs. 57, 58.). Then the ſolidity of each portion contained between two parallel planes will be equal to half the ſum of the two oppoſed ſurfaces multiplied by the diſtance between them; and its centre of gravity will be at the ſame altitude as that of the trapezium *a b c d*, (fig. 58.), which is in the vertical ſection paſſing through the keel. It is hence obvious, that the ſame rule as before is to be applied to find the altitude of the centre of gravity, with this difference only, that the word perpendicular or ordinate is to be changed into ſection. Hence the rule is, to the ſixth part of the loweſt ſection add the product of the ſixth part of the uppermoſt ſection by three times the number of ſections minus four; the ſecond ſection in aſcending twice the third, three times the fourth, &c. the ſum will be a firſt term. To half the ſum of upper and lower ſections add the intermediate ones, the ſum will be a ſecond term. Divide the firſt term by the ſecond, and the quotient multiplied by the diſtance between the ſections will give the altitude of the centre of gravity above the keel.

With regard to the centre of gravity of a ſhip, whether it is conſidered as loaded or light, the operation becomes more difficult. The momentum of every different part of the ſhip and cargo muſt be found ſeparately with reſpect to a horizontal and alſo a vertical plane. Now the ſums of theſe two momentums being divided by the weight of the ſhip, will give the altitude of the centre of gravity, and its diſtance from the vertical plane; and as this centre is in a vertical plane paſſing through the axis of the keel, its place is therefore determined. In the calculation of the momentums, it muſt be obſerved to multiply the weight, and not the magnitude of each piece, by the diſtance of its centre of gravity.

A more eaſy method of finding the centre of gravity of

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* Bezout's *Mechanique*, art. 279.

69 A mechanical method for aſcertaining the centre of gravity of a ſhip.

of a ſhip is by a mechanical operation, as follows: Conſtruct a block of as light wood as poſſible, exactly ſimilar to the parts of the propoſed draught or ſhip, by a ſcale of about one-fourth of an inch to a foot. The block is then to be ſuſpended by a ſilk-thread or very fine line, placed in different ſituations until it is found to be in a ſtate of equilibrium, and the centre of gravity will be pointed out. The block may be proved by faſtening the line which ſuſpends it to any point in the line joining the middles of the ſtem and poſt, and weights are to be ſuſpended from the extremities of this middle line at the ſtem and poſt. If, then, the block be properly conſtructed, a plane paſſing through the line of ſuſpenſion, and the other two lines, will alſo paſs through the keel, ſtem, and poſt. Now, the block being ſuſpended in this manner from any point in the middle line, a line is to be drawn on the block parallel to the line of ſuſpenſion, ſo that the plane paſſing through theſe two lines may be perpendicular to the vertical plane of the ſhip in the direction of the keel. The line by which the block is ſuſpended is then to be removed to ſome other convenient point in the middle line; and another line is to be drawn on the block parallel to the line ſuſpending it, as before. Then the point of interſection of this line with the former will give the poſition of the centre of gravity on the block, which may now be laid down in the draught.

CHAP. V. *Application of the preceding Rules to the Determination of the Centre of Gravity and the Height of the Metacenter above the Centre of Gravity of a ſhip of 74 Guns.*

In fig. 59. are laid down the ſeveral ſections in a horizontal direction, by planes parallel to the keel, and at equal diſtances from each other, each diſtance being 10 feet 0 inches 4 parts. Fig. 59.

I. *Determination of the Centre of Gravity of the Upper Horizontal Section.*

To find the diſtance of the centre of gravity of the plane 8 *g o* G from the firſt ordinate 8 *g*.

Ordinates.			Double Ord.			1ſt Factors.	1ſt Products.			2d Factors.	2d Products.		
Feet.	In.	Pts.	Feet.	In.	Pts.		Feet.	In.	Pts.		Feet.	In.	Pts.
14	9	0	29	6	0	$0\frac{1}{6}$	4	11	0	$0\frac{1}{6}$	14	9	0
17	1	6	34	3	0	1	34	3	0	1	34	3	0
18	9	0	37	6	0	2	75	0	0	1	37	6	0
19	10	0	39	8	0	3	119	0	0	1	39	8	0
20	7	6	41	3	0	4	165	0	0	1	41	3	0
21	1	9	42	3	6	5	211	5	6	1	42	3	6
21	6	3	43	0	6	6	258	3	0	1	43	0	6
21	7	9	43	3	6	7	303	0	6	1	43	3	6
21	7	9	43	3	6	8	346	4	0	1	43	3	6
21	7	6	43	3	0	9	389	3	0	1	43	3	0
21	4	0	42	8	0	10	426	8	0	1	42	8	0
20	10	6	41	9	0	11	459	3	0	1	41	9	0
19	9	0	39	6	0	12	474	0	0	1	39	6	0
17	4	6	34	9	0	13	451	9	0	1	34	9	0
13	1	3	26	2	6	$\left((3\times 15)-4\right)\times\frac{1}{6}$	179	1	1	$0\frac{1}{2}$	13	1	3
291	1	3	582	2	6		3897	3	1		554	4	3

Now $\frac{3897\quad 3\quad 1}{554\quad 4\quad 3}\times 10\quad 0\quad 4=\frac{3897\cdot 25}{554\cdot 25}\times 10.03=70.5.$

	Feet.
Hence the diſtance of the centre of gravity of double the plane 8 *g o* G from the firſt ordinate, 8 *g*, is - - - - - -	70.5
Diſtance of this ordinate from the aft ſide of ſtern-poſt, - -	13.5
Diſtance of the centre of gravity from the aft ſide of poſt, - -	84.0
Diſtance of the centre of gravity of double the trapezium AR *g* 8 from its ordinate AR,	8.42
Diſtance of this ordinate from the aft ſide of the ſtern-poſt, - -	0.58
Diſtance of the centre of gravity of this plane from the aft-ſide of the ſtern-poſt, -	9.0
Diſtance of the centre of gravity of double the trapezium G *o* γ γ from its ordinate G *o*,	5.44
Diſtance of this ordinate from the aft-ſide of the poſt, - -	153.78
Diſtance of the centre of gravity of this trapezium from the aft-ſide of the poſt,	159.22
Diſtance of the centre of gravity of the ſection of the ſtern-poſt from the aft part of the poſt,	0.29
Diſtance of the centre of gravity of the ſection of the ſtern from the aft-ſide of the poſt,	169.76

Centre of Gravity.

The areas of theſe ſeveral planes, calculated by the common method, will be as follow:

5558.90 for that of the plane, and its momentum $5558.9 \times 84 =$ 466947.6000
199.13 for that of double the trapezium AR*g* 8, and its momentum $199.13 \times 9 =$ 1792.1700
214.59 for that of double the trapezium G *o* γ γ, and its momentum $214.59 \times 159.22 =$ 34167.0236
0.77 for that of the ſection of the ſtern-poſt, and its momentum $0.77 \times 0.29 =$ 0.2233
0.77 for that of the ſection of the ſtem, and its momentum $0.77 \times 169.76 =$ 130.7152

5974.16 Sum - - - - - 503037.7321

Now $\frac{503037.7321}{5974.16} = 84.2$, the diſtance of the centre of gravity of the whole ſection from the aft ſide of the ſtern-poſt.

II. *Determination of the Centre of Gravity of the Second Horizontal Section.*

To find the diſtance of the centre of gravity of double the plane 8 *f n* G from its firſt ordinate 8 *f*.

Ordinates.			Double Ord.			1. Factors.	1. Products.			2. Fact.	2. Products.		
Feet.	In.	Pts.	Feet.	In.	Pts.		Feet.	In.	Pts.		Feet.	In.	Pts.
11	2	3	22	4	6	0⅙	3	8	9	0½	11	2	3
15	3	0	30	6	0	1	30	6	0	1	30	6	0
17	5	0	34	10	0	2	69	8	0	1	34	10	0
18	10	3	37	8	6	3	113	1	6	1	37	8	6
19	10	6	39	9	0	4	159	0	0	1	39	9	0
20	7	0	41	2	0	5	205	10	0	1	41	2	0
21	0	3	42	0	6	6	252	3	0	1	42	0	6
21	2	0	42	4	0	7	296	4	0	1	42	4	0
21	0	6	42	1	0	8	336	8	0	1	42	1	0
20	10	9	41	9	6	9	376	1	6	1	41	9	6
20	6	6	41	1	0	10	410	10	0	1	41	1	0
19	10	0	39	8	0	11	436	4	0	1	39	8	0
18	6	0	37	0	0	12	444	0	0	1	37	0	0
15	9	6	31	7	0	13	410	7	0	1	31	7	0
11	2	9	22	5	6	$\left((3 \times 15) - 4\right) \times \frac{1}{6}$	153	5	6	0½	11	2	9
273	2	3	546	4	6		3698	5	3		523	11	6

Hence the diſtance of the centre of gravity of double the plane 8 *f n* G from its firſt ordinate 8 *n* is
$\frac{3698\ \ 5\ \ 3}{523\ \ 11\ \ 6} \times 10.0.4 = \frac{3698.43}{523.95} \times 10.03 =$ - - - 70.79
Diſtance of this ordinate from the aft ſide of the ſtern-poſt - - 13.5

Diſtance of the centre of gravity of the above plane from the aft ſide of poſt - - 84.29

Diſtance of the centre of gravity of double the trapezium AR*f* 8 from its ordinate AR - 8.38
Diſtance of this ordinate from aft ſide of ſtern-poſt - - - 0.57

Diſtance of the centre of gravity of the trapezium from the aft ſide of the poſt - 8.95

Diſtance of the centre of gravity of the trapezium before the ordinate G *n* from that ordinate - 5.74
Diſtance of that ordinate from the aft ſide of the poſt - - - 153.78

Diſtance of the centre of gravity of the trapezium from the aft ſide of the poſt - 159.52

Diſtance of the centre of gravity of the ſection of the ſtern-poſt from the aft ſide of the poſt - 0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of the poſt - 169.76

The

The areas of theſe ſeveral planes being calculated, will be as follow:

5255.22 for that of the plane 8 *fn* G, and its momentum $5255.22\times84.29=$ - 442962.4938
153.11 for that of double the trapezium AR*f*8, and its momentum $153.11\times8.95=$ - 1370.3345
182.40 the area of the trapezium before, and its momentum $182.40\times159.52=$ - 29096.4480
0.77 the area of the ſection of the ſternpoſt, and its momentum $0.77\times0.29=$ - - 0.2233
0.77 the area of the ſection of the ſtem, and its momentum $0.77\times169.76=$ - - 130.7152

5592.27 Sum - - - - - 473560.2148

Now $\frac{473560.2148}{5952.27}=84.68$, the diſtance of the centre of gravity of the whole ſection from the aft-ſide of the ſtern-poſt.

III. *Determination of the Centre of Gravity of the Third Horizontal Section.*

Diſtance of the centre of gravity of double the plane 8 *em* G from its firſt ordinate 8 *e*.

Ordinates.			Double Ord.			1ſt Factors.	1ſt Products.			2d Fact.	2d Products.		
Feet.	In.	Pts.	Feet.	In.	Pts.		Feet.	In.	Pts.		Feet.	In.	Pts.
6	7	6	13	3	0	$0\frac{1}{6}$	2	2	6	$0\frac{1}{2}$	6	7	6
11	7	6	23	3	0	1	23	3	0	1	23	3	0
15	1	0	30	2	0	2	60	4	0	1	30	2	0
17	1	3	34	2	6	3	102	7	6	1	34	2	6
18	3	0	36	6	0	4	146	0	0	1	36	6	0
19	3	0	38	6	0	5	192	6	0	1	38	6	0
19	9	0	39	6	0	6	237	0	0	1	39	6	0
20	0	0	40	0	0	7	280	0	0	1	40	0	0
20	0	0	40	0	0	8	320	0	0	1	40	0	0
19	8	3	39	4	6	9	354	4	6	1	39	4	6
19	1	3	38	2	6	10	382	1	0	1	38	2	6
18	1	0	36	2	0	11	397	10	0	1	36	2	0
16	3	9	32	7	6	12	391	6	0	1	32	7	6
13	2	3	26	4	6	13	342	10	6	1	26	4	6
8	4	6	16	9	0	$\left((3\times15)-4\right)\times\frac{1}{6}=$	114	5	6	$0\frac{1}{2}$	8	4	6
242	5	3	484	10	6		3347	0	6		469	10	6

Hence the diſtance of the centre of gravity of double the plane 8 *em* G from its firſt ordinate 8 *e* is =
$\frac{4347\quad0\quad6}{469\quad10\quad6}\times10\quad0\quad4=\frac{3347.04}{469.87}\times10.03=$ - - - - 71.44
Diſtance of this ordinate from the aft ſide of the poſt - - - - 13.5

Hence the diſtance of the centre of gravity of this plane from the aft ſide of the poſt is - 84.94

Diſtance of the centre of gravity of double the trapezium AR *e* 8, from its ordinate AR - 8.03
Diſtance of this ordinate from the aft ſide of the poſt - - - 0.58

Diſtance of the centre of gravity of this trapezium from the aft ſide of the poſt - - 8.61

Diſtance of the centre of gravity of the foremoſt trapezium from its ordinate G *m* - 5.19
Diſtance of this ordinate from the aft ſide of the poſt - - - - - 153.78

Diſtance of the centre of gravity of this trapezium from the aft ſide of the poſt - 158.97

Diſtance of the centre of gravity of the ſection of the poſt from the aft ſide of the poſt - 0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of the poſt - 169.76

Centre of Gravity.

The areas of theſe ſeveral planes will be found to be as follow:

4712.7961	for that of double the plane 8*em*G, and its momentum 4712.7961 × 84.94=	400304.9007
93.84	the area of double the trapezium AR 3*e* 88, and its momentum 93.84 × 8.61=	807.9624
131.1	for the area of foremoſt trapezium, and its momentum 131.1 × 158.97= -	20840.967
0.77	the area of the ſection of the poſt, and its momentum 0.77 × 0.29= -	0.2233
0.77	the area of the ſection of the ſtem, and its momentum 0.77 × 169.76= -	130.7152
4939.2761	Sum - - - - - -	422084.7706

Now $\frac{422084.7706}{4939.2761}=85.45$, the diſtance of the centre of gravity of the whole ſection from the aft ſide of the poſt.

IV. *Determination of the Centre of Gravity of the Fourth Horizontal Section.*

Diſtance of the centre of gravity of double the plane 8 *d l* G from its firſt ordinate 8 *d*.

Ordinates.			Double Ord.			1. Factors.	1. Products.			2. Fact.	2. Products.		
Feet.	In.	Pts.	Feet.	In.	Pts.		Feet.	In.	Pts.		Feet.	In.	Pts.
3	3	6	6	7	0	$0\frac{1}{6}$	1	1	2	$0\frac{1}{2}$	3	3	6
7	9	0	15	6	0	1	15	6	0	1	15	6	0
11	11	0	23	10	0	2	47	8	0	1	23	10	0
14	8	9	29	5	6	3	88	4	6	1	29	5	6
16	3	0	32	6	0	4	130	0	0	1	32	6	0
17	4	9	34	9	6	5	173	11	5	1	34	9	6
18	1	9	36	3	6	6	217	9	0	1	36	3	6
18	5	0	36	10	0	7	257	10	0	1	36	10	0
18	3	0	36	6	0	8	292	0	0	1	36	6	0
17	10	9	35	9	6	9	322	1	6	1	35	9	6
17	2	6	34	5	0	10	340	10	0	1	34	5	0
15	10	3	31	8	6	11	348	9	6	1	31	8	6
13	6	0	27	0	0	12	324	0	0	1	27	0	0
9	7	6	19	3	0	13	250	3	0	1	19	3	0
5	4	9	10	9	6	$((3\times 15)-4)\times\frac{1}{6}$	73	8	11	$0\frac{1}{2}$	5	4	9
205	7	6	411	3	0		2883	11	0		402	6	9

Hence the diſtance of the centre of gravity of double the plane 8 *d l* G from its firſt ordinate 8 *d* is $=\frac{2883\ 11\ 0}{402\ 6\ 9}\times 10\ 0\ 4=\frac{2883.916}{402.56}\times 10.03=$ - - - - 71.85

Diſtance of this ordinate from the aft ſide of the poſt - - - -	13.5
Diſtance of the centre of gravity of the plane from the aft ſide of the poſt - - -	85.35
Diſtance of the centre of gravity of double the trapezium AR *d* 8 from its ordinate AR -	7.89
Diſtance of this ordinate from the aft ſide of the poſt - - - -	0.58
Diſtance of the centre of gravity of the trapezium from the aft ſide of the poſt - -	8.47
Diſtance of the centre of gravity of the foremoſt trapezium from its ordinate G *l* - -	4.83
Diſtance of this ordinate from aft ſide of the poſt - - - -	153.78
Diſtance of the centre of gravity of the trapezium from the aft ſide of the poſt - -	158.61
Diſtance of the centre of gravity of the ſection of the poſt from its aft ſide - -	0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of the poſt -	169.76

The

Centre of Gravity.

The areas of theſe ſeveral planes being calculated, will be as follow:

4037.6768	for that of double the plane 8 *d l* G, and its momentum 4037.6768 × 85.35 =	344615.7149
51.12	the area of double the trapezium AR *d* 8, and its momentum 51.12 × 8.47 =	432.9804
79.16	the area of the foremoſt trapezium, and its momentum 79.16 × 158.61 =	12555.5676
0.77	the area of the ſection of the poſt, and its momentum 0.77 × 0.29 =	0.2233
0.77	the area of the ſection of the ſtem, and its momentum 0.77 × 169.76 =	130.7152
4169.4968	Sum	357735.2074

Then $\frac{357735.2074}{4169.4968}=85.80$, the diſtance of the fourth horizontal ſection from the aft ſide of the ſtern-poſt.

V. *Determination of the Centre of Gravity of the Fifth Horizontal Section.*

Diſtance of the centre of gravity of double the plane 8 *c k* G from its firſt ordinate 8 *c*.

Ordinates.			Double Ord.			1. Factors.	1. Products.			2. Fact.	2. Products.		
Feet.	In.	L.	Feet.	In.	L.		Feet.	In.	L.		Feet.	In.	L.
1	9	0	3	6	0	$0\frac{1}{6}$	0	7	0	$0\frac{1}{2}$	1	9	0
4	6	0	9	0	0	1	9	0	0	1	9	0	0
8	3	0	16	6	0	2	33	0	0	1	16	6	0
11	8	3	23	4	6	3	70	1	6	1	23	4	6
13	10	3	27	8	6	4	110	10	0	1	27	8	6
15	3	0	30	6	0	5	152	6	0	1	30	6	0
16	0	3	32	0	6	6	192	3	0	1	32	0	6
16	5	0	32	10	0	7	229	10	0	1	32	10	0
16	3	0	32	6	0	8	260	0	0	1	32	6	0
15	9	0	31	6	0	9	283	6	0	1	31	6	0
14	10	0	29	8	0	10	296	8	0	1	29	8	0
12	10	3	25	8	6	11	282	9	6	1	25	8	6
9	8	9	19	5	6	12	233	6	0	1	19	5	6
6	1	6	12	3	0	13	159	3	0	1	12	3	0
3	3	0	6	6	0	$\left((3\times 15)-4\right)\times\frac{1}{6}$	44	5	0	$0\frac{1}{2}$	3	3	0
166	6	3	333	0	7		2358	3	0		328	0	6

Hence the diſtance of the centre of gravity of double the plane 8 *c k* G from its firſt ordinate is $\frac{2358\ \ 3\ \ 0}{328\ \ 0\ \ 6}\times 10\ \ 0\ \ 4=\frac{2358.25}{328.04}\times 10.03=$ - - - - - 72.10

Diſtance of this ordinate from the aft ſide of the poſt	13.50
Diſtance of the centre of gravity of the plane from the aft ſide of the poſt	85.60
Diſtance of the centre of gravity of double the trapezium AR *c* 8 from its ordinate AR	7.42
Diſtance of this ordinate from the aft ſide of poſt	0.58
Diſtance of centre of gravity of trapezium from aft ſide of the poſt	8.00
Diſtance of the centre of gravity of the foremoſt trapezium from its ordinate G *k*	4.22
Diſtance of this ordinate from the aft ſide of poſt	153.78
Diſtance of the centre of gravity of the foremoſt trapezium from the aft ſide of the poſt	158.00
Diſtance of the centre of gravity of the ſection of the poſt from the aft ſide of poſt	0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of poſt	169.76

The

The areas of theſe ſeveral planes being calculated, will be as follow :

3290.2412	for the area of double the plane 8 *c k* G, and its momentnm 3290.2412×85.6=	281644.6467
31.21	the area of double the trapezium AR *c* 8, and its momentum 31.21×8= -	249.68
42.43	the area of the foremoſt trapezium, and its momentum 42.43×158= -	6703.94
0.77	the area of the ſection of the poſt, and its momentum 0.77×0.29= - -	0.2233
0.77	the area of the ſection of the ſtem, and its momentum 0.77×169.76= - -	130.7152
3365.4212	Sum - - - - - - -	288729.2052

Now $\frac{288729.2052}{3365.4212}=85.79$, the diſtance of the centre of gravity of the whole ſection from the aft ſide of the ſtern.

VI. *Determination of the Centre of Gravity of the Sixth Horizontal Section.*

Diſtance of the centre of gravity of double the plane 8 *b i* G from its firſt ordinate 8 *b*.

Ordinates.			Double Ord.			1. Factors.	1. Products.			2. Fact.	2 Products.		
Feet.	In.	L.	Feet.	In.	L.		Feet.	In.	L.		Feet.	In.	L.
1	0	0	2	0	0	$0\frac{1}{6}$	0	4	0	$0\frac{1}{2}$	1	0	0
2	5	0	4	10	0	1	4	10	0	1	4	10	0
4	5	0	8	10	0	2	17	8	0	1	8	10	0
7	3	6	14	7	0	3	43	9	0	1	14	7	0
10	1	9	20	3	6	4	81	2	0	1	20	3	6
12	1	3	24	2	6	5	121	0	6	1	24	2	6
13	3	0	26	6	0	6	159	0	0	1	26	6	0
13	9	9	27	7	6	7	193	4	6	1	27	7	6
13	7	0	27	2	0	8	217	4	0	1	27	2	0
12	8	0	25	4	0	9	228	0	0	1	25	4	0
10	6	6	21	1	0	10	210	10	0	1	21	1	0
7	1	0	14	2	0	11	155	10	0	1	14	2	0
4	7	3	9	2	6	12	110	6	0	1	9	2	6
2	10	6	5	9	0	13	74	9	0	1	5	9	0
1	6	9	3	1	6	$\times\left((3\times15)-4\right)\times\frac{1}{6}$	21	4	3	$0\frac{1}{2}$	1	6	9
117	4	3	234	8	6		1639	9	3		232	1	9

Hence the diſtance of the centre of gravity of double the plane 8 *b v* G from its firſt ordinate 8 *b* is

$\frac{1639\quad 9\quad 3}{232\quad 1\quad 3}\times 10\quad 0\quad 4=\frac{1639.77}{232.14}\times 10.03=$ - - - -	70.84
Diſtance of this ordinate from aft ſide of poſt - - - - - -	13.50
Hence the diſtance of the centre of gravity of the plane from the aft ſide of the poſt is - -	84.34
Diſtance of the centre of gravity of the trapezium AR *b* 8 from its ordinate AR - -	6.88
Diſtance of this ordinate from the aft ſide of the poſt - - - -	0.58
Diſtance of the centre of gravity of the trapezium from the aft ſide of the poſt - -	7.46
Diſtance of the centre of gravity of the foremoſt trapezium from the ordinate G *i* - -	2.92
Diſtance of this ordinate from the aft ſide of poſt - - - -	153.78
Diſtance of the centre of gravity of this trapezium from the aft ſide of the poſt - -	156.70
Diſtance of the centre of gravity of the ſection of the poſt from its aft ſide - -	0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of the poſt -	169.76

The areas of theſe planes will be found to be as follow :

2328.3642	for that of double the plane 8 *b i* G, and its momentum 2328.3642 + 84.34 =	196374.2366
21.52	for the area of double the trapezium AR *b* 8, and its momentum 21.52 × 7.46 =	160.5392
15.04	the area of the foremoſt trapezium, and its momentum 15.04 × 156.7 = -	2356.7680
0.77	the area of the ſection of the poſt, and its momentum 0.77 × 0.29 = -	0.2233
0.77	the area of the ſection of the ſtem, and its momentum 0.77 × 169.76 = -	130.7152
2366.4642	Sum - - - - - -	199022.4823

Now

Now $\frac{199022.4823}{2366.4642}=84.1$, the diſtance of the centre of gravity of the whole from the aft ſide of the poſt.

VII. *Determination of the Centre of Gravity of the Seventh Horizontal Section.*

Diſtance of the centre of gravity of double the plane 8 *a h* G from its firſt ordinate 8 *a*.

Ordinates.			Double Ord.			1. Factors.	1. Products.			2. Fact.	2. Products.		
Feet.	In.	Lin.	Feet.	In.	Lin.		Feet.	In.	Lin.		Feet.	In.	Lin.
0	8	0	1	4	0	$0\frac{1}{6}$	0	2	8	$0\frac{1}{2}$	0	8	0
1	1	6	2	3	0	1	2	3	0	1	2	3	0
1	7	6	3	3	0	2	6	6	0	1	3	3	0
1	10	9	3	9	6	3	11	4	6	1	3	9	6
2	1	3	4	2	6	4	16	10	0	1	4	2	6
2	1	0	4	2	0	5	20	10	0	1	4	2	0
1	10	9	2	9	6	6	22	9	0	1	3	9	6
1	8	0	3	4	0	7	23	4	0	1	3	4	0
1	1	0	2	2	0	8	17	4	0	1	2	2	0
0	9	0	1	6	0	9	13	6	0	1	1	6	0
0	8	0	1	4	0	10	13	4	0	1	1	4	0
0	8	0	1	4	0	11	14	8	0	1	1	4	0
0	8	0	1	4	0	12	16	0	0	1	1	4	0
0	8	0	1	4	0	13	17	4	0	1	1	4	0
0	8	0	1	4	0	$((3\times15)-4)\times\frac{1}{6}$	9	1	4	$0\frac{1}{2}$	0	8	0
18	2	9	36	5	6		205	4	6		35	1	6

Hence the diſtance of the centre of gravity of double this plane from its firſt ordinate is $\frac{205\ 4\ 6}{35\ 1\ 6}\times 10\ 0\ 4$ $=\frac{205.37}{35.12}\times10.83=$ - - 58.65

The diſtance of this ordinate from aft ſide of poſt = - - - - -	13.50
Hence the diſtance of the centre of gravity of this plane from the aft ſide of the poſt is	72.15
Diſtance of the centre of gravity of double the rectangle AR *a* 8 from its ordinate AR	6.45
Diſtance of this ordinate from the aft ſide of the poſt - - - -	0.58
Diſtance of the centre of gravity of this rectangle from the aft ſide of the poſt -	7.03
Diſtance of the centre of gravity of the foremoſt rectangle from its ordinate $7'\,7\,e\,7'$	1.25
Diſtance of this ordinate from the aft ſide of the poſt - - -	153.78
Diſtance of the centre of gravity of this rectangle from the aft ſide of the poſt	155.03
Diſtance of the centre of gravity of the ſection of the poſt from its aft ſide -	0.29
Diſtance of the centre of gravity of the ſection of the ſtem from the aft ſide of the poſt - - - - -	169.76

Now, the areas of theſe ſeveral plans being calculated will be as follows.

352.2536,	the area of double the plan 8 *a h* G, and its momentum 352.2536 × 72.15=	25415 9 2
17.1570,	the area of double the rectangle AR *a* 8, and its momentum 17.1570 × 7.03=	120.6137
3.3250,	the area of the foremoſt rectangle, and its momentum 3.3250 × 155.03=	515.4747
0.77,	the area of the ſection of the poſt, and its momentum 0.77 × 0.29=	0.2233
0.77,	the area of the ſection of the ſtem and its momentum 0.77 × 166.76=	130.7152
374.2756	Sum	26182.1242

Then $\frac{26182.1242}{374.2756}=69.95$, the diſtance of the centre of gravity of the whole ſection from the aft ſide of the poſt.

VIII. *Determination of the Centre of Gravity of the Eighth Plane.*

This plane is equal in length to the ſeventh horizontal plane, and its breadth is equal to that of the keel. The diſtance between the ſeventh and eighth planes is three feet, but which is here taken equal to 2 feet $11\frac{1}{8}$ inches.

Centre of Gravity.

Diſtance between the aft ſide of the poſt and the firſt ordinate - - -	13.5
Fourteen intervals between the fifteen ordinates, each interval being 10.03 feet	140.42
Diſtance of the laſt ordinate from the fore foot	2.2
Hence the length of the eighth plane is	156.12
Which multiplied by the breadth	1.33
The product is the area of this plane	208.
The diſtance of its centre of gravity from the aft ſide of the poſt, being equal to half its length, is - - -	78.06

The centres of gravity of theſe eight planes being found, the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt, and alſo its altitude, may from thence be eaſily determined.

From the principles already explained, the diſtance of the centre of gravity of the bottom from the aft ſide of the poſt, is equal to the ſum of the momentums of an infinite number of horizontal planes, divided by the ſum of theſe planes, or, which is the ſame, by the ſolidity of the bottom. As, however, we have no more than eight planes, we muſt therefore conceive their momentums as the ordinates of a curve, whoſe diſtances may be the ſame as that of the horizontal planes. Now the ſum of theſe ordinates minus half the ſum of the extreme ordinates being multiplied by their diſtance, gives the ſurface of the curve; of which any ordinate whatever repreſents the momentum of the horizontal plane at the ſame altitude as theſe ordinates; and the whole ſurface will repreſent the ſum of the momentums of all the horizontal planes.

Hor. Planes.	Fact.	Products.	Momentums.	Fact.	Products.
5974.16	$0\frac{1}{2}$	2987.08	503937.73	$0\frac{1}{2}$	251518.80
5592.27	1	5592.27	473560.21	1	473560.21
4939.27	1	4939.27	422084.77	1	422084.77
4169.50	1	4169.50	357735.21	1	357735.21
3365.42	1	3365.42	288729.20	1	288729.20
2366.46	1	2366.46	199022.48	1	199022.48
374.27	1	374.27	21682.12	1	21682.12
208.00	$0\frac{1}{2}$	104.00	16236.48	$0\frac{1}{2}$	8118.24
		23898.27			2022451.09

Now $\frac{2022451.09}{23898.27}=84.63$, the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt.

The height of the centre of gravity of the bottom above the lower edge of the keel may be determined by the ſame principles. Thus,

To one-ſixth of the lowermoſt horizontal ſection add the product of one-ſixth of the uppermoſt ſection by three times the number of ſections minus four the ſecond ſection in aſcending, twice the third, three times the fourth, &c.; and to half the ſum of the extreme planes add all the intermediate ones. Now the firſt of theſe ſums, multiplied by the diſtance between the planes or ſections, and divided by the ſecond ſum, gives the altitude of the centre of gravity of the bottom of the ſhip above the lower edge of the keel as required.

Centre of Gravity.

Hor. Planes.	1ſt Fact.	1ſt Products.	2d Fact.	2d Products.
208.00	$0\frac{1}{6}$	34.67	$0\frac{1}{2}$	104.00
374.27	1	374.27	1	374.27
2366.46	2	4732.92	1	2366.46
3365.42	3	10096.26	1	3365.42
4169.50	4	16678.00	1	4169.50
4939.27	5	24696.35	1	4939.27
5592.27	6	33553.62	1	5592.27
5974.16	$\left((3\times8)-4\right)\times\frac{1}{6}$	19913.87	$0\frac{1}{2}$	2987.08
		110079.96		23898.27

Now $\frac{110079.96}{23898.27}\times2.95=13.588$, the height of the centre of gravity of the bottom of the ſhip above the lower edge of the keel.

We have now found the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt, and its altitude above the lower edge of the keel. Hence the ſhip being ſuppoſed in an upright poſition, this centre of gravity will neceſſarily be in the vertical longitudinal ſection which divides the ſhip into two equal and ſimilar parts; the poſition of this centre is therefore determined.

70 Determination of the height of the metacenter above the centre of gravity.

It now remains to find the height of the metacenter above the centre of gravity; the expreſſion for this altitude, as found in Chap. III. is $\frac{\frac{2}{3}\int y^3 x}{V}$; which we ſhall now apply to determine the metacenter of the ſhip of 74 guns, whoſe centre of gravity we have already found.

Ord. of the Plane of Floatation.				*Cub. of Ordinates.*
Feet.	Inches.		Feet and dec. of Foot.	
14	9	0	14.7	3209.046
17	1	6	17.1	5000.211
18	9	0	18.7	6591.797
19	10	0	19.8	7762.392
20	7	6	20.6	8741.816
21	1	9	21.2	9595.703
21	6	3	21.5	9938.375
21	7	9	21.7	10289.109
21	7	9	21.7	10289.109
21	7	6	21.7	10289.109
21	4	0	21.3	9663.597
20	10	6	20.9	9129.329
19	9	0	19.7	7703.734
17	4	6	17.4	5268.024
13	1	3	13.1	2248.091
291	1	3	291.1	115719.442

Ordinate at 10.03 feet abaft the ordinate 8 g,=4, of which the cube is 64, and 64 × ½ - -	32.
Ordinate at 10.03 feet afore the ordinate G o= 6, cube of which is 216 and 216 × ½ - -	108.
Sum - -	115859.442
Diſtance between the ordinates -	10.03
Product - - -	1162070.20326

Product

entre of Gravity.

Product		1162070.20326
Half the cube of the aftermoſt ordinate	32.	
Half the cube of the thickneſs of the ſtem	0.14	
Sum	32.14	
Diſtance between the ordinates	3.0	
Product		96.42
Half the cube of the foremoſt ordinate	108.	
Half the cube of the thickneſs of the ſtem	.14	
Sum	108.14	
Diſtance between the ordinates	5.5	
Product		594.77
$\int y^3 x$		1162761.39326
$2\int y^3 x$		2325522.78652
$\frac{2}{3}\int y^3 x$		775174.26217

The ſolidity of the bottom is $2527\frac{3}{4}$ tons$=70018.67$ cubic feet: hence $\frac{\frac{2}{3}\int y^3 x}{V}=\frac{77517.26}{70018.67}=11.07$ feet, the altitude of the metacenter above the centre of gravity of the bottom of the ſhip.

APPENDIX.

When a ſhip is built, ſhe muſt be fitted with maſts, yards, ſails, ropes, and blocks, or, in other words, ſhe muſt be *rigged* before ſhe can go to ſea. To complete this article, it may therefore be thought neceſſary to treat of the art of rigging veſſels; but we have elſewhere (ſee *MAST-Rigging*, ROPE-MAKING, and SAIL) ſhown how the ſeveral parts of a ſhip's rigging are made; and the art of putting them properly together, ſo as to make the ſhip beſt anſwer the purpoſe for which ſhe is intended, depends upon a juſt knowledge of the impulſe and reſiſtance of fluids, and of the theory and practice of ſeamanſhip. See *RESISTANCE of Fluids* and SEAMANSHIP). Nothing, therefore, of the ſubject is left to us here, except we were to ſtate in few words the progreſſive method of rigging ſhips; but there is no one undeviating mode which is purſued, as the nature of the operation is ſuch that all the parts of it may be advancing at the ſame time. We ſhall therefore take our leave of *ſhips* and *ſhip-building* with a few general obſervations on *ſail-making*, and refer our readers for farther information to the very elegant work on *the Elements and Practice of Rigging and Seamanſhip* in two volumes quarto.

Sails are made of canvas, of different textures, and are extended on or between the maſts, to receive the wind that forces the veſſel through the water. They are quadrilateral or triangular, as has been elſewhere deſcribed, and are cut out of the canvas cloth by cloth. The width is governed by the length of the yard, gaff, boom, or ſtay; the depth by the height of the maſt.

Appendix.

In the valuable work to which we have juſt referred, the following directions are given for cutting ſails. "The width and depth being given, find the number of cloths the width requires, allowing for ſeams, tabling on the leeches, and ſlack cloth; and, in the depth, allow for tabling on the head and foot. For ſails cut ſquare on the head and foot, with gores only on the leeches, as ſome topſails, &c. the cloths on the head, between the leeches, are cut ſquare to the depth; and the gores on the leeches are found by dividing the depth of the ſail by the number of cloths gored, which gives the length of each gore. The gore is ſet down from a ſquare with the oppoſite ſelvage; and the canvas being cut diagonally, the longeſt gored ſide of one cloth makes the ſhorteſt ſide of the next; conſequently, the firſt gore being known, the reſt are cut by it. In the leeches of topſails cut hollow, the upper gores are longer than the lower ones; and in ſails cut with a roach leech, the lower gores are longer than the upper ones. This muſt be regulated by judgment, and care taken that the whole of the gores do not exceed the depth of the leech. Or, by drawing on paper the gored ſide of the ſail, and delineating the breadth of every cloth by a convenient ſcale of equal parts of an inch to a foot, the length of every gore may be found with preciſion. Sails, gored with a ſweep on the head or the foot, or on both, have the depth of their gores marked on the ſelvage, from the ſquare of the given depth on each cloth, and are cut as above; the longeſt ſelvage of one ſerving to meaſure the ſhorteſt ſelvage of the next, beginning with the firſt gored cloth next the middle in ſome ſails, and the firſt cloth next to the maſt leech in others. For thoſe gores that are irregular no ſtrict rule can be given; they can only be determined by the judgement of the ſail-maker, or by a drawing.

Elements and Practice of Rigging and Seamanſhip, vol. i. p. 91.

"In the royal navy, mizen topſails are cut with three quarters of a yard hollow in the foot; but, in the merchant ſervice, top and topgallant ſails are cut with more or leſs hollow in the foot. Flying jibs are cut with a roach curve on the ſtay, and a three-inch gore in each cloth, ſhortening from the tack to the clue. Lower ſtudding-ſails are cut with ſquare leeches, and topmaſt and topgallant-maſt ſtudding ſails with goring leeches.

"The length of reef and middle bands is governed by the width of the ſail at their reſpective places; the leech-linings, buntline-cloths, top-linings, maſt-cloths, and corner-pieces, are cut agreeably to the depth of the ſail; each cloth and every article ſhould be properly marked with charcoal, to prevent confuſion or miſtake. Sails that have bonnets are cut out the whole depth of the ſail and bonnet included, allowing enough for the tablings on the foot of the ſail and head and foot of the bonnet. The bonnet is cut off after the ſail is ſewed together. If a drabler is required, it is allowed for in the cutting out the ſame as the bonnet.

When the cloth is thus properly cut, the different pieces are to be joined together in the form of a ſail; and for doing this properly we have the following directions in the work already quoted. "Sails have a double flat ſeam, and ſhould be ſewed with the beſt Engliſh made twine of three threads, ſpun 360 fathoms to the pound, and have from one hundred and eight to one hundred and ſixteen ſtitches in every yard in length. The twine for large ſails, in the royal navy, is waxed by by hand, with genuine bees wax, mixed with one ſixth part of clear turpentine; and, for ſmall ſails, in a mixture made with bees wax 4 lb. hogs lard 5 lb. and clear turpentine 1 lb. In the merchant ſervice, the twine is dipped in tar (L), ſoftened with a proper proportion of oil.

“ It is the erroneous practice of ſome ſailmakers not to ſew the ſeams any farther than where the edge is creaſed down for the tabling; but all ſails ſhould be ſewed quite home to the end, and, when finiſhed, ſhould be well rubbed down with a rubber. In the merchant ſervice ſeams are ſometimes made broader at the foot than at the head, being ſtronger. Broad ſeams are not allowed to be made on courſes, in the royal navy, but goring leeches are adopted in lieu of them. Boom-mainſails and the ſails of ſloops generally have the ſeams broader at the foot than at the head. The ſeams of courſes and topſails are ſtuck or ſtitched up, in the middle of the ſeams, along the whole length, with double ſeaming twine; and have from 68 to 72 ſtitches in a yard. In the merchant ſervice it is common to ſtick the ſeams with two rows of ſtitches, when the ſail is half worn, as they will then laſt till the ſail is worn out.

“ The breadth of the ſeams of courſes, topſails, and other ſails, in the royal navy, to be as follow, viz. courſes and topſails, for 50 gun ſhips and upwards, one inch and a half, and for 44 gun ſhips and under, one inch and a quarter, at head and foot; all other ſails, one inch at head and foot.

“ The tablings of all ſails are to be of a proportionable breadth to the ſize of the ſail, and ſewed at the edge, with 68 to 72 ſtitches in a yard. Thoſe for the heads of main and fore courſes to be four to ſix inches wide; for ſprit courſes and mizens, drivers, and other boom ſails, 3 to 4 inches wide; for topſails, 3 inches to 4 inches and a half; topgallant and ſprit topſails, 3 inches; royal ſails, 2 inches and a half; jib and other ſtayſails, 3 inches to 4 inches and a half, on the ſtay or hoiſt; and for ſtudding ſails, 3 inches to 4 inches on the head. Tablings on the foot and leeches of main and fore courſes to be 3 inches to 5 inches broad; ſprit courſe and topſails, 3 inches; topgallant and ſprit topſails, 2 inches and a half; royals, 2 inches; fore leeches of mizen, driver, and other boomſails, 3 inches and a half to 4 inches; after leech, 3 inches; and on the foot 2 or 3 inches. Tablings on the after leech of jibs and other ſtayſails to be from 2 to 3 inches broad; and, on the foot, 2 to 2 inches and a half: on ſtudding ſail leeches one inch and a half to two inches and a half; and on the foot, from one to two inches.

“ Main and fore courſes are lined on the leeches, from clue to earing, with one cloth ſeamed on and ſtuck or ſtitched in the middle, and have a middle band half way between the lower reef band and the foot, alſo four buntline cloths, at equal diſtances between the leeches, the upper ends of which are carried under the middle band, that the lower ſide of the band may be tabled upon or ſewed over the end of the buntline pieces. They have likewiſe two reef bands; each in breadth one third of the breadth of the canvas; the upper one is one ſixth of the depth of the ſail from the head, and the lower band is at the ſame diſtance from the upper one; the ends go four inches under the leech linings, which are ſeamed over the reef bands. All linings are ſeamed on, and are ſtuck with 68 to 72 ſtitches in a yard.

“ Main, fore, and mizen topſails have leech linings, maſt and top-linings, buntline cloths, middle bands, and reef bands. The leech linings are made of one breadth of cloth, ſo cut and ſewed as to be half a cloth broad at the head, and a cloth and a half broad at the foot; the piece cut out being half the breadth of the cloth at one end, and tapering to a point at the other. The middle bands are put on half way between the lower reef and foot, the buntline cloths join the top-linings, and the buntline cloths and top-linings are carried up to the lower ſide of the middle band, which is tabled on them. The maſt lining is of two cloths, and extends from the foot of the ſail to the lower reef, to receive the beat or chafe of the maſt. The middle band is made of one breadth of canvas, of the ſame number as the top-lining. It is firſt folded and rubbed down, to make a creaſe at one third of the breadth; then tabled on the ſelvage, and ſtuck along the creaſe; then turned down, and tabled and ſtuck through both the double and ſingle parts, with 68 to 72 ſtitches in a yard. It is the opinion of many, that middle bands ſhould not be put on until the ſail is half worn.

“ Main and fore topſails have three and ſometimes four reef bands from leech to leech, over the leech linings; the upper one is one eighth of the depth of the ſail from the head, and they are the ſame diſtance aſunder in the royal navy, but more in the merchant ſervice. The reef bands are each of half a breadth of canvas put on double; the firſt ſide is ſtuck twice, and the laſt turned over, ſo that the reef holes may be worked upon the double part of the band, which is alſo ſtuck with 68 to 72 ſtitches in a yard.

“ The top-lining of topſails is of canvas, N^{o} 6 or 7. The other linings of this, and all the linings of other ſails, ſhould be of the ſame quality as the ſails to which they belong.

“ Top-linings and maſt cloths are put on the aft ſide, and all other linings on the fore-ſide, of ſails. Mizens are lined with one breadth of cloth from the clue five yards up the leech, and have a reef band ſewed on, in the ſame manner as on other ſails, at one fifth the depth of the ſail from the foot; they have alſo a nock-piece and a peek-piece, one cut out of the other, ſo that each contains one yard. Mizen topſails of 50 gun ſhips and upwards have three reefs, the upper one is one eighth of the depth of the ſail from the head, and the reefs are at the ſame diſtance aſunder. Mizen topſails of ſhips of 44 guns and under have two reefs one ſeventh part of the depth of the ſail aſunder, the upper one being at the ſame diſtance from the head. Main and main top ſtudding ſails have each one reef, at one eighth of the depth of the ſail from the head. Reef bands ſhould not be put on until the ſail is ſewed up, a contrary practice being very erroneous. Lower ſtayſails,

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(L) The dipping of the twine in tar, we are perſuaded, is a very bad practice, for the reaſon aſſigned in ROPE-MAKING. See that article, N^{o} 32.

SHIP-BUILDING. *PLATE CCCCLXXXIV.*

Fig. 1.

PIECES of the HULL.

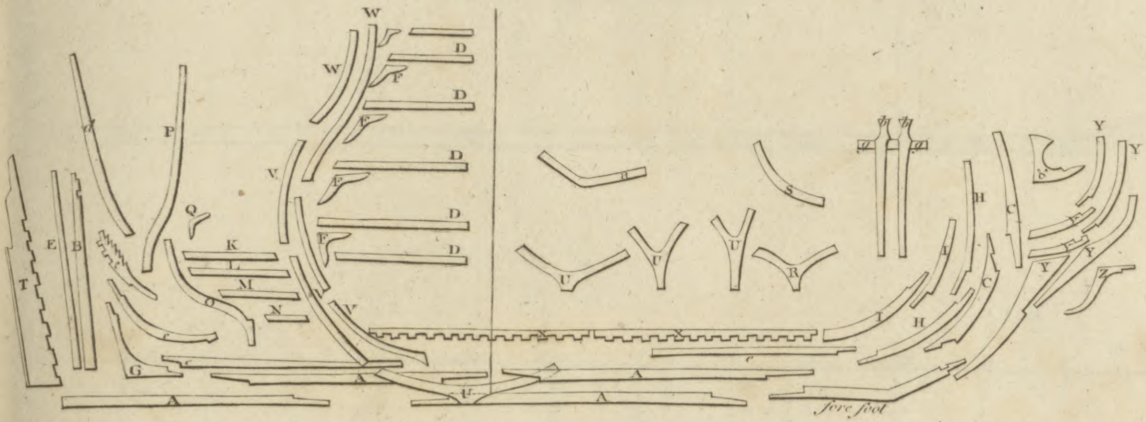
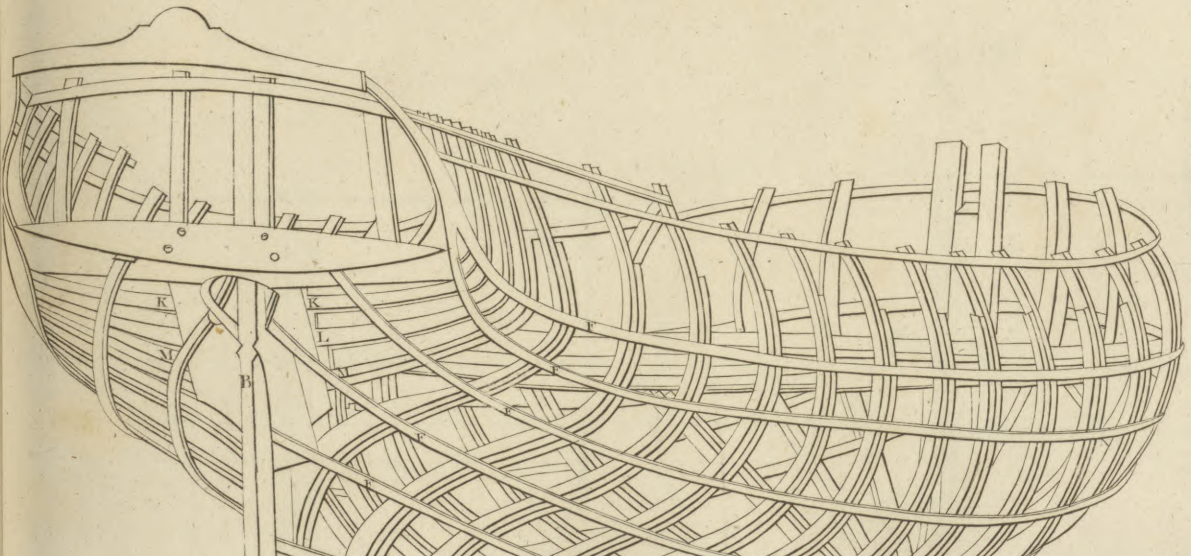


Fig. 2.

FRAMES of a SHIP.



E. Mitchell sculp.t

Fig. 3.

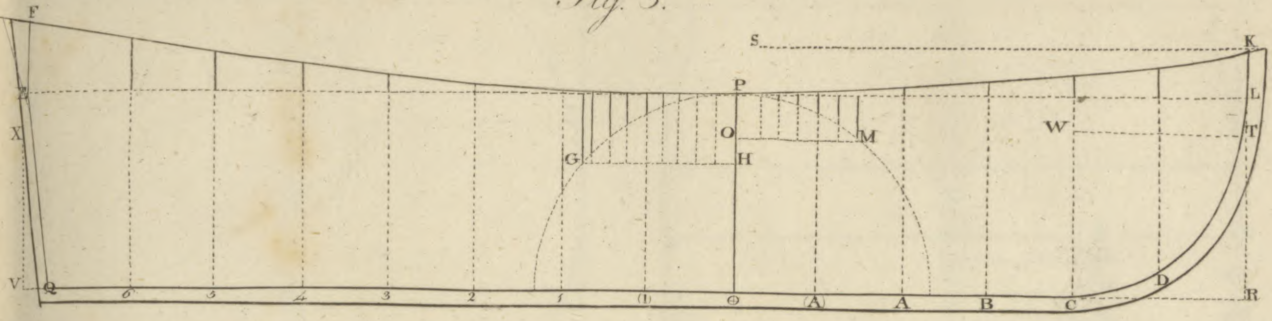


Fig. 4.

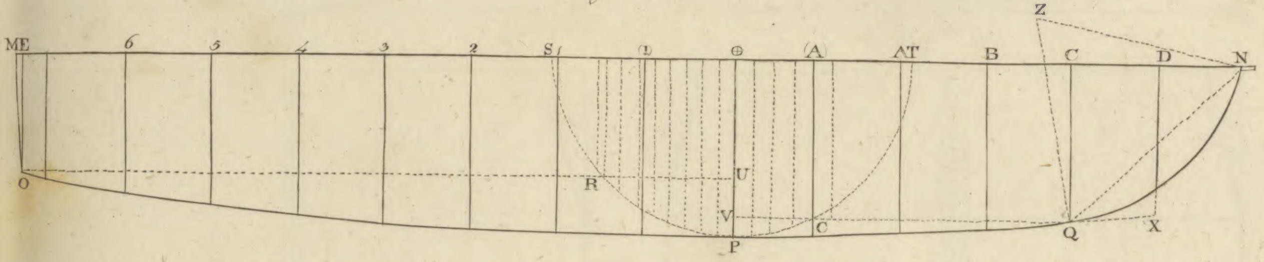
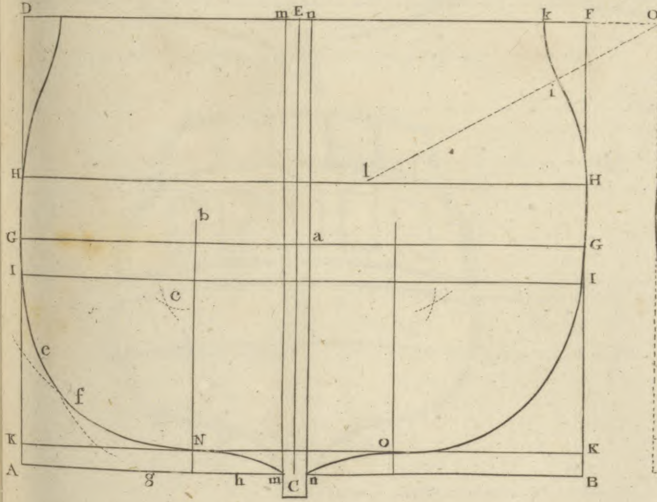


Fig. 5.



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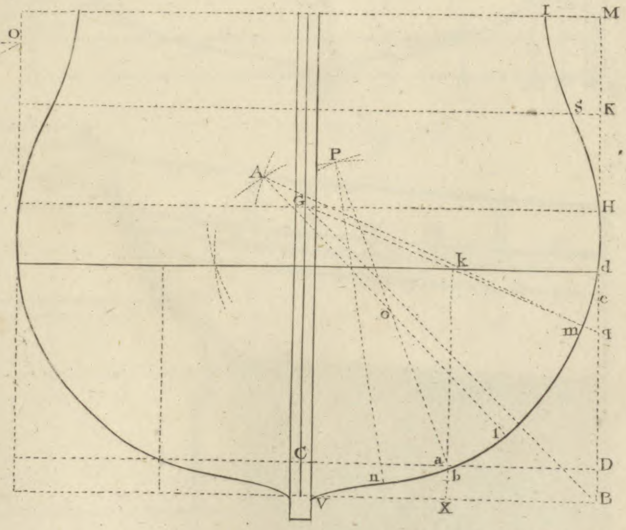
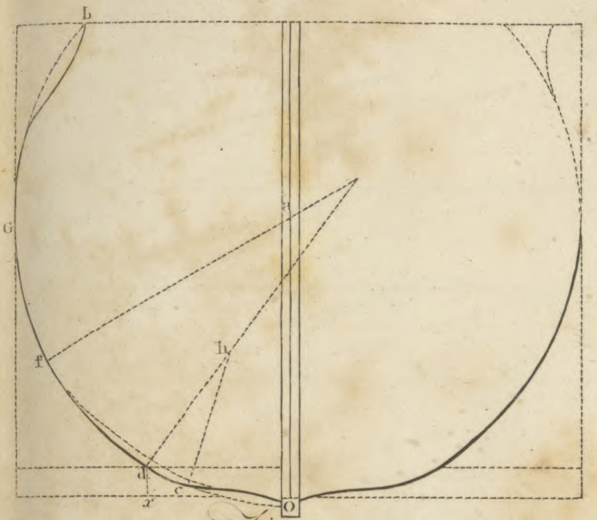


E. Mitchell sculp.

Fig. 7.



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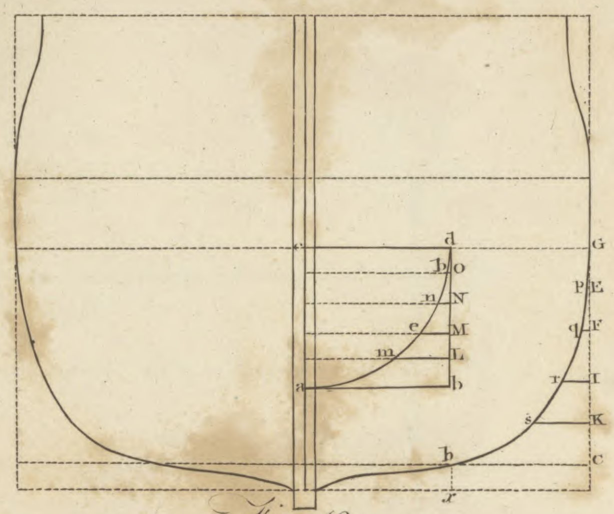

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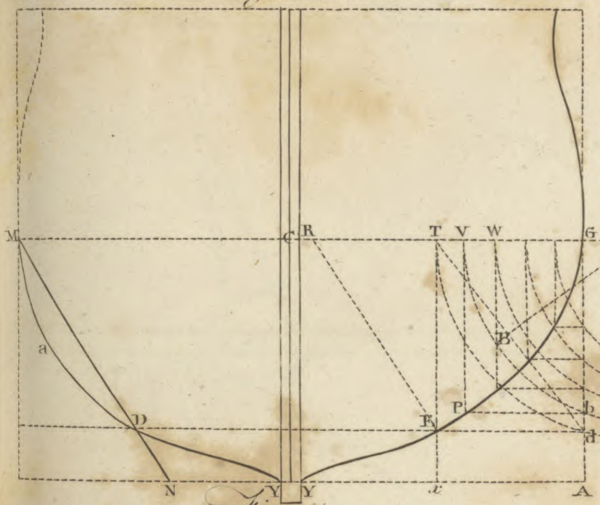

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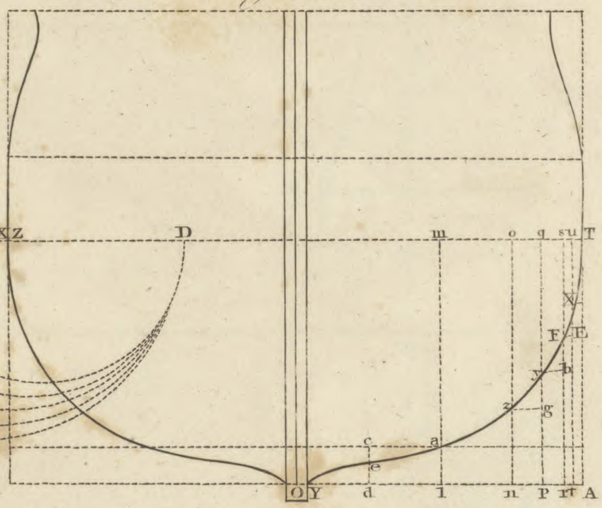

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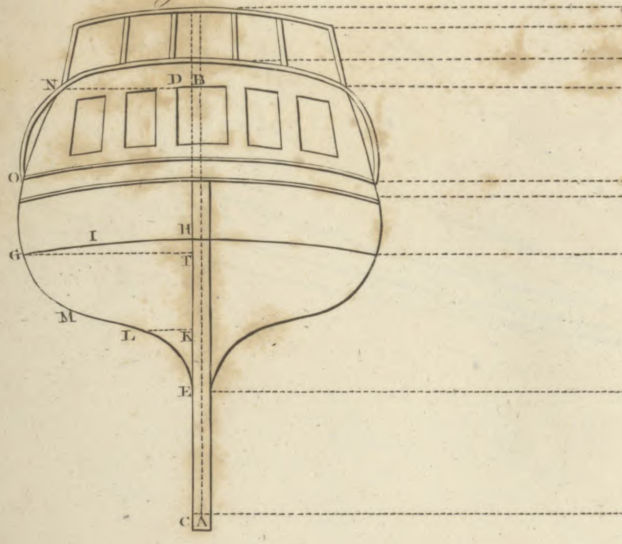

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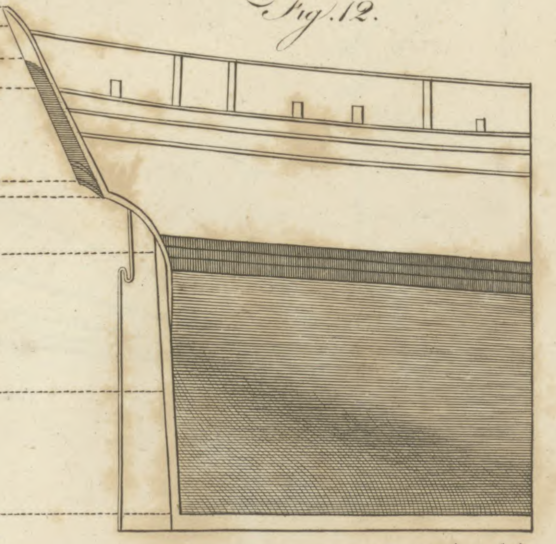


R. Train Sculp.t

SHIP BUILDING. *PLATE CCCCLXXXVII.*

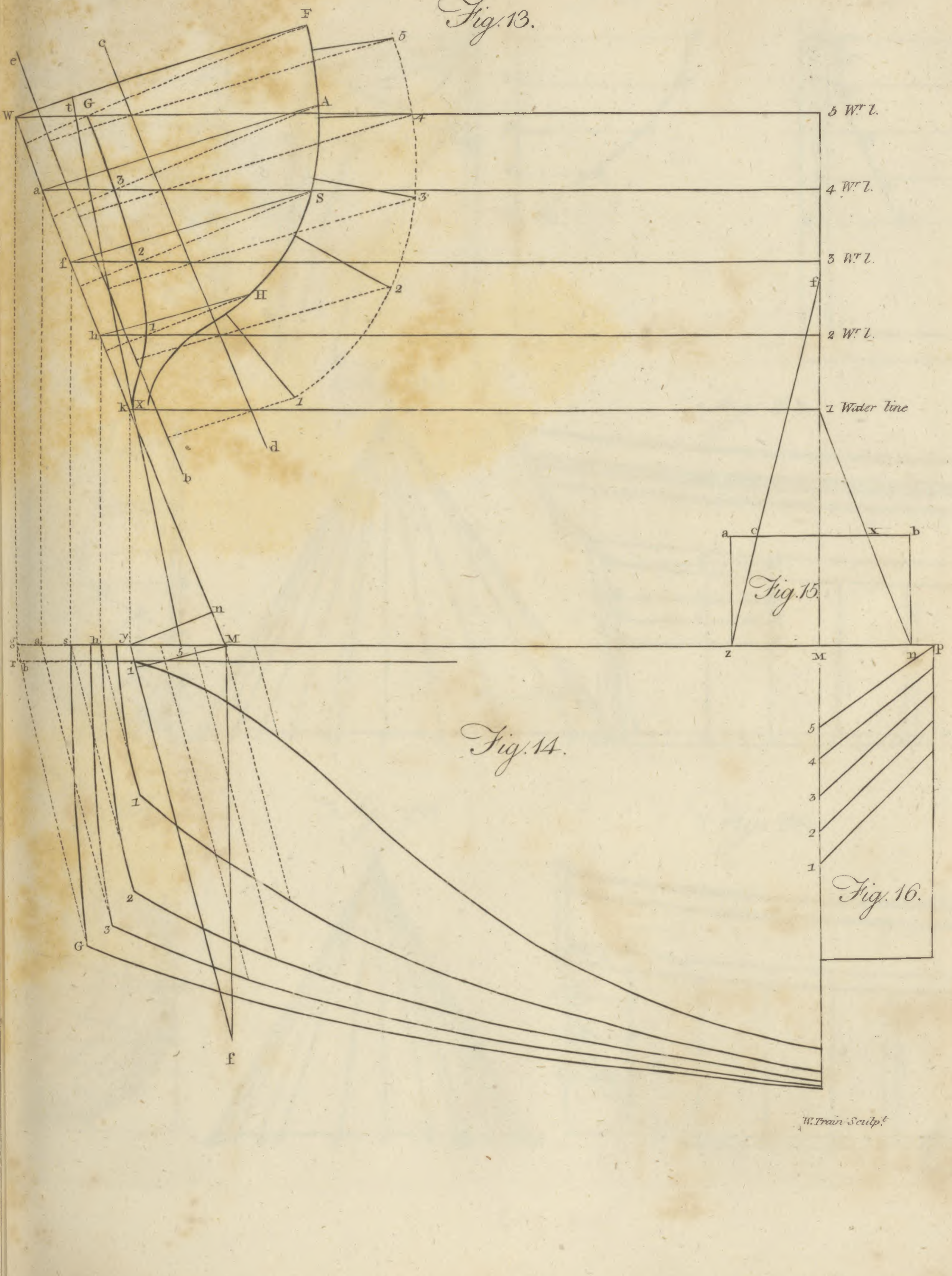


Fig. 13.

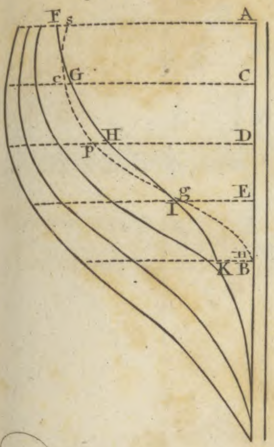
Fig. 14.

Fig. 15.

Fig. 16.

W. Train Sculp^t.

Fig. 17.



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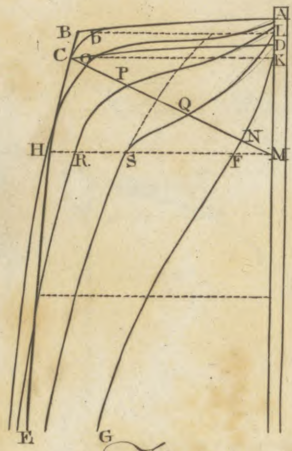


Fig. 19.

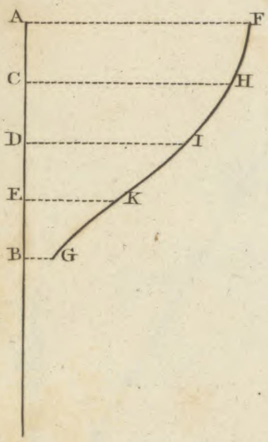
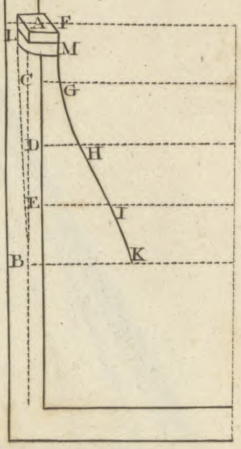


Fig. 20.



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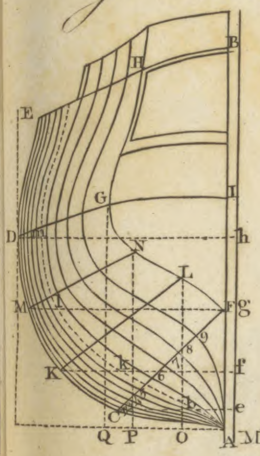
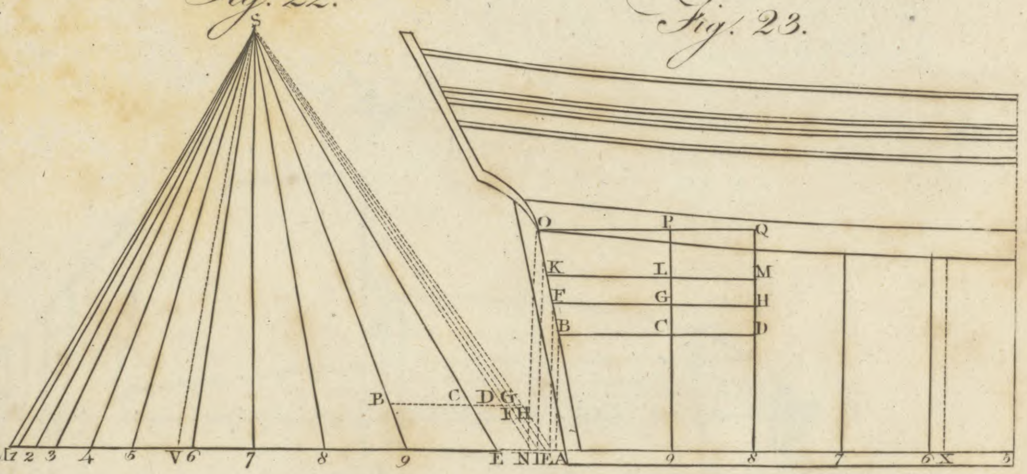


Fig. 22.

Fig. 23.



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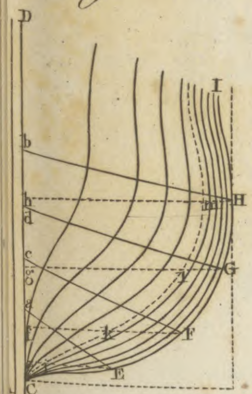

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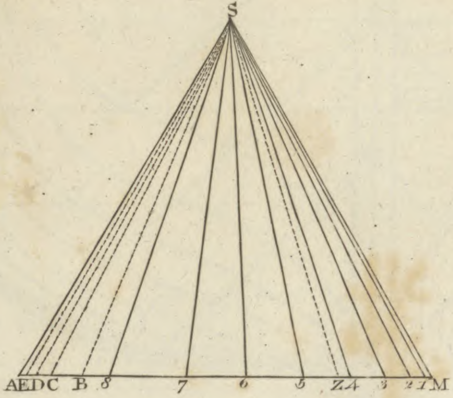

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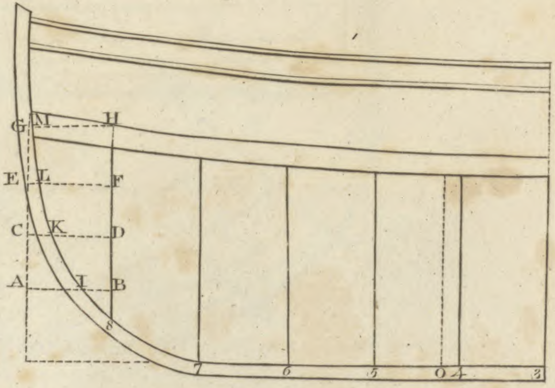
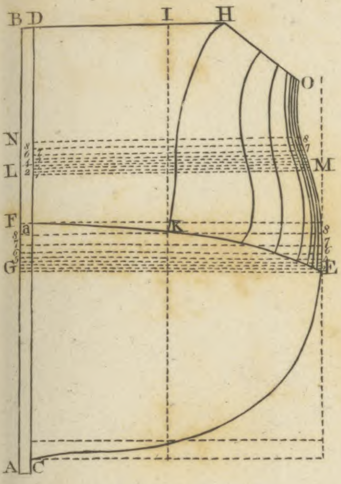


W. Train Sculp^t.

Fig. 27.



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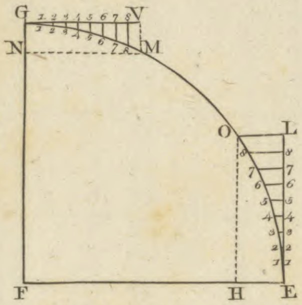

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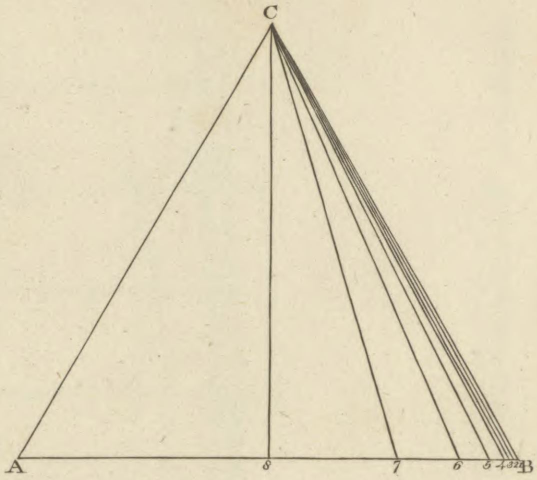

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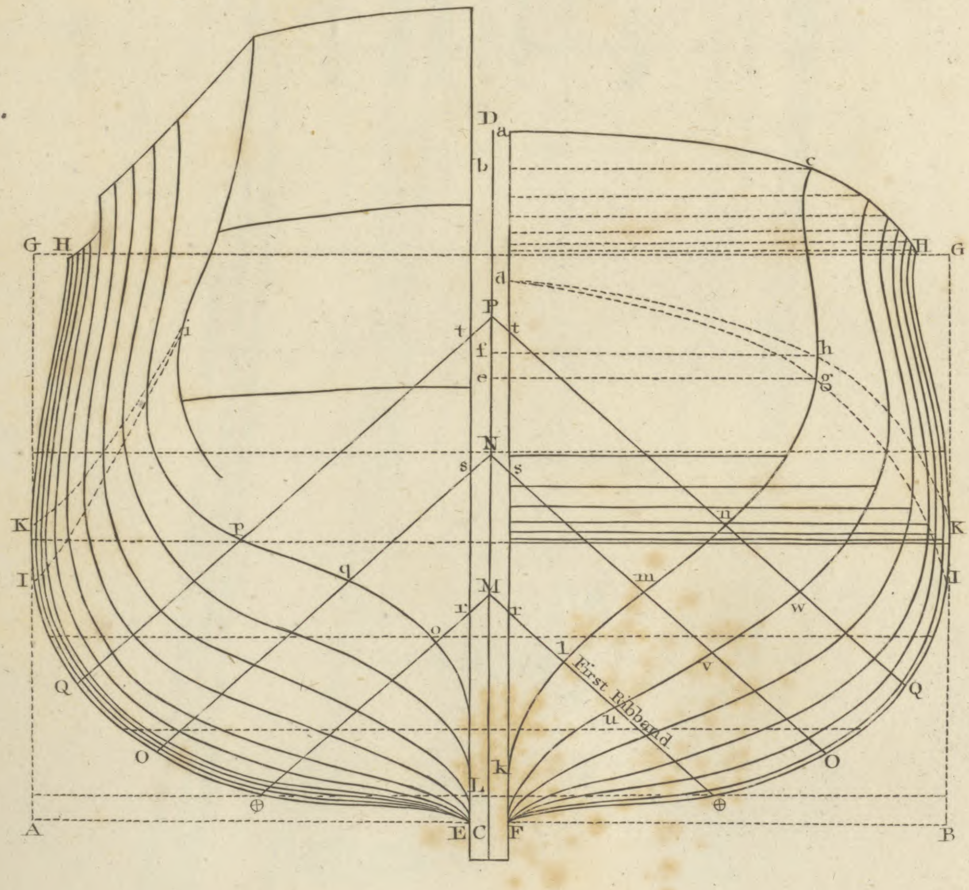


Wm Train Sculpt.

Fig. 30.

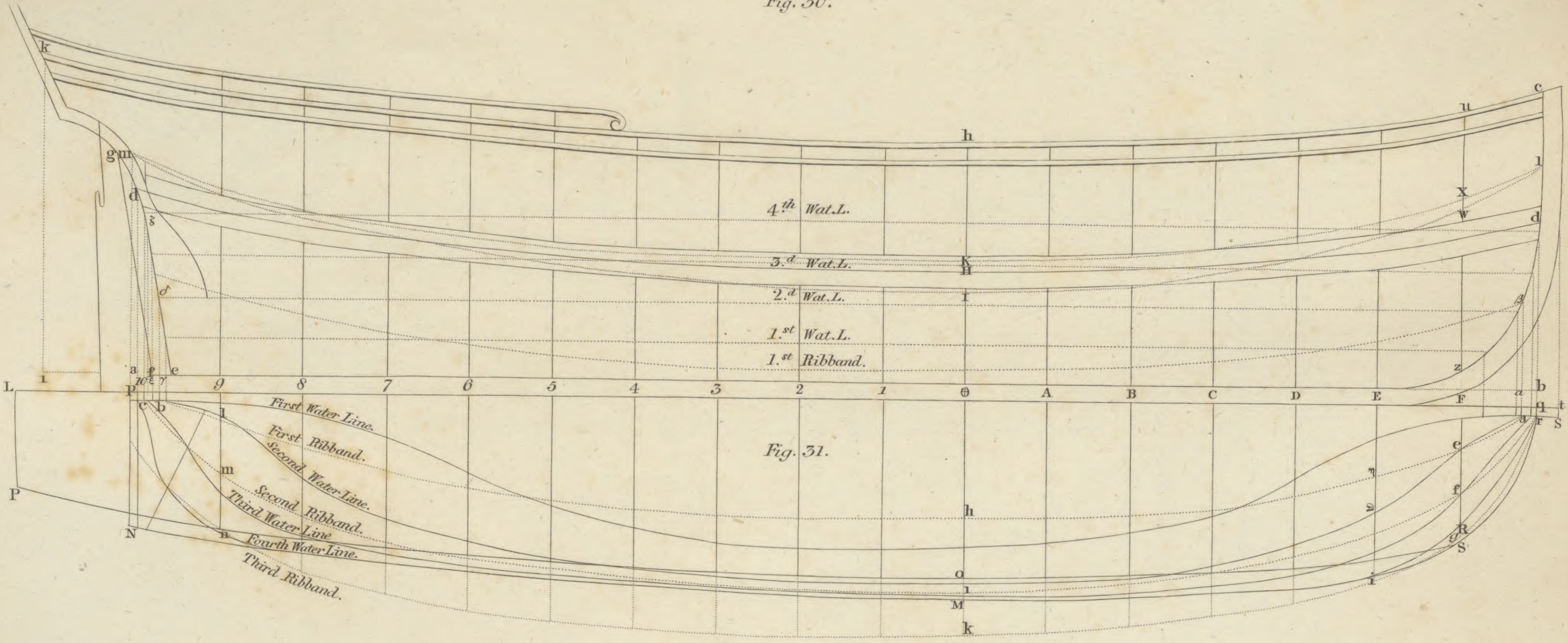
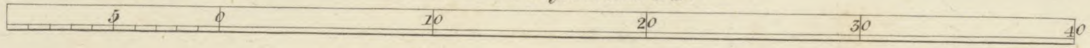


Fig. 31.

Scale of Feet to Fig. 30. 31. & 32.



W. Archibald sculp.t

Fig. 33.

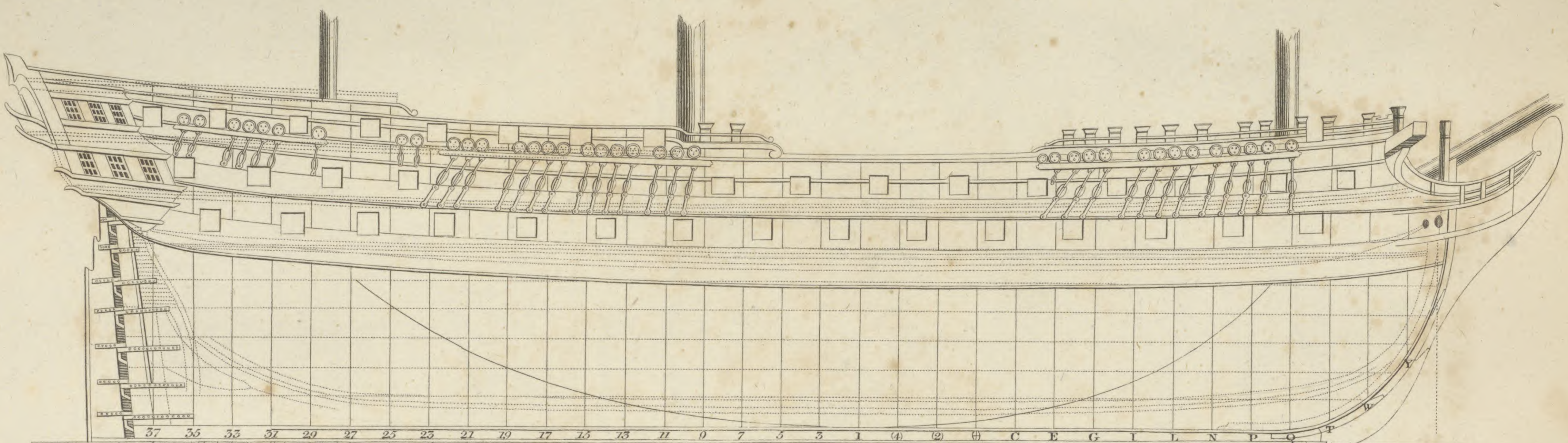
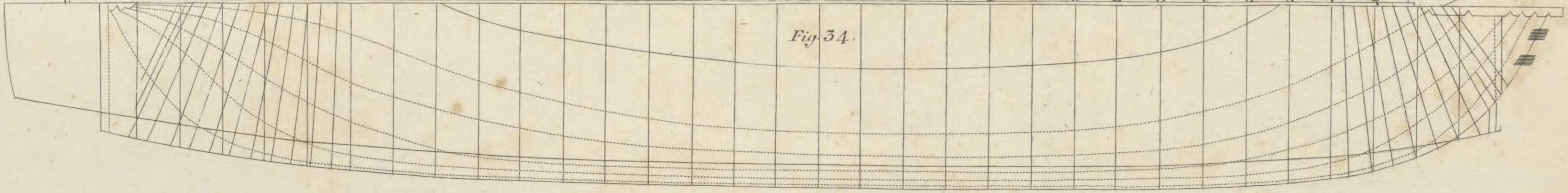
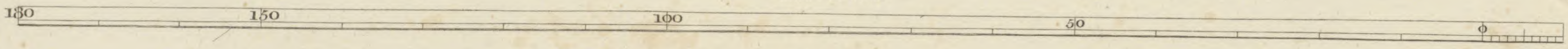


Fig. 34.

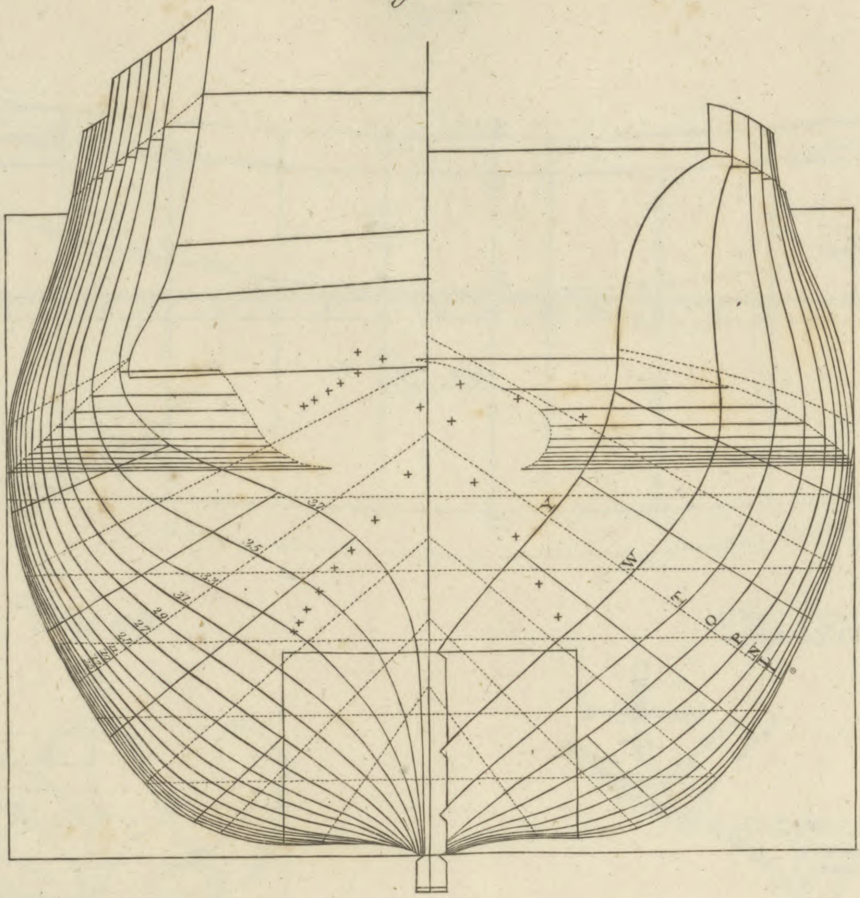


SCALE OF FEET.



W. Archibald Sculp.t

Fig. 35.



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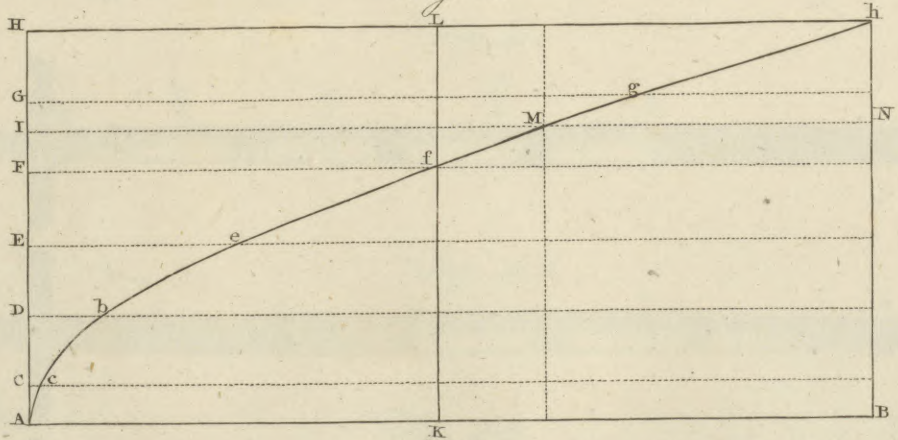
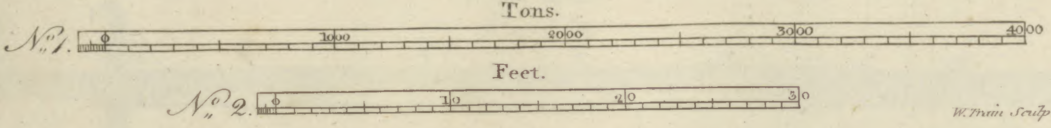
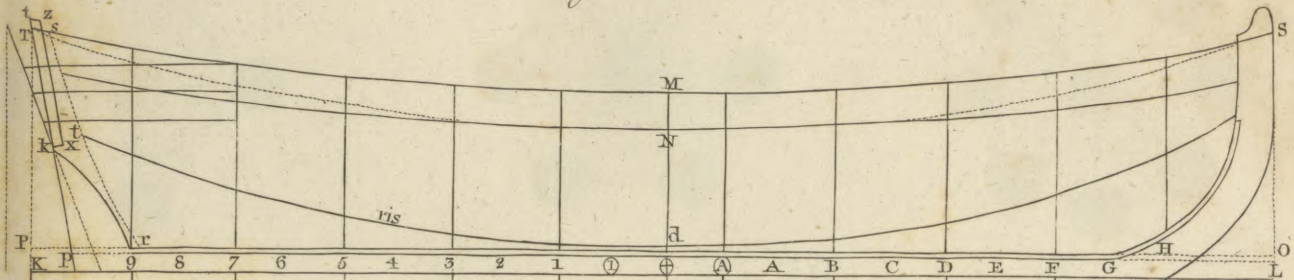




W. Train Sculpt.

Fig. 37.



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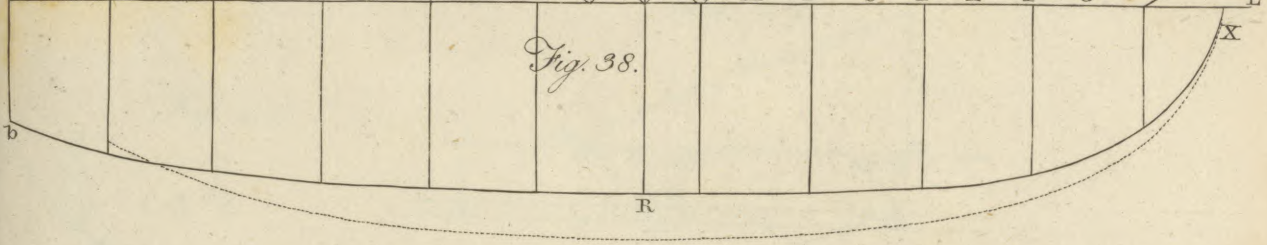

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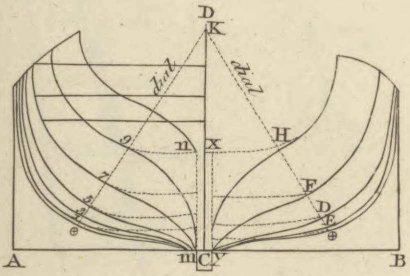

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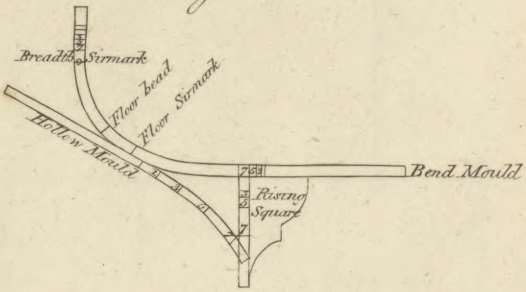

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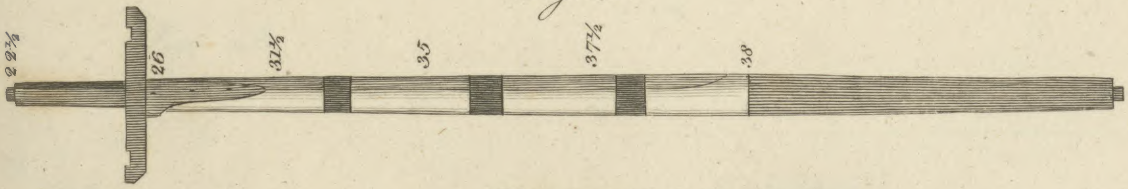


Fig. 42.

Fig. 43.

W. Train Sculp^t

SHIP-BUILDING. *PLATE CCCCXCIV.*

Fig. 44.

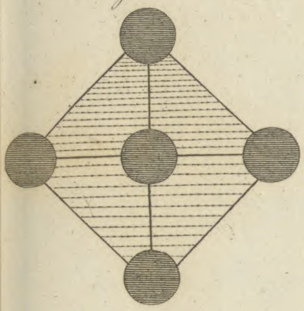
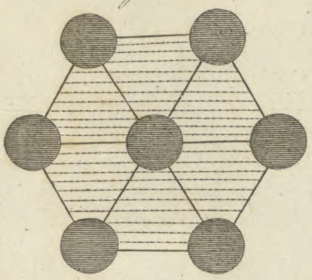


Fig. 45.



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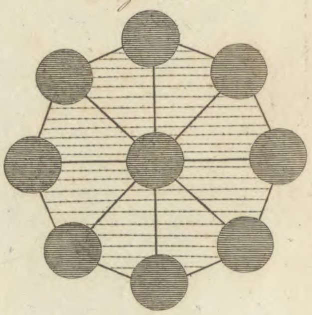


Fig. 49.

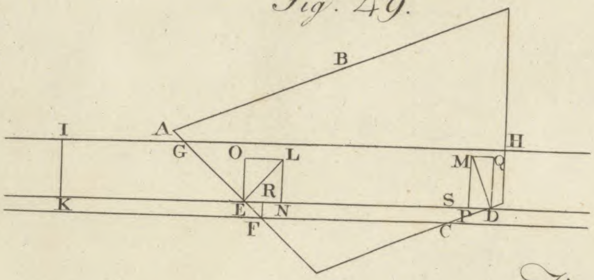


Fig. 47.

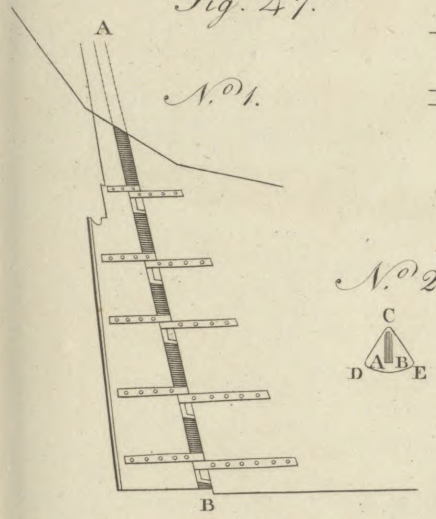


Fig. 50.

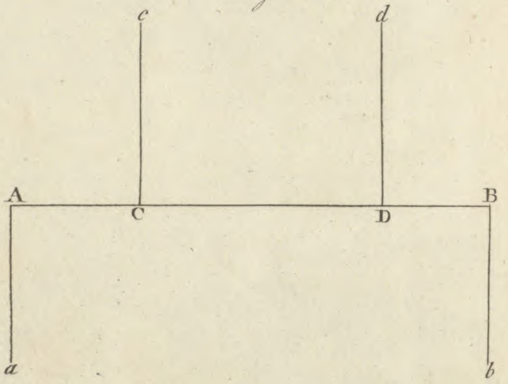
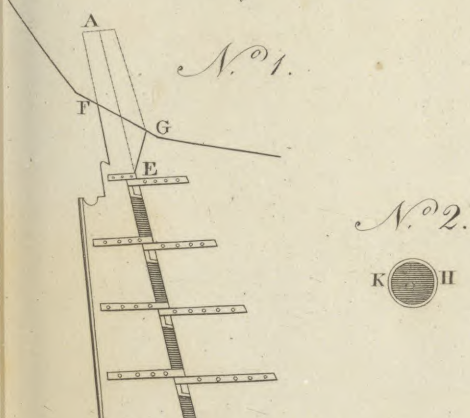
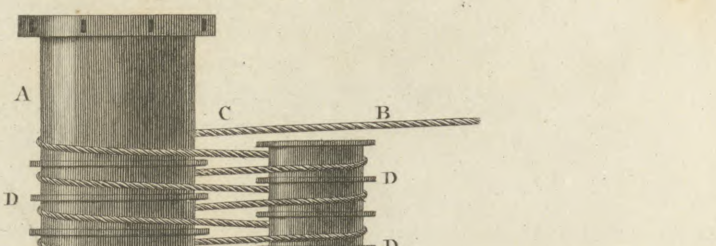


Fig. 48.



BOSWELL'S improved CAPSTAN.



W. Archibald sculp.t

SHIP-BUILDING. *PLATE CCCCXCV.*

Fig. 51.

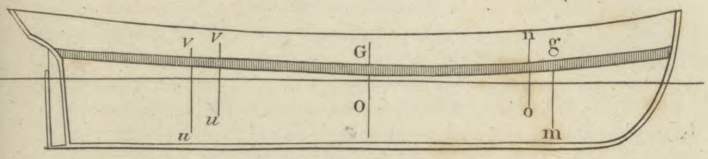


Fig. 52.

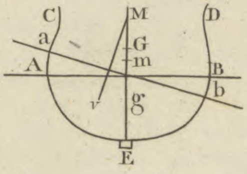


Fig. 53.

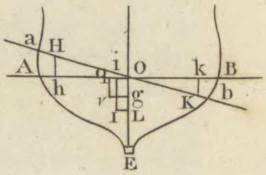


Fig. 54.

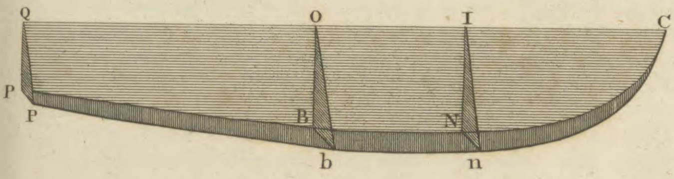


Fig. 55.

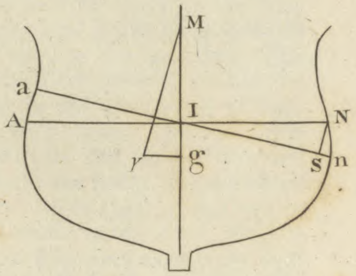


Fig. 56.

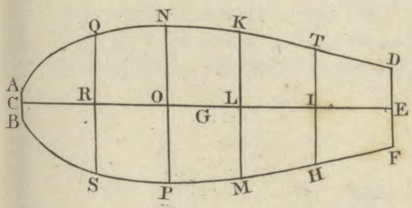


Fig. 57.

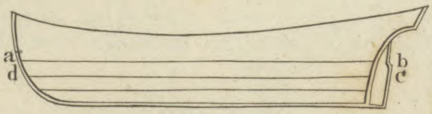


Fig. 58.

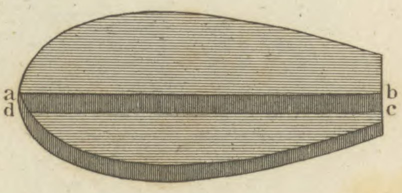
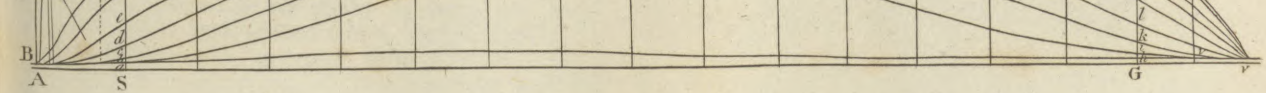


Fig. 59.



E. Mitchell sculp.

ſails, fore top and main top ſtayſails, and flying jibs, have clue-pieces two yards long. Square tack ſtayſails, have half a breadth of cloth at the fore part, with a clue-piece containing two yards, and a peek-piece, containing one yard.

“ Sails have two holes in each cloth, at the heads and reefs of courſes, topſails, and other ſquare ſails; one hole in every yard in the ſtay of flying jibs, and one in every three quarters of a yard in the ſtays of ſquare tack and other ſtayſails. Theſe are made by an inſtrument called a *pegging awl*, or a ſtabber, and are fenced round by ſtitching the edge to a ſmall grommet, made with log or other line; when finiſhed, they ſhould be well ſtretched or rounded up by a pricker or a marline ſpike. Reef and head holes of large ſails have grommets of twelve-thread line, worked round with 18 to 21 ſtitches; ſmaller ſails have grommets of nine-thread line, with 16 to 18 ſtitches, or as many as ſhall cover the line, and ſmaller holes in proportion. The holes for marling the clues of ſails and the top-brims of topſails have grommets of log-line, and ſhould have from 9 to 11 ſtitches; twelve holes are worked in each cloth. Main courſes have marling holes from the clue to the lower bow line cringle up the leech, and from the clue to the firſt buntline cringle on the foot. Fore courſes have marling holes one-eighth of the depth of the ſail up the leech, and from the clue to the firſt buntline cringle at the foot. Main and fore topſails have marling holes three feet each way from the clue and at the top-brims. Spritſails, mizen topſails, lower ſtayſails, main and fore top ſtayſails, and jibs, have marling holes two feet each way from the clues. All other ſails are ſewed home to the clues. Marling holes of courſes are at three-fourths of the depth of the tablings at the clues from the rope, and thoſe of topſails are at half the depth of the tablings at the clues and top brim from the rope.”

The rope, which is ſewed on the edges of ſails to prevent their rending, and which is called *bolt-rope*, ſhould be well made of fine yarn, ſpun from the beſt Riga rhine hemp well topt, and ſewed on with good Engliſh made twine of three threads, ſpun 200 fathom to the pound; the twine in the royal navy is dipped in a compoſition made with bees-wax 4 lbs. hogs lard 5 lbs. and clear turpentine one pound; and in the merchant ſervice, in tar ſoftened with oil. They ſhould be ſtoved in a ſtove by the heat of a flue, and not in a baker's oven or a ſtove tub; and tarred in the beſt Stockholm tar. The flexibility of them ſhould be always conſidered, in taking in the ſlack, which muſt reſt on the judgment of the ſailmaker.

“ Bolt ropes of courſes, topſails, and all other ſails, ſhould be neatly ſewed on through every buntline of the rope; and, to avoid ſtretching, the rope muſt be kept tightly twiſted while ſewing on, and care taken that neither too much nor too little ſlack is taken in; they are to be croſs ſtitched at the leeches every twelve inches in length; at every ſeam, and in the middle of every cloth at the foot, with three croſs-ſtitches: four croſs-ſtitches ſhould be taken at all beginnings and faſtenings off; the firſt ſtitch given twice, and the laſt three times. Small ſails have two croſs ſtitches at every ſeam, and three at every faſtening off.

“ On main and fore courſes two inches ſlack cloth ſhould be allowed in the head and foot, and one inch and a half in the leeches, in every yard in length. Topſails are allowed 3 inches ſlack in every cloth in the foot, one inch and a half in every yard in the leech, and two inches in every cloth left open in the top-brim. Mizen courſes have two inches ſlack in every yard in the foremoſt leech, but none in the after leech or foot. Spritſail courſes have no ſlack cloth. Jibs have four inches ſlack in every yard in the ſtay, one inch in every cloth in the foot, and none in the leech. Stayſails have three inches ſlack in every yard in the ſtay, one inch in every cloth in the foot, but none in the leech. Topgallant ſails have two inches ſlack in every cloth in the foot, and one inch in every yard in the leech. Studding ſails have an inch and a half ſlack in every yard in goring leeches, but no ſlack in ſquare leeches, and one inch in every cloth in the head and foot.”

Theſe directions for ſailmaking, we truſt may be uſeful. They are indeed very general, but the ſailmaker will find every inſtruction that he can want in the *Elements of Rigging and Seamanſhip*, a work which we therefore recommend to his attention.

SHIP'S Form Gauge, an inſtrument recommended by Mr Hutchinſon as fit to aſcertain any alteration in the bottom of a ſhip, by its hogging or ſagging; and alſo to regulate the ſtowage of a ſhip.

“ All ſhips (ſays he) of any conſequence are built with ſtaunchions fixed from the kelſon to the middle of all the lower-deck beams fore and aft, in order to ſupport them in their exact, regular height, as well as the whole frame of the ſhip in the regular form in which ſhe was built upon the ſtocks; yet notwithſtanding theſe ſtaunchions, it is proved from experience that our ſhips bottoms, hitherto, by the preſſure of water, and improper ſtowage, have generally been hogged upwards, or ſagged downwards, and moſt about the midſhip frame or main body of the ſhip, which is commonly about the fore part of the main hatchway; which naturally makes it the beſt place at which to fix the ſhip's form gauge, where either the hogging or ſagging of her bottom may be obſerved and ſeen ſooneſt and beſt, to regulate the ſtowage of heavy materials to the greateſt advantage, ſo as to keep her bottom nearly in the ſame form in which ſhe was built.

“ The gauge I recommend is nothing more than a narrow plate of iron divided into inches and quarters like the ſlide of a carpenter's rule. Let this be fixed to the after ſide of the ſtaunchion now mentioned, with its upper end projecting two or three inches above the ſtaunchion; a groove being cut out for it in the after ſide of the lower-deck beam, and a mark being made (when the ſhip is on the ſtocks) at the part of the beam which correſponds to the o on the gauge. When the ſhip alters in her ſhape, the gauge will ſlide up and down-

down in this groove, and the quantity of hogging or ſagging will be pointed out on the gauge by the mark on the beam. The ſtowage may then be ſo managed as to bring this mark to coincide again with the 0, or to approach it as near as we ſee neceſſary."

SHIP-Money, was an impoſition charged upon the ports, towns, cities, boroughs, and counties of this realm, in the reign of King Charles I. by writs, commonly called *ſhip-writs*, under the great ſeal of England, in the years 1635 and 1636, for the providing and furniſhing of certain ſhips for the king's ſervice, &c. which was declared to be contrary to the laws and ſtatutes of this realm, the *petition of right* and liberty of the ſubject, by ſtat. 17 Car. I. c. 14. See *Blackſtone's Commentaries*, vol. iv. p. 30.

SHIP-Shape, according to the faſhion of a ſhip, or in the manner of an expert ſailor; as, The maſt is not rigged ſhip-ſhape; Trim your ſails ſhip-ſhape.

Stowing and Trimming of SHIPS, the method of diſpoſing of the cargo in a proper and judicious manner in the hold of a ſhip.

A ſhip's ſailing, ſteering, ſtaying, and wearing, and being lively and comparatively eaſy at ſea in a ſtorm, depends greatly on the cargo, ballaſt, or other materials, being properly ſtowed, according to their weight and bulk, and the proportional dimenſions of the built of the ſhip, which may be made too crank or too ſtiff to paſs on the ocean with ſafety. Theſe things render this branch of knowledge of ſuch conſequence, that rules for it ought to be endeavoured after, if but to prevent, as much as poſſible, the danger of a ſhip overſetting at ſea, or being ſo labourſome as to roll away her maſts, &c. by being improperly ſtowed, which is often the caſe.

When a ſhip is new, it is prudent to conſult the builder, who may be ſuppoſed beſt acquainted with a ſhip of his own planning, and moſt likely to judge what her properties will be, to adviſe how the cargo or materials, according to the nature of them, ought to be diſpoſed of to advantage, ſo as to put her in the beſt ſailing trim; and at every favourable opportunity afterwards it will be proper to endeavour to find out her beſt trim by experiment.

Ships muſt differ in their form and proportional dimenſions; and to make them anſwer their different purpoſes, they will require different management in the ſtowage, which ought not to be left to mere chance, or done at random, as goods or materials happen to come to hand, which is too often the cauſe that ſuch improper ſtowage makes ſhips unfit for ſea: therefore the ſtowage ſhould be conſidered, planned, and contrived, according to the built and properties of the ſhip, which if they are not known ſhould be inquired after. If ſhe is narrow and high-built in proportion, ſo that ſhe will not ſhift herſelf without a great weight in the hold, it is a certain ſign ſuch a ſhip will require a great part of heavy goods, ballaſt, or materials, laid low in the hold, to make her ſtiff enough to bear ſufficient ſail without being in danger of overſetting. But if a ſhip be built broad and low in proportion, ſo that ſhe is ſtiff and will ſupport herſelf without any weight in the hold, ſuch a ſhip will require heavy goods, ballaſt, or materials, ſtowed higher up, to prevent her from being too ſtiff and labourſome at ſea, ſo as to endanger her maſts being rolled away, and the hull worked looſe and made leaky.

In order to help a ſhip's ſailing, that ſhe ſhould be lively and eaſy in her pitching and aſcending motions, it ſhould be contrived by the ſtowage, that the principal and weightieſt part of the cargo or materials ſhould lie as near the main body of the ſhip, and as far from the extreme ends, fore and aft, as things will admit of. For it ſhould be conſidered, that the roomy part of our ſhips lengthwiſe forms a ſweep or curve near four times as long as they are broad; therefore thoſe roomy parts at and above the water's edge, which are made by a full harping and a broad tranſom to ſupport the ſhip ſteady and keep her from plunging into the ſea, and alſo by the entrance and run of the ſhip having little or no bearing body under for the preſſure of the water to ſupport them, of courſe ſhould not be ſtowed with heavy goods or materials, but all the neceſſary vacancies, broken ſtowage, or light goods, ſhould be at theſe extreme ends fore and aft; and in proportion as they are kept lighter by the ſtowage, the ſhip will be more lively to fall and riſe eaſy in great ſeas; and this will contribute greatly to her working and ſailing, and to prevent her from ſtraining and hogging; for which reaſon it is a wrong practice to leave ſuch a large vacancy in the main hatchway, as is uſual, to coil and work the cables, which ought to be in the fore or after hatchway, that the principal weight may be more eaſily ſtowed in the main body of the ſhip, above the flatteſt and loweſt floorings, where the preſſure of the water acts the more to ſupport it.

Improved Capſtan of SHIPS.—A capſtan has been contrived by Mr Boſwell, which works without requiring the meſſenger or cable coiled around it, to be ever ſurged; an operation which is neceſſary with common capſtans, and is always attended with delay, and frequently with danger. This capſtan has been approved by ſome gentlemen connected with the Britiſh navy. A model of this machine was preſented to the Society for the Encouragement of Arts, and Mr Boſwell received the gold medal of the ſociety for his invention [*].

For the information of thoſe unacquainted with maritime affairs, Mr Boſwell gives an account of the manner in which cables are hauled on board of large ſhips. For the purpoſe of ſhewing the advantage of his improved capſtan, cables, he obſerves, above a certain diameter are too inflexible to admit of being coiled round a capſtan; in ſhips where cables of ſuch large dimenſions are neceſſary, a ſmaller cable is employed for this purpoſe, which is called the *meſſenger*, the two ends of which are made faſt together ſo as to form an endleſs rope, which, as the capſtan is turned about, rolls round it in unceaſing ſucceſſion, paſſing on its courſe to the head of the ſhip, and again returning to the capſtan. To this returning part of the meſſenger, the great cable is made faſt by a number of ſmall ropes called nippers, placed at regular intervals; theſe nippers are applied, as the cable enters the hawſe hole, and are again removed as it approaches the capſtan, after which it is lowered into the cable tier.

The meſſenger, or any other rope coiled round the capſtan, muſt deſcend a ſpace at every revolution equal to the diameter of the rope or cable uſed; this circum-

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[*] *Tranſ.* fo 1807. *Phi Mag.* xxxi 267.

ſtance brings the coils in a few turns to the bottom of the capſtan, when it can no longer be turned round, till the coils are looſened and raiſed up to its other extremity, after which the motion proceeds as before. This operation of ſhifting the place of the coils of the meſſenger on the capſtan is called *ſurging the meſſenger*. It always cauſes conſiderable delay; and when the meſſenger chances to ſlip in changing its poſition, which ſometimes happens, no ſmall danger is incurred by thoſe who are employed about the capſtan.

One method of preventing the neceſſity of ſurging, by placing a horizontal roller beneath the meſſenger when it firſt enters on the capſtan, adds conſiderably to the labour in turning the capſtan, and the great friction which the meſſenger muſt ſuffer, muſt occaſion a very great wear and injury to the meſſenger.

Another method to prevent ſurging was, that for which Mr Plucknet obtained a patent. In this way a number of upright lifters, placed round the capſtan, were made to riſe in ſucceſſion as the capſtan turned round by a circular inclined plane placed beneath them; a method Mr Boſwell thinks ſuperior to the former; but ſtill the wear of the meſſenger from the lateral friction in riſing againſt the whelps of the capſtan remains undiminiſhed.

A third method propoſed by Captain Hamilton, left the lateral friction, and wear of the meſſenger againſt the whelps of the capſtan, as great as in the others, having alſo the inconvenience of cauſing the coils to become looſe as they aſcend, the upper part of the barrel being nearly one third leſs in the diameter than the lower part.

In Mr Boſwell's method of preventing the neceſſity of ſurging, none of the lateral friction of the meſſenger or cable againſt the whelps of the capſtan, can poſſibly take place, and of courſe the wear of the meſſenger occaſioned thereby will be entirely avoided, while it performs its purpoſe with a leſs moving power than any of them.

His method conſiſts in the ſimple addition of a ſecond ſmaller barrel or capſtan of leſs dimenſions to the large one; beſide which it is to be placed in a ſimilar manner, and which need not in general exceed the ſize of a half barrel caſk. The coils of the meſſenger are to be paſſed alternately round the large capſtan and this ſmall barrel, but with their direction reverſed in the different barrels, ſo that they may croſs each other in the intervals between the barrels, in order to have the more extenſive contact with, and better gripe on each barrel. To keep the coils diſtinct, and prevent their touching each other in paſſing from one barrel to the other, projecting rings are faſtened round each barrel at a diſtance from each other equal to about two diameters of the meſſenger, and the thickneſs of the ring. Thoſe rings ſhould be ſo fixed on the two barrels that thoſe on one barrel ſhould be exactly oppoſite the middle of the intervals between thoſe on the other barrel; the only circumſtance which requires particular attention in the conſtruction of this capſtan. The rings ſhould project about as much as the meſſenger from the barrels, which may be formed with whelps, and in every other reſpect, not before mentioned, in the uſual manner for capſtan barrels. The ſmall barrel ſhould be furniſhed with falling palls as well as the large one; a fixed iron ſpindle aſcending from the deck will be the beſt for it, as it will take up leſs room. The ſpindle may be ſecured below the deck, ſo as to bear any ſtrain, as the ſmall barrel need not be much above half the height of the large barrel; the capſtan bars can eaſily paſs over it in heaving round, when it is thought fit to uſe capſtan bars on the ſame deck with the ſmall barrel. As two turns of the meſſenger round both barrels will be at leaſt equivalent to three turns round the common capſtan, it will ſcarcely ever be neceſſary to uſe more than four turns round the two barrels.

That which prevents the lateral friction of the meſſenger in Mr Boſwell's double capſtan is, that in it each coil is kept diſtinct from the reſt, and muſt paſs on to the ſecond barrel before it can gain the next elevation on the firſt, by which no one coil can have any influence in raiſing or depreſſing another; and what each ſeparate coil deſcends in a ſingle revolution it regains as much as is neceſſary in its paſſage between the barrels when in the air, and free from all contact with any part of the apparatus, it attains a higher elevation without a poſſibility of friction or wear.

It is equally applicable in large and in ſmaller veſſels, in the former of which meſſengers are neceſſary, from the ſize of the cables; but in the latter alſo, where cables can be managed with the ſame eaſe as meſſengers. The ſame principle may be alſo eaſily applied to windlaſſes, by having a ſmall horizontal barrel placed parallel to the body of the windlaſs, and having both fitted with rings in the ſame way as is propoſed for the capſtan. The place for the ſmall horizontal barrel is forward, juſt before the windlaſs, and it ſhould alſo be furniſhed with catch polls.

Beſides the advantages now ſtated, the improved capſtan is ſimple in its conſtruction, can be fitted up at ſmall expence, is eaſily repaired, and requires but little room.

Plate ccccxciv.

A repreſents the common capſtan; B, another of ſmaller dimenſions; C, the coils of the meſſenger paſſing alternately round the large and ſmall capſtans, but with the direction reverſed on the different barrels, ſo that they may croſs each other in the interval between them; DDDD, are projecting rings round each barrel, ſo fixed on the two barrels, that thoſe on one barrel ſhould be exactly oppoſite the middle of the intervals between thoſe on the other barrel.

Machine for meaſuring a SHIP'S *Way*.—We have already deſcribed a variety of machines or inſtruments which have been propoſed for this purpoſe under the article LOG. In this place, therefore, we ſhall confine ourſelves to the machine invented by Francis Hopkinſon, Eſq. Judge of the Admiralty in Pennſylvania.—After having ſhown the fallacies to which the common log, and alſo that particular kind of inſtrument invented by M. Saumarez, are liable, he proceeds to deſcribe his own machine as follows:

Tranſactions of the American Philoſophical Society, vol. ii. p. 160.

Plate cccclxxxiii. fig. 5.

This machine, in its moſt ſimple form, is repreſented by fig. 5. wherein AB is a ſtrong rod of iron moveable on the fulcrum C. D is a thin circular palate of braſs rivetted to the lower extremity of the rod. E a horizontal arm connected at one end with the top of the rod AB by a moveable joint F, and at the other end with the bottom of the index H, by a like moveable joint G. H is the index turning on its centre I, and travelling over the graduated arch K; and L is a ſtrong ſpring, bearing againſt the rod AB, and conſtantly counteracting the preſſure upon the palate D.

The rod AB ſhould be applied cloſe to the cut-water or ſtem, and ſhould be of ſuch a length that the palate D may be no higher above the keel than is neceſſary to ſecure it from injury when the veſſel is aground, or ſails in ſhoal water. As the bow of the ſhip curves inward towards the keel M, the palate D will be thrown to a diſtance from the bottom of the veſſel, although the perpendicular rod to which it is annexed lies cloſe to the bow above; and therefore the palate will be more fairly acted upon. The arm E ſhould enter the bow ſomewhere near the hawſe hole, and lead to any convenient place in the forecaſtle, where a ſmooth board or plate may be fixed, having the index H, and graduated arch K, upon it.

It is evident from the figure, that as the ſhip is urged forward by the wind, the palate D will be preſſed upon by the reſiſting medium, with a greater or leſs force, according to the progreſſive motion of the ſhip; and this will operate upon the levers ſo as to immediately affect the index, making the leaſt increaſe or diminution of the ſhip's way viſible on the graduated arch; the ſpring L always counteracting the preſſure upon the palate, and bringing back the index, on any relaxation of the force impreſſed.

This machine is advantageouſly placed at the bow of the ſhip, where the current firſt begins, and acts fairly upon the palate, in preference to the ſtern, where the tumultuous cloſing of the water cauſes a wake, viſible to a great diſtance. The palate D is ſunk nearly as low as the keel, that it may not be influenced by the heaping up of the water and the daſhing of the waves at and near the water line. The arch K is to aſcertain how many knots or miles ſhe would run in one hour at her then rate of ſailing. But the graduations on this arch muſt be unequal; becauſe the reſiſtance of the ſpring L will increaſe as it becomes more bent, ſo that the index will travel over a greater ſpace from one to five miles than from five to twelve. Laſtly, The palate, rod, ſpring, and all the metallic parts of the inſtrument, ſhould be covered with a ſtrong varniſh, to prevent ruſt from the corroſive quality of the ſalt water and ſea-air.

Fig. 5. This machine may be conſiderably improved as follows: Let the rod or ſpear AB (fig. 5.) be a round rod of iron or ſteel, and inſtead of moving on the fulcrum or joint, as at C, let it paſs through and turn freely in a ſocket, to which ſocket the moveable joint muſt be annexed, as repreſented in fig. 6. Fig. 6. The rod muſt have a ſhoulder to bear on the upper edge of the ſocket, to prevent its ſlipping quite down. The rod muſt alſo paſs through a like ſocket at F, fig. 5. The joint of the lower ſocket muſt be fixed to the bow of the ſhip, and the upper joint or ſocket muſt be connected with the horizontal arm E. On the top of the uppermoſt ſocket let there be a ſmall circular plate, bearing the 32 points of the mariner's compaſs; and let the top of the rod AB come through the centre of this plate, ſo as to carry a ſmall index upon it, as is repreſented in fig. 7. Fig 7. This ſmall index muſt be fixed to the top of the rod on a ſquare, ſo that by turning the index round the plate, the rod may alſo turn in the ſockets, and of courſe carry the palate D round with it; the little index always pointing in a direction with the face of the palate. The ſmall compaſs plate ſhould not be faſtened to the top of the ſocket, but only fitted tightly on, that it may be moveable at pleaſure. Suppoſe then the intended port to bear S. W. from the place of departure, the palate muſt be turned on the ſocket till the ſouth-weſt point therein looks directly to the ſhip's bow; ſo that the ſouth-weſt and north-eaſt line on the compaſs plate may be preciſely parallel with the ſhip's keel, and in this poſition the plate muſt remain during the whole voyage. Suppoſe, then, the ſhip to be ſailing in the direct courſe of her intended voyage, with her bowſprit pointing ſouth-weſt. Let the little index be brought to the ſouth-weſt point on the compaſs plate, and the palate D will neceſſarily preſent its broad face toward the port of deſtination; and this it muſt always be made to do, be the ſhip's courſe what it may. If, on account of unfavourable winds, the ſhip is obliged to deviate from her intended courſe, the little index muſt be moved ſo many points from the ſouth-weſt line of the compaſs plate as the compaſs in the binnacle ſhall ſhow that ſhe deviates from her true courſe; ſo that in whatever direction the ſhip ſhall ſail, the palate D will always look full to the ſouth-weſt point of the horizon, or towards the port of deſtination, and conſequently will preſent only an oblique ſurface to the reſiſting medium, more or leſs oblique as the ſhip deviates more or leſs from the true courſe of her voyage. As, therefore, the reſiſtance of the water will operate leſs upon the palate in an oblique than in a direct poſition, in exact proportion to its obliquity, the index H will not ſhow how many knots the veſſel runs in her then courſe, but will indicate how many ſhe gains in the direct line of her intended voyage.—Thus, in fig. 9. Fig. 9. if the ſhip's courſe lies in the direction of the line AB, but ſhe can ſail by the wind no nearer than AC; ſuppoſe, then, her progreſſive motion ſuch as to perform AC equal to five knots or miles in an hour, yet the index H will only point to four knots on the graduated arch, becauſe ſhe gains no more than at that rate on the true line of her voyage, viz. from A to B. Thus will the difference between her real motion and that pointed out by the index be always in proportion to her deviation from her intended port, until ſhe ſails in a line at right angles therewith, as AD; in which caſe the palate would preſent only a thin ſharp edge to the reſiſting medium, the preſſure of which ſhould not be ſufficient to overcome the friction of the machine and the bearing of the ſpring L. So that at whatever rate the ſhip may ſail on that line, yet the index will not be affected, ſhowing that ſhe gains nothing on her true courſe. In this caſe, and alſo when the veſſel is not under way, the action of the ſpring L ſhould cauſe the index to point at O, as repreſented by the dotted lines in fig. 5. and 8.

As the truth of this inſtrument muſt depend on the equal preſſure of the reſiſting medium upon the palate D, according to the ſhip's velocity, and the proportionable action of the ſpring L, there ſhould be a pin or ſcrew at the joints C and F, ſo that the rod may be readily unſhipped and taken in, in order to clean the palate from any foulneſs it may contract, which would greatly increaſe its operation on the index H, and thereby render the graduated arch falſe and uncertain.

Further, the ſpring L may be expoſed too much to injury from the ſalt water, if fixed on the outſide of the ſhip's bow. To remedy this, it may be brought under cover, by conſtructing the machine as repreſented by fig. 8. where AB is the rod, C the fulcrum or centre Fig. 8.

of its motion, D the palate, E the horizontal arm leading through a ſmall hole into the forecaſtle; M is a ſtrong chain faſtened at one end to the arm E, and at the other to a rim or barrel on the wheel G, which by means of its teeth gives motion to the ſemicircle I and index H. The ſpring L is ſpiral, and encloſed in a box or barrel, like the main-ſpring of a watch. A ſmall chain is fixed to, and paſſing round the barrel, is faſtened by the other end to the fuzee W. This fuzee is connected by its teeth with the wheel G, and counteracts the motion of the palate D. N, N, are the two ſockets through which the rod AB paſſes, and in which it is turned round by means of the little index R. S is the ſmall compaſs plate, moveable on the top of the upper ſocket N. The plate S hath an upright rim round its edge, cut into teeth or notches, ſo that when the index R is a little raiſed up, in order to bring it round to any intended point, it may fall into one of theſe notches, and be detained there; otherwiſe the preſſure of the water will force the palate D from its oblique poſition, and turn the rod and index round to the direction in which the ſhip ſhall be then ſailing.—Should it be apprehended that the palate D, being placed ſo far forward, may affect the ſhip's ſteerage, or obſtruct her rate of ſailing, it ſhould be conſidered that a very ſmall plate will be ſufficient to work the machine, as one of three or four inches in diameter would probably be ſufficient, and yet not large enough to have any ſenſible effect on the helm or ſhip's way.

The greateſt difficulty, perhaps, will be in graduating the arch K, (if the machine is conſtructed as in fig. 5.); the unequal diviſions of which can only be aſcertained by actual experiment on board of each ſhip reſpectively, inaſmuch as the accuracy of theſe graduations will depend on three circumſtances, viz. the poſition of the fulcrum C with reſpect to the length of the rod, the ſize of the palate D, and the ſtrength or bearing of the ſpring L. When theſe graduations, however, are once aſcertained for the machine on board of any one veſſel, they will not want any future alterations, provided the palate D be kept clean, and the ſpring L retains its elaſticity.

But the unequal diviſions of the graduated arch will be unneceſſary, if the machine is conſtructed as in fig. 8.; for as the chain goes round the barrel L, and then winds through the ſpiral channel of the fuzee W, the force of the main ſpring muſt operate equally, or nearly ſo, in all poſitions of the index, and conſequently the diviſions of the arch K may in ſuch caſe be equal.

After all, it is not expected that a ſhip's longitude can be determined to a mathematical certainty by this inſtrument. The irregular motions and impulſes to which a ſhip is continually expoſed, make ſuch an accuracy unattainable perhaps by any machinery: But if it ſhould be found, as we flatter ourſelves it will on fair experiment, that it anſwers the purpoſe much better than the common log, it may be conſidered as an acquiſition to the art of navigation.

It ſhould be obſerved, that in aſcertaining a ſhip's longitude by a time-piece, this great inconvenience occurs, that a ſmall and trifling miſtake in the time makes a very great and dangerous error in the diſtance run: Whereas the errors of this machine will operate no farther than their real amount; which can never be great or dangerous, if corrected by the uſual obſervations made by mariners for correcting the common log.

A like machine, made in its ſimple form (as at fig. 5), ſo conſtructed as to ſhip and unſhip, might occaſionally be applied alongſide about midſhips, in order to aſcertain the leeway; which, if rightly ſhown, will give the ſhip's preciſe longitude. As to ſea currents, this and all other machines hitherto invented muſt be ſubject to their influence; and proper allowances muſt be made according to the ſkill and knowledge of the navigator.

Laſtly, ſome diſcretion will be neceſſary in taking obſervations from the machine to be entered on the log-book: that is, the moſt favourable and equitable moment ſhould be choſen for the obſervation; not whilſt the ſhip is rapidly deſcending the declivity of a wave, or is ſuddenly checked by a ſtroke of the ſea, or is in the very act of plunging. In all caſes, periods may be found in which a ſhip proceeds with a true average velocity; to diſcover which, a little experience and attention will lead the ſkilful mariner.

It has been obſerved of the machine now deſcribed, that an ingenious mechanic would probably conſtruct it to better advantage in many reſpects. The author only meant to ſuggeſt the principle; experiment alone can point out the beſt method of applying it. He is ſenſible of at leaſt one deficiency, viz. that the little index R, fig. 4. will not be ſtrong enough to retain the palate D in an oblique poſition when the ſhip is ſailing by the wind; more eſpecially as the compaſs plate S, in whoſe notched rim the index R is to fall, is not fixed to, but only fitted tight on the ſocket N. Many means, however, might be contrived to remedy this inconvenience.

SHIP-Wreck. A French author has lately propoſed ſome methods of ſaving the lives of perſons ſhipwrecked near the coaſt. He obſerves, that the moſt proper means for ſaving the crews of ſhipwrecked veſſels is, to eſtabliſh a rope of communication from them to the ſhore. To a bomb or cannon ball ſhould be faſtened the end of a rope, extended afterwards in a zig-zag direction before the mortar or cannon, or ſuſpended on a piece of wood raiſed ſeveral feet. But as it was neceſſary to know if the cord would not break by the force of the exploſion and the velocity of the motion, the author thought it proper to conſult profeſſional men. He accordingly wrote to ſome officers of the artillery in garriſon at La Fere in France, and they almoſt all replied that the rope would infallibly break.

Not deeming this anſwer ſatiſfactory, he happily conceived the idea of making the experiment on a ſmall ſcale. He cauſed a piece of the barrel of a muſket to be filed into the form of a ſmall mortar of 18 lines in length internally; and having tied a packthread to a common ball of lead, he made an experiment which perfectly ſucceeded, as did many others which he afterwards repeated, even with the ſtrongeſt charges of powder. This ſucceſs he communicated to the officers of artillery, who replied, that there was a great difference between a quarter of an ounce of powder and four or five pounds employed for a bomb; and were ſtill of opinion that the rope would break.

Having already made experiments, he was ſtill diſpoſed to doubt the truth of this aſſertion, and therefore tried a four-inch mortar with a ball of the ſame calibre, and 18 ounces of powder with a rope only three or four

four lines in diameter, and his ſucceſs was equally flattering as before. Theſe experiments were repeated by order of government at La Fere, four times with an eight inch mortar, and three times with one of twelve inches, all of which happily ſucceeded. The ſame author goes on to obſerve;

"It ought to be remembered, that a veſſel is never caſt away, or periſhes on the coaſt, but becauſe it is driven thither againſt the will of the captain, and by the violence of the waves and the wind, which almoſt always blows from the ſea towards the ſhore, without which there would be no danger to be apprehended: conſequently in theſe circumſtances, the wind comes always from the ſea, either directly or obliquely, and blows towards the ſhore.

"1ſt, A common paper kite, therefore, launched from the veſſel and driven by the wind to the ſhore, would be ſufficient to ſave a crew of 1500 ſeamen, if ſuch were the number of a ſhip of war. This kite would convey to the ſhore a ſtrong packthread, to the end of which might be affixed a cord, to be drawn on board by means of the ſtring of the kite; and with this cord a rope, or as many as ſhould be neceſſary, might be conveyed to the ſhip.

"2d, A ſmall balloon, of ſix or ſeven feet in diameter, and raiſed by rarefied air, would be alſo an excellent means for the like purpoſe. Being driven by the wind from the veſſel to the ſhore, it would carry thither a ſtring capable of drawing a cord with which ſeveral ropes might be afterwards conveyed to the veſſel. Had not the diſcovery of Montgolfier produced any other benefit, it would be entitled on this account to be conſidered as of great importance.

"3dly, A ſky-rocket, of a large diameter, would be of equal ſervice. It would alſo carry, from the veſſel to the ſhore, a ſtring capable of drawing a rope after it.

"Laſtly, A fourth plan for ſaving the crew of a ſhipwrecked veſſel, is that of throwing from the veſſel into the ſea an empty caſk with a cord attached to it. The wind and the waves would drive the caſk to the ſhore, and afford the means of eſtabliſhing that rope of communication already mentioned."

The author juſt quoted ſays, that he announced his diſcovery in a French journal in January 1794. It is, however, to be obſerved, that the method he propoſes of conveying a rope to the ſhore, by faſtening it to a bullet or bomb, to be afterwards fired from a cannon or mortar, was propoſed ſome years ago by a ſerjeant or officer of artillery at Woolwich, and it is ſaid, ſimilar experiments were made at Portſmouth, and ſucceeded*.

SHIRAUZ. See SCHIRAS.

SHIRE, is a Saxon word ſignifying a diviſion; but a county, *comitatus*, of the ſame import, is plainly derived from *comes*, "the count of the Franks;" that is, the earl or alderman (as the Saxons called him) of the ſhire, to whom the government of it was entruſted. This he uſually exerciſed by his deputy, ſtill called in Latin *vice-comes*, and in Engliſh the *ſheriff*, *ſhrieve*, or *ſhire-reeve*, ſignifying the "officer of the ſhire;" upon whom, in proceſs of time, the civil adminiſtration of it totally devolved. In ſome counties there is an intermediate diviſion between the ſhire and the hundred; as lathes in Kent and rapes in Suſſex, each of them containing about three or four hundred a-piece. Theſe had formerly their lathe-reeves and rape-reeves, acting in ſubordination to the ſhire-reeve. Where a county is divided into three of theſe intermediate juriſdictions, they are called *trithings*, which were anciently governed by a trithing reeve. Theſe trithings ſtill ſubſiſt in the large county of York, where, by an eaſy corruption, they are denominated *ridings*; the north, the eaſt, and the weſt ridings.

SHIRL, SHORL, or COCKLE, a ſpecies of mineral. See SCHORL, MINERALOGY *Index*.

SHIRT, a looſe garment, commonly of linen, worn next the body.—Some doubt the propriety of changing the linen when a perſon is ſick. Clean linen promotes perſpiration; and it may be renewed as often as the patient pleaſes, whether the diſorder be of the acute or the chronical kind. Except during a criſis in fevers, whilſt the patient is in a ſweat, a change of linen, if well dried and warmed, may be daily uſed.

Shirts were not worn by the Jews, Greeks, or Romans, but their place was ſupplied by thin *tunicæ* of wool. The want of linen among the ancients made frequent waſhings and ablutions neceſſary.

SHIVER, a name given by miners to ſome of the ſtrata which accompany coal. See SCHISTUS, MINERALOGY *Index*.

SHIVERS, in the ſea language, names given to the little rollers, or round wheels of pulleys.

SHOAD, among miners, denotes a train of metalline ſtones, ſerving to direct them in the diſcovery of mines.

SHOAD-Stones, a term uſed by the miners of Cornwall and other parts of this kingdom, to expreſs ſuch looſe maſſes of ſtone as are uſually found about the entrances into mines, ſometimes running in a ſtraight courſe from the load or vein of ore to the ſurface of the earth.

Theſe are ſtones of the common kinds, appearing to have been pieces broken from the ſtrata or larger maſſes; but they uſually contain mundic, or marcaſitic matter, and more or leſs of the ore to be found in the mine. They appear to have been at ſome time rolled about in water, their corners being broken off, and their ſurface ſmoothed and rounded.

The antimony mines in Cornwall are always eaſily diſcovered by the ſhoad-ſtones, theſe uſually lying up to the ſurface, or very nearly ſo; and the matter of the ſtone being a white ſpar, or debaſed cryſtal, in which the native colour of the ore, which is a ſhining bluiſh black, eaſily diſcovers itſelf in ſtreaks and threads.

Shoad-ſtones are of ſo many kinds, and of ſuch various appearances, that it is not eaſy to deſcribe or know them; but the miners, to whom they are of the greateſt uſe in the tracing or ſearching after new mines, diſtinguiſh them from other ſtones by their weight; for if very ponderous, though they look ever ſo much like common ſtones, there is great reaſon to ſuſpect that they contain ſome metal. Another mark of them is their being ſpongy and porous; this is a ſign of eſpecial uſe in the tin countries; for the tin ſhoad-ſtones are often ſo porous and ſpongy, that they reſemble large bodies thoroughly calcined. There are many other appearances of tin ſhoads, the very hardeſt and firmeſt ſtones often containing this metal.

When the miners, in tracing a ſhoad up hill, meet with ſuch odd ſtones and earths that they know not well what to make of them, they have recourſe to vanning, that is, they calcine and powder the ſtone, clay, or whatever elſe is ſuppoſed to contain the metal; and then

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* *Phil. Mag.* vol. iv. p. 247.

then waſhing it in an inſtrument, prepared for that purpoſe, and called a *vanning ſhovel*, they find the earthy matter waſhed away, and of the remainder, the ſtony or gravelly matter lies behind, and the metalline matter at the point of the ſhovel. If the perſon who performs this operation has any judgment, he eaſily diſcovers not only what the metal is that is contained in the ſhoad, but alſo will make a very probable gueſs at what quantity the mine is likely to yield of it in proportion to the ore.

SHOAL, in the ſea language, denotes a place where the water is ſhallow; and likewiſe a great quantity of fiſhes, ſuch as a *ſhoal of herrings*.

SHOCK, in *Electricity*. The effect of the exploſion of a charged body, that is, the diſcharge of its electricity on any other body, is called the *electric ſhock*.

SHOE, a covering for the foot, uſually of leather.

SHOES, among the Jews, were made of leather, linen, ruſh, or wood; thoſe of ſoldiers were ſometimes of braſs or iron. They were tied with thongs which paſſed under the ſoles of the feet. To put off their ſhoes was an act of veneration; it was alſo a ſign of mourning and humiliation: to bear one's ſhoes, or to untie the latchets of them, was conſidered as the meaneſt ſervice.

Among the Greeks ſhoes of various kinds were uſed. Sandals were worn by women of diſtinction. The Lacedemonians wore red ſhoes. The Grecian ſhoes generally reached to the middle of the leg. The Romans uſed two kinds of ſhoes; the *calceus*, which covered the whole foot ſomewhat like our ſhoes, and was tied above with latchets or ſtrings; and the *ſolea* or ſlipper, which covered only the ſole of the foot, and was faſtened with leathern thongs. The calceus was always worn along with the *toga* when a perſon went abroad: ſlippers were put on during a journey and at feaſts, but it was reckoned effeminate to appear in public with them. Black ſhoes were worn by the citizens of ordinary rank, and white ones by the women. Red ſhoes were ſometimes worn by the ladies, and purple ones by the coxcombs of the other ſex. Red ſhoes were put on by the chief magiſtrates of Rome on days of ceremony and triumphs. The ſhoes of ſenators, patricians, and their children, had a creſcent upon them which ſerved for a buckle; theſe were called *calcei lunati*. Slaves wore no ſhoes; hence they were called *cretati* from their duſty feet. Phocion alſo and Cato Uticenſis went without ſhoes. The toes of the Roman ſhoes were turned up in the point; hence they were called *calcei roſtrati*, *repandi*, &c.

In the 9th and 10th centuries the greateſt princes of Europe wore wooden ſhoes, or the upper part of leather and the ſole of wood. In the reign of William Rufus, a great beau, Robert, ſurnamed *the horned*, uſed ſhoes with long ſharp points, ſtuffed with tow, and twiſted like a ram's horn. It is ſaid, the clergy, being highly offended, declaimed againſt the long-pointed ſhoes with great vehemence. The points, however, continued to increaſe till, in the reign of Richard II. they were of ſo enormous a length that they were tied to the knees with chains, ſometimes of gold, ſometimes of ſilver. The upper parts of theſe ſhoes in Chaucer's time were cut in imitation of a church window. The long-pointed ſhoes were called *crackowes*, and continued in faſhion for three centuries in ſpite of the bulls of popes, the decrees of councils, and the declamations of the clergy. At length the parliament of England interpoſed by an act A. D. 1463, prohibiting the uſe of ſhoes or boots with pikes exceeding two inches in length, and prohibiting all ſhoemakers from making ſhoes or boots with longer pikes under ſevere penalties. But even this was not ſufficient: it was neceſſary to denounce the dreadful ſentence of excommunication againſt all who wore ſhoes or boots with points longer than two inches. The preſent faſhion of ſhoes was introduced in 1633, but the buckle was not uſed till 1670.

In Norway they uſe ſhoes of a particular conſtruction, conſiſting of two pieces, and without heels; in which the upper leather ſits cloſe to the foot, the ſole being joined to it by many plaits or folds.

The ſhoes or ſlippers of the Japaneſe, as we are informed by Profeſſor Thunberg, are made of rice-ſtraw woven, but ſometimes for people of diſtinction of fine ſlips of ratan. The ſhoe conſiſts of a ſole, without upper leather or hind-piece; forwards it is croſſed by a ſtrap, of the thickneſs of one's finger, which is lined with linen; from the tip of the ſhoe to the ſtrap a cylindrical ſtring is carried, which paſſes between the great and ſecond toe, and keeps the ſhoe faſt on the foot. As theſe ſhoes have no hind-piece, they make a noiſe when people walk in them like ſlippers. When the Japaneſe travel, their ſhoes are furniſhed with three ſtrings made of twiſted ſtraw, with which they are tied to the legs and feet, to prevent them from falling off. Some people carry one or more pairs of ſhoes with them on their journeys, in order to put on new, when the old ones are worn out. When it rains, or the roads are very dirty, theſe ſhoes are ſoon wetted through, and one continually ſees a great number of worn-out ſhoes lying on the roads, eſpecially near the brooks, where travellers have changed their ſhoes after waſhing their feet. Inſtead of theſe, in rainy or dirty weather they wear high wooden clogs, which underneath are hollowed out in the middle, and at top have a band acroſs like a ſtirrup, and a ſtring for the great toe; ſo that they can walk without ſoiling their feet. Some of them have their ſtraw ſhoes faſtened to theſe wooden clogs. The Japaneſe never enter their houſes with their ſhoes on; but leave them in the entry, or place them on the bench near the door, and thus are always barefooted in their houſes, ſo as not to dirty their neat mats. During the time that the Dutch live at Japan, when they are ſometimes under an obligation of paying viſits at the houſes of the Japaneſe, their own rooms at the factory being likewiſe covered with mats of this kind, they wear, inſtead of the uſual ſhoes, red, green, or black ſlippers, which, on entering the houſe, they pull off: however, they have ſtockings on, and ſhoes made of cotton ſtuff with buckles in them, which ſhoes are made at Japan, and can be waſhed whenever they are dirty. Some have them of black ſatin, in order to avoid waſhing them.

SHOE of an Anchor, a ſmall block of wood, convex on the back, and having a ſmall hole, ſufficient to contain the point of the anchor fluke, on the foreſide. It is uſed to prevent the anchor from tearing or wounding the planks on the ſhip's bow, when aſcending or deſcending; for which purpoſe the ſhoe ſlides up and down along the bow between the fluke of the anchor and the planks, as being preſſed cloſe to the latter by the weight of the former.

To SHOE an Anchor, is to cover the flukes with a broad triangular piece of plank, whoſe area or ſuperficies is much larger than that of the flukes. It is intended to give the anchor a ſtronger and ſurer hold of the bottom in very ſoft and oozy ground.

SHOEMAKERS MACHINE for working at in a ſtanding poſture. A machine for this purpoſe was invented by Mr Thomas Parker, who, on the 22d of November, 1804, attended a committee appointed by the Society of Arts, and informed them that he had made uſe of this apparatus for twelve months, and found it very uſeful. He obſerved that all the work of ſhoemaking may be done with it ſtanding; but that in ſome parts thereof he found an advantage in uſing along with it a high ſtool; and that prior to the uſe of this machine, he never ſaw or heard of a ſimilar invention; and that he found it of great ſervice to his health.

He eſtimated the coſt of ſuch a machine at two guineas.

Plate CCCCXCVI. fig. 1.

Plate CCCCXCVI. fig. 1. T, a bench ſtanding on four legs, about four feet from the ground.

V, A circular cuſhion affixed to the bench, in the centre of which cuſhion is an open ſpace quite through the bench, through which hole a leather ſtrap U is brought up from below. This ſtrap holds the work and laſt firm upon the cuſhion in any poſition required, by means of the workman's foot placed upon the treadle W.

X, Shews the laſt upon the cuſhion, with the ſtrap holding it firm.

Y, An implement uſed in cloſing boots.

Z, A ſmall flat leather cuſhion, uſeful in adjuſting the laſt and ſtrap.

L, The ſhoe-laſt ſhewn ſeparate from the cuſhion. The round cuſhion is formed of a circular piece of wood, covered with leather or ſtuffed with wool or hair to give it ſome elaſticity.

Another machine for the ſame purpoſe has been invented by Mr Holden of Fettleworth in Suſſex, and the following account of it was preſented to the Society of Arts. He obſerves that the ſitting poſture had ſo greatly injured his health, as to render it neceſſary to give up his buſineſs, and in this difficulty he invented the machine which he found to anſwer the purpoſe fully, as it enabled him to reſume his work with the recovery of his health. He recommends it as the quickeſt way of cloſing all the thread work, and he adds, that he has made 1800 or 2000 pairs of ſhoes with the machine, and ſtill continues to employ it. The following is a deſcription of the machine.

Fig. 2.

Fig. 2. A, the bed for the cloſing block, and to lay the ſhoe in, whilſt ſewing.

B, The cloſing block.

C, A looſe bed to lay the ſhoe in whilſt ſtitching; the lower part of which is here exhibited reverſed, to ſhew how it is placed in the other bed A.

D, The hollow or upper part of the looſe bed C, in which the ſhoe is laid while ſtitching.

E, A table on which the tools wanted are to be laid.

F, An iron ſemicircle, fixed to each end of the bed A, to allow the bed to be raiſed or depreſſed. This half circle moves in the block G.

H, Another iron ſemicircle, with notches, which catch upon a tooth in the centre of the block, to hold the bed in any angle required. This ſemicircle moves ſidewiſe on two hooks in ſtaples at each end of the bed.

I, The tail or ſtem of the bed A, moving in a cylindrical hole in the pillar, enabling the bed to be turned in any required direction, and which, with the movement F, enables the operator to place the ſhoe in any poſition neceſſary.

K, the pillar, formed like the pillar of a clawtable, excepting the two ſide legs being in a direct line, and the other leg at a right angle with them.

L, The ſemicircle H, ſhewn ſeparately, to explain how it is connected with the ſtaples, and how the notches are formed.

M, The tail or ſtem of the bed A, and the lower part of the bed N, ſhewn ſeparately, to explain how the upper part of the bed is raiſed or depreſſed occaſionally.

Horſe-SHOE. See FARRIERY, N° 131.

SHOOTING, in the military art. See ARTILLERY, GUNNERY, and PROJECTILES.

1 Shooting in ſportmanſhip.

SHOOTING, in ſportmanſhip, the killing of game by the gun, with or without the help of dogs.

Under this article we ſhall lay down all the rules which are neceſſary to be obſerved in order to render one accompliſhed and ſucceſsful in the art of ſhooting.

2 Directions for chooſing a fowling piece.

The firſt thing which the ſportſman ought to attend to is the choice of his fowling-piece. Conveniency requires that the barrel be as light as poſſible, at the ſame time it ought to poſſeſs that degree of ſtrength which will make it not liable to burſt. Experience has proved, that a thin and light barrel, which is of equal thickneſs in every part of its circumference, is much leſs liable to burſt than one which is conſiderably thicker and heavier, but which, from being badly filed or bored, is of unequal ſtrength in different places.

It is alſo of importance to determine of what length the barrel ought to be, in order to acquire that range which the ſportſman has occaſion for. On this ſubject we have received the following information from an experienced ſportſman. We have, at different times, compared barrels of all the intermediate length between 28 and 40 inches, and of nearly the ſame caliber, that is to ſay, from 22 to 26; and theſe trials were made both by firing the pieces from the ſhoulder, and from a firm block, at an equal diſtance, and with equal weights of the ſame powder and of the ſame ſhot.

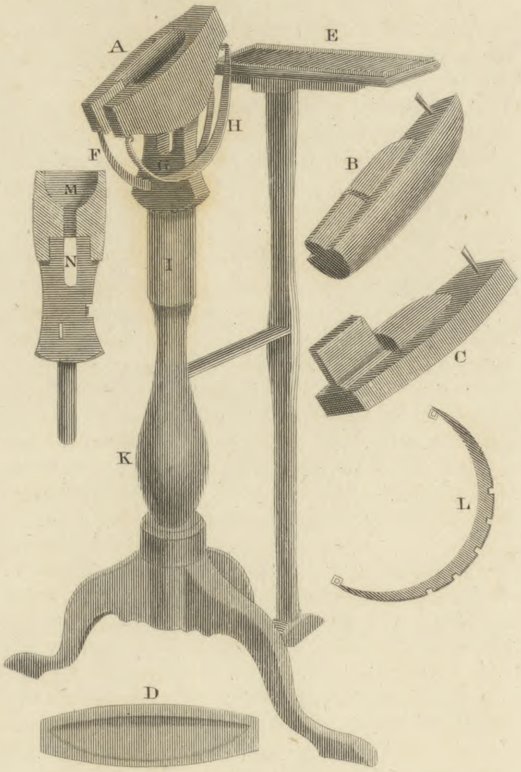
To avoid every poſſibility of error, the quires of paper at which we fired were fixed againſt planks inſtead of being placed againſt the wall. From theſe trials frequently repeated, we found that the ſhot pierced an equal number of ſheets, whether it was fired from a barrel of 28, 30, 32, 34, 36, 38, or 40, inches in length. Nay more, we have compared two barrels of the ſame caliber, but one of them 33, and the other 66 inches long, by repeatedly firing them in the ſame manner as the others, at different diſtances from 45 to 100 paces, and the reſults have always been the ſame, i. e. the barrel of 33 inches drove its ſhot through as many ſheets of paper as that of 66 did. The concluſion from all this is, that the difference of 10 inches in the length of the barrel, which ſeems to be more than is ever inſiſted upon among ſportſmen, produces no ſenſible difference in the range of the piece; and therefore, that every one may pleaſe himſelf in the length of his barrel, without either detriment or advantage to the range.

It may appear as an objection to this, that a duck-gun which is five or ſix feet long kills at a greater diſtance than

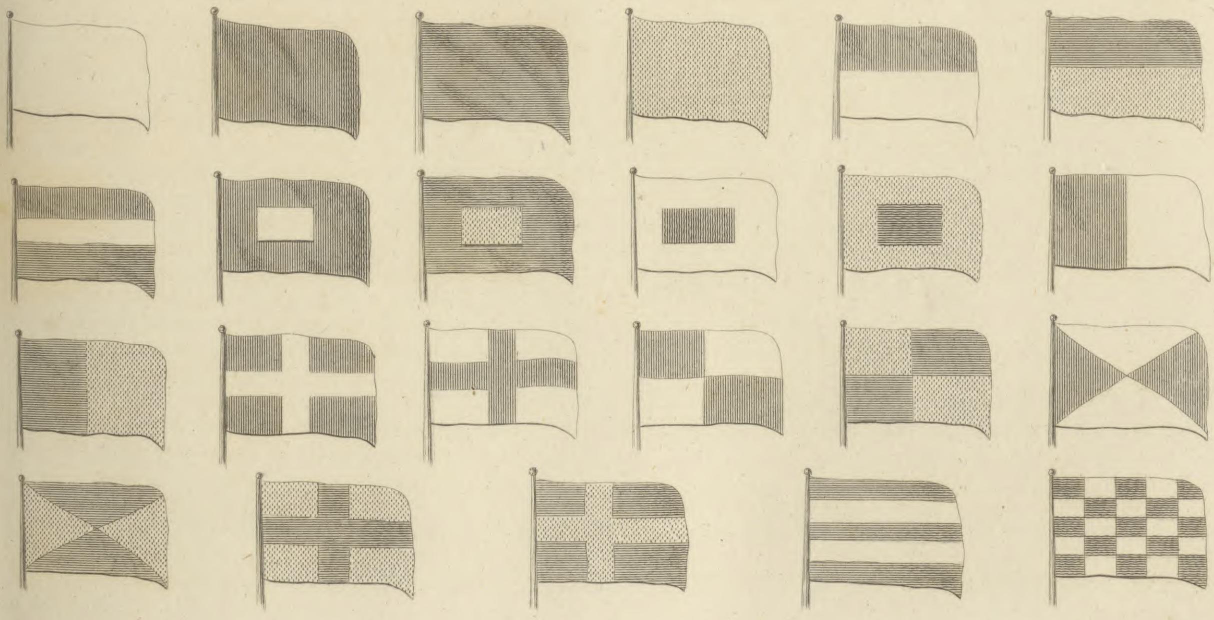
SHOEMAKERS MACHINE. PLATE CCCCXCVI.

Fig. 1.

Fig. 2.



NAVAL SIGNALS.



E. Mitchell sculp.t

than a fowling-piece; but this is not owing to its length, but to its greater weight and thickneſs, which give it ſuch additional ſtrength, that the ſhot may be increaſed, and the charge of powder doubled, trebled, and even quadrupled. But a barrel of five or ſix feet length would be very inconvenient for fowling. Thoſe who conſult the appearance of the piece, lightneſs, and the eaſe with which it is managed, will find that a barrel from 32 to 38 inches will anſwer beſt.

3
roper
ngth of
e barrel.

4
aliber.

The next thing to be conſidered is, of what dimenſions the caliber or bore of a fowling-piece ought to be. This matter has been ſubjected to experiment, and it has been found, that a barrel of 22 or 24, which is the largeſt caliber uſually employed in fowling-pieces, throws its ſhot as cloſely as one of the ſmalleſt caliber, viz. of 30 or 32 (A).

5
ength and
rm of the
ock.

As to the length and form of the ſtock, it may be laid down as a principle, that a long ſtock is preferable to a ſhort one, and at the ſame time rather more bent than uſual; for a long ſtock ſits firmer to the ſhoulder than a ſhort one, and particularly ſo when the ſhooter is accuſtomed to place his left hand, which principally ſupports the piece, near to the entrance of the ramrod into the ſtock.

It is certain, however, that the ſtock may be ſo formed as to be better ſuited to one man than another. For a tall, long-armed man, the ſtock of a gun ſhould be longer than for one of a leſs ſtature and ſhorter arm. That a ſtraight ſtock is proper for him who has high ſhoulders and a ſhort neck; for, if it be much bent, it would be very difficult for him, eſpecially in the quick motion required in ſhooting at a flying or running object, to place the butt of the gun-ſtock firmly to the ſhoulder, the upper part alone would in general be fixed; which would not only raiſe the muzzle, and conſequently ſhoot high, but make the recoil much more ſenſibly felt, than if the whole end of the ſtock were firmly placed on his ſhoulder. Beſides, ſuppoſing the ſhooter to bring the butt home to his ſhoulder, he would ſcarcely be able to level his piece at the object. On the contrary, a man with low ſhoulders, and a long neck, requires a ſtock much bent; for if it is ſtraight, he will, in the act of lowering his head to that place of the ſtock at which his cheek ſhould reſt in taking aim, feel a conſtraint which he never experiences, when by the effect of the proper degree of bent, the ſtock lends him ſome aſſiſtance, and, as it were, meets his aim half way.

Having now deſcribed the fowling-piece which has been found to anſwer beſt, it will next be proper to give ſome inſtructions for the choice of gunpowder, ſhot, and wadding.

6
ſt gun-
wder.

The various kinds of gunpowder are well known; but, in the opinion of ſome experienced ſportſmen, Hervey's battle-powder is the beſt. Thoſe who wiſh to examine the ſtrength of powder, may determine it by drying ſome of it very well, and then trying how many ſheets of paper it will drive the ſhot through, at the diſtance of 10 or 12 yards. In this trial we ſhould be careful to employ the ſame ſized ſhot in each experiment, the quantity both of the ſhot and the powder being regulated by exact weight; otherwiſe we cannot, even in this experiment, arrive at any certainty in comparing the ſtrength of different powders, or of the ſame powder at different times.

7
To be kept
dry.

Powder ought to be kept very dry, for every degree of moiſture injures it; and if conſiderable, the ſaltpetre is diſſolved, and the intimate combination of the ſeveral ingredients is entirely deſtroyed. It is obſerved, that after firing with damp powder the piece becomes very foul, which ſeems to ariſe from the diminution of the activity of the fire in the exploſion. Flaſks of copper or tin are much better for keeping powder in than thoſe made of leather, or than ſmall caſks. Their necks ought to be ſmall and well ſtopped with cork.

8
Size of
ſhot.

The *patent milled ſhot* is now very generally uſed, and is reckoned ſuperior to any other. The ſize of the ſhot muſt vary according to the particular ſpecies of game which is the object of the ſportſman's purſuit, as well as be adapted to the ſeaſon. In the firſt month of partridge ſhooting, N° 1. is moſt proper; for ſince at this time the birds ſpring near at hand, and we ſeldom fire at more than the diſtance of 40 paces, if the ſhooter takes his aim but tolerably well, it is almoſt impoſſible for a bird at this diſtance to eſcape in the circle which the ſhot forms.

As hares ſit cloſer, and are thinly covered with fur at this ſeaſon, they may eaſily be killed with this ſhot at 30 or 35 paces. N° 1. is equally proper for ſhooting ſnipes or quails. About the beginning of October, when the partridges are ſtronger, N° 3. is the moſt proper ſhot to be uſed. Many ſportſmen uſe no other during the whole ſeaſon. The directions which have now been given refer only to the patent ſhot.

We ſhall now ſubjoin a table, which will ſhew at one view the number of pellets compoſing an ounce weight of each ſort of ſhot, the patent and the common, beginning with the ſmalleſt ſize.

PATENT SHOT.

N° 8.	1 ounce	620
7	id.	480
×	(B) id.	300
1	id.	220
2	id	180
3	id.	157
4	id.	105
5	id.	83

COMMON SHOT.

N° 7.	1 ounce	350
6	id.	260
5	id.	235
4	id.	190
3	id.	140
2	id.	110
1	id.	95

9
Proportion
of powder
and ſhot in
the charge.

For a fowling-piece of a common caliber, which is from 24 to 30 balls to the pound weight, a dram and a quarter,

---

(A) In ſpeaking of the ſize of the caliber, we mean by 22 or 24, that ſo many balls exactly fitting it weigh juſt one pound; and every caliber is marked in the ſame way.

(B) The reader will obſerve that the patent ſhot has no N° 6, the × being ſubſtituted in its place, and that the numbers do not follow each other in the order of progreſſion: The reaſon of this we cannot aſſign.

quarter, or at moſt a dram and a half, of good powder; and an ounce, or an ounce and a quarter of ſhot, is ſufficient. But when ſhot of a larger ſize is uſed, ſuch as N° 5. the charge of ſhot may be increaſed one-fourth, for the purpoſe of counterbalancing in ſome degree what the ſize of the ſhot loſes in the number of pellets, and alſo to enable it to garniſh the more. For this purpoſe the ſportſman will find a meaſure marked with the proper gauges very convenient to him. An inſtrument of this nature has been made by an ingenious artiſt of London, Egg, of the Haymarket.

A conſequence of overloading with ſhot, is the powder has not ſufficient ſtrength to throw it to its proper diſtance; for if the object fired at be diſtant, one-half of the pellets compoſing the charge, by their too great quantity and weight, will ſtrike againſt each other, and fall by the way; and thoſe which reach the mark will have ſmall force, and will produce but little or no effect.

10
Wadding.

The uſe of the *wadding* is to carry the ſhot in a body to a certain diſtance from the muzzle of the piece. It ought to be of ſoft and pliable materials. The beſt kind of wadding, in the opinion of an experienced fowler, is a piece of an old hat; but this cannot be obtained in ſufficient quantity. Next to it nothing is better than ſoft brown paper, which combines ſuppleneſs with conſiſtence, moulds itſelf to the barrel, and never falls to the ground within 12 or 15 paces from the muzzle of the piece. Tow anſwers very well, and cork has been extolled for poſſeſſing the peculiar virtue of increaſing the range and cloſeneſs of the ſhot.

The wadding ought to be quite cloſe in the barrel, but not rammed too hard; for if it be rammed too cloſe, or be of a rigid ſubſtance, the piece will recoil, and the ſhot will ſpread too much. On the other hand, if the wadding be very looſe, or is compoſed of too ſoft materials, ſuch as wool or cotton, the diſcharge will not poſſeſs proper force.

11
Powder and ſhot to be ſlightly rammed down.

In loading a piece, the powder ought to be ſlightly rammed down by only preſſing the ramrod two or three times on the wadding, and not by drawing up the ramrod and then returning it into the barrel with a jerk of the arm ſeveral times. For when the powder is violently compreſſed, ſome of the grains muſt be bruiſed, which will prevent the exploſion from being quick, and will ſpread the ſhot too wide. In pouring the powder into the barrel, the meaſure ought to be held ſo as that the powder may fall moſt readily to the bottom. That no grains may adhere to the ſides of the barrel, the butt-end of the piece may be ſtruck againſt the ground. The ſhot ought never to be rammed down with force: it is ſufficient to ſtrike the butt-end of the gun againſt the ground as before. Then the wadding is to be put down gently. A ſportſman ought never to carry his gun under his arm with the muzzle inclined downwards, for this practice looſens the wadding and charge too much.

12
Directions for loading and firing.

Immediately after the piece is fired it ought to be reloaded; for while the barrel is ſtill warm, there is no danger of any moiſture lodging in it to hinder the powder from falling to the bottom. As it is found that the coldneſs of the barrel, and perhaps the moiſture condenſed in it, diminiſhes the force of the powder in the firſt ſhot; it is proper to fire off a little powder before the piece is loaded. Some prime before loading, but this is not proper unleſs the touch-hole be very large. After every diſcharge the touch-hole ought to be pricked, or a ſmall feather may be inſerted to clear away any humidity or foulneſs that has been contracted.

The ſportſman having loaded his piece, muſt next prepare to fire. For this purpoſe he ought to place his hand near the entrance of the ramrod, and at the ſame time graſp the barrel firmly. The muzzle ſhould be a little elevated, for it is more uſual to ſhoot low than high. This direction ought particularly to be attended to when the object is a little diſtant; becauſe ſhot as well as ball only moves a certain diſtance point blank, when it begins to deſcribe the curve of the parabola.

13
Diſtance a which the ſportſma ought to kill.

Practice ſoon teaches the ſportſman the proper diſtance at which he ſhould ſhoot. The diſtance at which he ought infallibly to kill any kind of game with patent ſhot, N° 3. provided the aim be well taken, is from 25 to 35 paces for the footed, and from 40 to 45 paces for the winged, game. Beyond this diſtance even to 50 or 55 paces, both partridges and hares are ſometimes killed; but in general the hares are only ſlightly wounded, and carry away the ſhot; and the partridges at that diſtance preſent ſo ſmall a ſurface, that they frequently eſcape untouched between the ſpaces of the circle. Yet it does not follow that a partridge may not be killed with N° 3. patent ſhot at 60 and even 70 paces diſtance, but then theſe ſhots are very rare.

14
How the aim is to b taken.

In ſhooting at a bird flying, or a hare running acroſs, it is neceſſary to take aim before the object in proportion to its diſtance at the time of firing. If a partridge flies acroſs at the diſtance of 30 or 35 paces, it will be ſufficient to aim at the head, or at moſt but a ſmall ſpace before it. If it be 50, 60, or 70 paces diſtant, it is then requiſite to aim at leaſt half a foot before the head. The ſame practice ought to be obſerved in ſhooting at a hare, rabbit, or fox, when running in a croſs direction; at the ſame time making due allowance for the diſtance and ſwiftneſs of the pace. Another thing to be attended to is, that the ſhooter ought not involuntarily to ſtop the motion of the arms at the moment of pulling the trigger; for the inſtant the hand ſtops in order to fire, however inconſiderable the time be, the bird gets beyond the line of aim, and the ſhot will miſs it. A ſportſman ought therefore to accuſtom his hand while he is taking aim to follow the object. When a hare runs in a ſtraight line from the ſhooter, he ſhould take his aim between the ears, otherwiſe he will run the hazard either of miſſing, or at leaſt not of killing dead, or as it is ſometimes called *clean*.

15
Every part of the piec to be kept clean and dry.

A fowling-piece ſhould not be fired more than 20 or 25 times without being waſhed; a barrel when foul neither ſhoots ſo ready, nor carries the ſhot ſo far as when clean. The flint, pan, and hammer, ſhould be well wiped after each ſhot; this contributes greatly to make the piece go off quick; but then it ſhould be done with ſuch expedition, that the barrel may be reloaded whilſt warm, for the reaſons we have before advanced. The flint ſhould be frequently changed, without waiting untill it miſſes fire before a new one is put in. Fifteen or eighteen ſhots, therefore, ſhould only be fired with the ſame flint; the expence is too trifling to be regarded, and by changing it thus often much vexation will be prevented.

A gun alſo ſhould never be fired with the prime of the preceding day; it may happen that an old priming will ſometimes go off well, but it will more frequently contract moiſture and fuze in the firing; then the object will moſt probably be miſſed, and that becauſe the piece was not freſh primed.

16 Vhen and iow game to be ought for.

For the information of the young ſportſman we ſhall add a few more general directions. In warm weather he ought to ſeek for game in plains and open grounds, and in cold weather he may ſearch little hills expoſed to the ſun, along hedges, among heath, in ſtubbles, and in paſtures where there is much furze and fern. The morning is the beſt time of the day, before the dew is exhaled, and before the game has been diſturbed. The colour of the ſhooters dreſs ought to be the ſame with that of the fields and trees; in ſummer it ought to be green, in winter a dark gray. He ought to hunt as much as poſſible with the wind, not only to prevent the game from perceiving the approach of him and his dog, but alſo to enable the dog to ſcent the game at a greater diſtance.

He ſhould never be diſcouraged from hunting and ranging the ſame ground over and over again, eſpecially in places covered with heath, brambles, high graſs, or young coppice wood. A hare or rabbit will frequently ſuffer him to paſs ſeveral times within a few yards of its form without getting up. He ſhould be ſtill more patient when he has marked partridges into ſuch places, for it often happens, that after the birds have been ſprung many times, they lie ſo dead that they will ſuffer him almoſt to tread upon them before they will riſe. Pheaſants, quails, and woodcocks, do the ſame.

He ought to look carefully about him, never paſſing a buſh or tuft of graſs without examination; but he ought never to ſtrike them with the muzzle of his gun for it will looſen his wadding. He who patiently beats and ranges his ground over again, without being diſcouraged, will always kill the greateſt quantity of game; and if he is ſhooting in company, he will find game where others have paſſed without diſcovering any.

When he has fired he ſhould call in his dog, that he may not have the mortification to ſee game riſe which he cannot ſhoot. When he has killed a bird, inſtead of being anxious about picking it up, he ought to follow the reſt of the covey with his eye till he ſee them ſettle.

17 ogs fit ſport.

Three ſpecies of dogs are capable of receiving the proper inſtruction, and of being trained. Theſe are the ſmooth pointer, the ſpaniel, and the rough pointer. The laſt is a dog with long curled hair, and ſeems to be a mixed breed of the water-dog and the ſpaniel. The ſmooth pointer is active and lively enough in his range, but in general is proper only for an open country.

The greateſt part of theſe dogs are afraid of water, brambles, and thickets; but the ſpaniel and the rough pointer are eaſily taught to take the water, even in cold weather, and to range the woods and rough places as well as the plain. Greater dependence may therefore be had on theſe two laſt ſpecies of dogs than on the ſmooth pointer.

18 rections training ointer,

The education of a pointer may commence when he is only five or ſix months old. The only leſſons which he can be taught at this time are to *fetch* and *carry* any thing when deſired; to come in when he runs far off, and to go behind when he returns; uſing, in the one caſe, the words *here, come in*, and in the other *back* or *behind*. It is alſo neceſſary at this period to accuſtom him to be tied up in the kennel or ſtable; but he ought not at firſt to be tied too long. He ſhould be let looſe in the morning, and faſtened again in the evening. When a dog is not early accuſtomed to be chained, he diſturbs every perſon in the neighbourhood by howling. It is alſo of importance that the perſon who is to train him ſhould give him his food.

When the dog has attained the age of 10 or 12 months, he may be carried into the field to be regularly trained. At firſt he may be allowed to follow his own inclination, and to run after every animal he ſees. His indiſcriminating eagerneſs will ſoon abate, and he will purſue only partridges and hares. He will ſoon become tired of following partridges in vain, and will content himſelf after having fluſhed them to follow them with his eyes. It will be more difficult to prevent him from following hares.

All young dogs are apt to *rake*; that is, to hunt with their noſes cloſe to the ground, to follow birds rather by the track than by the wind. But partridges lie much better to dogs that *wind* them, than to thoſe that follow them by the track. The dog that winds the ſcent approaches the birds by degrees and without diſturbing them; but they are immediately alarmed when they ſee a dog tracing their footſteps. When you perceive that your dog is committing this fault, call to him in an angry tone *hold up*; he will then grow uneaſy and agitated, going firſt to the one ſide and then to the other, until the wind brings him the ſcent of the birds. After finding the *game* four or five times in this way, he will take the wind of himſelf, and hunt with his noſe high. If it be difficult to correct this fault, it will be neceſſary to put the *puzzle peg* upon him. This is of very ſimple conſtruction, conſiſting only of a piece of oak or deal inch board, one foot in length, and an inch and a half in breadth, tapering a little to one end; at the broader end are two holes running longitudinally, through which the collar of the dog is put, and the whole is buckled round his neck; the piece of wood being projected beyond his noſe, is then faſtened with a piece of leather thong to his under jaw. By this means the peg advancing ſeven or eight inches beyond his ſnout, the dog is prevented from putting his noſe to the ground and raking.

As ſoon as the young dog knows his game, you muſt bring him under complete ſubjection. If he is tractable, this will be eaſy; but if he is ſtubborn, it will be neceſſary to uſe the *traſh cord*, which is a rope or cord of 20 or 25 fathoms in length faſtened to his collar. If he refuſe to come back when called upon, you muſt check him ſmartly with the cord, which will often bring him upon his haunches. But be ſure you never call to him except when you are within reach of the cord. After repeating this ſeveral times he will not fail to come back when called; he ought then to be careſſed, and a bit of bread ſhould be given him. He ought now conſtantly to be tied up, and never unchained, except when you give him his food, and even then only when he has done ſomething to deſerve it.

The next ſtep will be to throw down a piece of bread on the ground, at the ſame moment taking hold of of the dog by the collar, calling out to him, "take heed,—ſoftly." After having held him in this manner for ſome ſpace of time, ſay to him, "ſeize—lay hold." If he is impatient to lay hold of the piece of bread before the ſignal is given, correct him gently with a ſmall whip. Repeat this leſſon until he "takes heed" well, and no longer requires to be held faſt to prevent him from laying hold of the bread. When he is well accuſtomed to this manége, turn the bread with a ſtick, holding it in the manner you do a fowling-piece, and having done ſo, cry *ſeize*. Never ſuffer the dog to eat either in the houſe or field without having firſt made him take heed in this manner.

Then, in order to apply this leſſon to the game, fry ſmall pieces of bread in hogs lard, with the dung of partridge; take theſe in a linen bag into the fields, ſtubbles, ploughed grounds, and paſtures, and there put the pieces in ſeveral different places, marking the ſpots with little cleft pickets of wood, which will be rendered more diſtinguiſhable by putting pieces of card in the nicks. This being done, caſt off the dog and conduct him to theſe places, always hunting in the wind. After he has caught the ſcent of the bread, if he approaches too near, and ſeems eager to fall upon it, cry to him in a menacing tone, "take heed;" and if he does not ſtop immediately, correct him with the whip. He will ſoon comprehend what is required of him, and will ſtand.

At the next leſſon, take your gun charged only with powder, walk gently round the piece of bread once or twice, and fire inſtead of crying *ſeize*. The next time of practiſing this leſſon, walk round the bread four or five times, but in a greater circle than before, and continue to do this until the dog is conquered of his impatience, and will ſtand without moving until the ſignal is given him. When he keeps his point well, and ſtands ſteady in this leſſon, you may carry him to the birds; if he run in upon them, or bark when they ſpring up, you muſt correct him; and if he continue to do ſo, you muſt return to the fried bread; but this is ſeldom neceſſary.

When the dog has learned by this uſe of the bread to take heed, he may be carried to the fields with the traſh-cord dragging on the ground. When he ſprings birds for the firſt time, if he runs after them or barks, check him by calling out to him, *take heed*. If he point properly, careſs him; but you ought never to hunt without the chord until he point ſtaunch.

19 and preventing his running after ſheep.

If the dog runs after ſheep, and it be difficult to cure him, couple him with a ram, and then whip the dog as long as you can follow him. His cries will at firſt alarm the ram; he will run with all his ſpeed, and drag the dog along with him; but he will at length take courage, turn upon the dog, and butt him ſeverely with his horns. When you think the dog is ſufficiently chaſtiſed, untie him: he will never run at ſheep again.

Having now given a few general inſtructions concerning the beſt method of training pointers, we ſhall ſubjoin a few obſervations reſpecting the moſt common ſpecies of game, the partridge, pheaſant, grouſe, woodcock, ſnipe, and wild duck.

20 Obſervations concerning the partridge.

Partridges pair in the ſpring, and lay their eggs (generally from 15 to 20) during May and part of June. The young begin to fly about the end of June, and their plummage is complete in the beginning of October. The male has a conſpicuous horſe ſhoe upon his breaſt, an obtuſe ſpur on the hinder part of the leg, which diſtinguiſh him from the female. He is alſo rather larger.

When a ſportſman is ſhooting in a country where the birds are thin, and he no longer chooſes to range the field for the bare chance of meeting with them, the following method will ſhow him where to find them on another day. In the evening, from ſunſet to nightfall, he ſhould poſt himſelf in a field, at the foot of a tree or a buſh, and there wait until the partridges begin to call or juck, which they always do at that time; not only for the purpoſe of drawing together when ſeparated, but alſo when the birds compoſing the covey are not diſperſed. After calling in this manner for ſome little ſpace of time, the partridges will take to flight; then, if he mark the place where they alight, he may be aſſured they will lie there the whole night, unleſs diſturbed. Let him return to the ſame poſt the next morning by break of day, and there watch a while; being careful to keep his dog in a ſtring, if he is not under perfect command.

As ſoon as the dawn begins to peep, the partridges will begin to call, and ſoon afterwards will perform the ſame manœuvre as on the preceding evening; that is, after having called a while, they will take their flight, and will moſt commonly ſettle at a little diſtance. There in a few minutes they will call again, and ſometimes take a ſecond flight, but that will be to no great diſtance. Then as ſoon as the ſun is riſen, and the ſportſman can ſee to ſhoot, he may caſt off his dog and purſue them.

21 Pheaſant.

The *pheaſant* is of the ſize of a common dunghill cock, and lays its eggs generally in the woods, the number of which is 10 or 12.

Pheaſants are accounted ſtupid birds; for when they are ſurpriſed they will frequently ſquat down like a rabbit, ſuppoſing themſelves to be in ſafety as ſoon as their heads are concealed; and in this way they will ſometimes ſuffer themſelves to be killed with a ſtick. They love low and moiſt places, and haunt the edges of thoſe pools which are found in woods, as well as the high graſs of marſhes that are near at hand; and above all, places where there are clumps of alders.

22 Grouſe.

Grouſe, or moor-game, are found in Wales, in the northern counties of England, and in great abundance in Scotland. They chiefly inhabit thoſe mountains and moors which are covered with heath, and ſeldom deſcend to the low grounds. They fly in companies of four or five braces, and love to frequent moſſy places, particularly in the middle of the day or when the weather is warm. In purſuing this game, when the pointer ſets, and the ſportſman perceives the birds running with their heads erect, he muſt run after them as faſt as he can, in the hope that he may get near enough to ſhoot when they riſe upon the wing; for he may be pretty certain they will not lie well that day. As theſe birds are apt to grow ſoon putrid, they ought to be drawn carefully the inſtant they are ſhot and ſtuffed with any heath, and if the feathers happen to be wetted they muſt be wiped dry.

23 Woodcock

The *woodcock* is a bird of paſſage; it commonly arrives about the end of October, and remains until the middle of March. Woodcocks are fatteſt in December and January, but from the end of February they are lean. At their arrival they drop anywhere, but afterwards

wards take up their reſidence in copſes of nine or ten years growth. They ſeldom, however, ſtay in one place longer than 12 or 15 days. During the day, they remain in thoſe parts of the woods where there are void ſpaces or glades, picking up earth-worms and grubs from the fallen leaves. In the evening they go to drink and waſh their bills at pools and ſprings, after which they repair to the open fields and meadows for the night. It is remarkable, that when a woodcock ſprings from a wood to go into the open country, he always endeavours to find ſome glade or opening, which he follows to the boundaries of the wood. At his return he purſues the ſame path a good way, and then turns to the right or left oppoſite to ſome glade, in order to drop into a thick part of the wood, where he may be ſheltered from the wind. He may therefore be watched with advantage in theſe narrow paſſes and little alleys on the edges of woods which lead to a pool or ſpring, or he may be watched in the duſk of the evening near the pools which he frequents.

24 Snipe. The *ſnipe* is a bird of paſſage as well as the woodcock. This bird is ſcarcely worth ſhooting till the froſt commences. In the month of November they begin to grow fat. Snipes, like woodcocks, frequent ſprings, bogs, and marſhy places, and generally fly againſt the wind. The ſlant and croſs ſhots are rather difficult, as the birds are ſmall and fly very quickly. The ſportſman ought to look for them in the direction of the wind; becauſe then they will fly towards him, and preſent a fairer mark.

25 Wild duck. The *wild duck* is alſo a bird of paſſage, and arrives here in great flocks from the northern countries in the beginning of winter. Still, however, a great many remain in our marſhes and fens during the whole year, and breed.

The wild duck differs little in plumage from the tame duck, but is eaſily diſtinguiſhed by its ſize, which is leſs; by the neck, which is more ſlender; by the foot, which is ſmaller; by the nails, which are more black; and above all, by the web of the foot, which is much finer and ſofter to the touch.

In the ſummer ſeaſon, when it is known that a team of young ducks are in a particular piece of water, and juſt beginning to fly, the ſportſman is ſure to find them early in the morning dabbling at the edges of the pool, and amongſt the long graſs, and then he may get very near to them: it is uſual alſo to find them in thoſe places at noon.

In the beginning of autumn almoſt every pool is frequented by teams of wild ducks, which remain there during the day, concealed in the ruſhes. If theſe pools are of ſmall extent, two ſhooters, by going one on each ſide, making a noiſe and throwing ſtones into the ruſhes, will make them fly up; and they will in this way frequently get ſhots, eſpecially if the pool is not broad, and contracts at one end. But the ſureſt and moſt ſucceſsful way, is to launch a ſmall boat or trow on the pool, and to traverſe the ruſhes by the openings which are found; at the ſame time making as little noiſe as poſſible. In this manner the ducks will ſuffer the ſportſmen to come ſufficiently near them to ſhoot flying; and it often happens that the ducks, after having flown up, only make a circuit, return in a little time, and again alight upon the pool. Then the ſportſmen endeavour a ſecond time to come near them. If ſeveral ſhooters are in company, they ſhould divide; two ſhould go in the boat, whilſt the others ſpread themſelves about the edge of the pool, in order to ſhoot the ducks in their flight. In pools which will not admit a trow, water-ſpaniels are abſolutely neceſſary for this ſport.

In winter they may be found on the margins of little pools; and when pools and rivers are frozen up, they muſt be watched for in places where there are ſprings and waters which do not freeze. The ſport is then much more certain, becauſe the ducks are confined to theſe places in order to procure aquatic herbs, which are almoſt their only food at this period.

SHOP-LIFTERS, are thoſe that ſteal goods privately out of ſhops; which, being to the value of 5s. though no perſon be in the ſhop, is felony without the benefit of clergy by the 10 and 11 W. III. c. 23.

SHORE, a place waſhed by the ſea, or by ſome large river.

Count Marſigli divides the ſea-ſhore into three portions: the firſt of which is that tract of land which the ſea juſt reaches in ſtorms and high tides, but which it never covers; the ſecond part of the ſhore is that which is covered in high tides and ſtorms, but is dry at other times; and the third is the deſcent from this, which is always covered with water.

The firſt part is only a continuation of the continent, and ſuffers no alteration from the neighbourhood of the ſea, except that it is rendered fit for the growth of ſome plants, and wholly unfit for that of others, by the ſaline ſteams and impregnations: and it is ſcarce to be conceived by any, but thoſe who have obſerved it, how far on land the effects of the ſea reach, ſo as to make the earth proper for plants which will not grow without this influence; there being ſeveral plants frequently found on high hills and dry places, at three, four, and more miles from the ſea, which yet would not grow unleſs in the neighbourhood of it, nor will ever be found elſewhere.

The ſecond part or portion of the ſhore is much more affected by the ſea than the former, being frequently waſhed and beaten by it. Its productions are rendered ſalt by the water, and it is covered with ſand, or with the fragments of ſhells in form of ſand, and in ſome places with a tartarous matter depoſited from the water; the colour of this whole extent of ground is uſually duſky and dull, eſpecially where there are rocks and ſtones, and theſe covered with a ſlimy matter.

The third part of the ſhore is more affected by the ſea than either of the others; and is covered with an uniform cruſt of the true nature of the bottom of the ſea, except that plants and animals have their reſidence in it, and the decayed parts of theſe alter it a little.

SHORE, *Jane*, the celebrated concubine of the licentious King Edward IV. was the wife of Mr Matthew Shore, a goldſmith in Lombard-ſtreet, London. Kings are ſeldom unſucceſsful in their amorous purſuits; therefore there was nothing wonderful in Mrs Shore's removing from Lombard-ſtreet to ſhine at court as the royal favourite. Hiſtorians repreſent her as extremely beautiful, remarkably cheerful, and of moſt uncommon generoſity. The king, it is ſaid, was no leſs captivated with her temper than with her perſon: ſhe never made uſe of her influence over him to the prejudice of any perſon; and if ever ſhe importuned him, it was in favour of the unfortunate. After the death of Edward, ſhe attached herſelf to the lord Haſtings; and when Richard III. cut off that nobleman as an obſtacle to his ambitious ſchemes, Jane Shore was arreſted as an accomplice, on the ridiculous accuſation of witchcraft. This, however, terminated only in a public penance; excepting that Richard rifled her of all her little property: but whatever ſeverity might have been exerciſed towards her, it appears that ſhe was alive, though ſufficiently wretched, under the reign of Henry VIII. when Sir Thomas More ſaw her poor, old, and ſhrivelled, without the leaſt trace of her former beauty. Mr Rowe, in his tragedy of Jane Shore, has adopted the popular ſtory related in the old hiſtorical ballad, of her periſhing by hunger in a ditch where Shoreditch now ſtands. But Stow aſſures us that ſtreet was ſo named before her time.

SHORL. See SCHORL, MINERALOGY *Index*.

SHORLING and MORLING, are words to diſtinguiſh fells of ſheep; *ſhorling* being the fells after the fleeces are ſhorn off the ſheep's back; and *morling* the fells flead off after they die or are killed. In ſome parts of England, they underſtand by a *ſhorling* a ſheep whoſe face is ſhorn off; and by a *morling*, a ſheep that dies.

SHORT, JAMES, an eminent optician, was born in Edinburgh on the 10th of June O. S. in the year 1710. At ten years of age, having loſt his father and mother, and being left in a ſtate of indigence, he was received into Heriot's hoſpital, (ſee *EDINBURGH*, *Public Buildings*, N° 16.) where he ſoon diſplayed his mechanical genius, in conſtructing for himſelf, little cheſts, book-caſes, and other conveniences, with ſuch tools as fell in his way. At the age of twelve he was removed from the Hoſpital to the High School, where he ſhowed a conſiderable taſte for claſſical literature, and generally kept at the head of his forms. In the year 1726 he was entered into the univerſity, where he paſſed through the uſual courſe of education, and took his maſter's degree with great applauſe.

By his friends he was intended for the church; but after attending a courſe of theological lectures, his mind revolted from a profeſſion which he thought little ſuited to his talents; and he devoted his whole time to mathematical and mechanical purſuits. He had been fortunate enough to have the celebrated M'Laurin for his preceptor; who having ſoon diſcovered the bent of his genius, and made a proper eſtimate of the extent of his capacity, encouraged him to proſecute thoſe ſtudies in which nature had qualified him to make the greateſt figure. Under the eye of that eminent maſter, he began in 1732 to conſtruct Gregorian teleſcopes; and, as the profeſſor obſerved in a letter to Dr Jurin, "by taking care of the figure of his ſpecula, he was enabled to give them larger apertures, and to carry them to greater perfection than had ever been done before him." (See OPTICS, N° 89.).

In the year 1736 Mr Short was called to London, at the deſire of Queen Caroline, to give inſtructions in mathematics to William duke of Cumberland; and immediately on his appointment to that very honourable office he was elected a fellow of the royal ſociety, and patronized by the earls of Morton and Macclesfield. In the year 1739 he accompanied the former of thoſe noble lords to the Orkney iſles, where he was employed in adjuſting the geography of that part of Scotland: and happy it was for him that he was ſo employed, as he might otherwiſe have been involved in a ſcuffle which took place between the retainers of Sir James Stewart of Barra and the attendants of the earl, in which ſome of the latter were dangerouſly wounded.

Mr Short having returned to London, and finally eſtabliſhed himſelf there in the line of his profeſſion, was in 1742 employed by Lord Thomas Spencer to make for him a reflector of 12 feet focus, for which he received 600 guineas. He made ſeveral other teleſcopes of the ſame focal diſtance with greater improvements and higher magnifiers; and in 1752 finiſhed one for the king of Spain, for which, with its whole apparatus, he received 1200l. This was the nobleſt inſtrument of the kind that had then been conſtructed, and perhaps it has never yet been ſurpaſſed except by the aſtoniſhing reflectors of Herſchel. See TELESCOPE.

Mr Short uſed to viſit the place of his nativity once every two or three years during his reſidence in London, and in 1766 he viſited it for the laſt time. On the 15th of June 1768 he died, after a very ſhort illneſs, at Newington Butts, near London, of a mortification in his bowels, and was buried on the 22d of the ſame month, having completed, within a few days, his fifty-eighth year. He left a fortune of about 20,000l. of which 15,000l. was bequeathed to two nephews, and the reſt in legacies to his friends. In gratitude for the ſteady patronage of the earl of Morton, he left to his daughter the lady Mary Douglas, afterwards counteſs of Aboyne, 1000l. and the reverſion of his fortune, ſhould his nephews die without iſſue; but this reverſionary legacy the lady, at the deſire of her father, generouſly relinquiſhed by a deed in favour of Mr Short's brother Mr Thomas Short and his children. Mr Short's eminence as an artiſt is univerſally known, and we have often heard him ſpoken of by thoſe who were acquainted with him from his youth, as a man of virtue and of very amiable manners.

SHORT-Hand Writing. See STENOGRAPHY.

SHORT-Jointed, in the *Manege*. A horſe is ſaid to be ſhort-jointed that has a ſhort paſtern; when this joint, or the paſtern is too ſhort, the horſe is ſubject to have his fore legs from the knee to the cornet all in a ſtraight line. Commonly your ſhort-jointed horſes do not manege ſo well as the long-jointed; but out of the manege the ſhort-jointed are the beſt for travel or fatigue.

SHORT-Sightedneſs, a certain defect in viſion, by which objects cannot be diſtinctly ſeen, unleſs they are very near the eye. See OPTICS, N° 142.

SHORTFORD, q. d. *fore-cloſe*, an ancient cuſtom in the city of Exeter, when the lord of the fee cannot be anſwered rent due to him out of his tenement, and no diſtreſs can be levied for the ſame. The lord is then to come to the tenement, and there take a ſtone, or ſome other dead thing off the tenement, and bring it before the mayor and bailiff, and thus he muſt do ſeven quarter days ſucceſſively; and if on the ſeventh quarter-day the lord is not ſatisfied of his rent and arrears, then the tenement ſhall be adjudged to the lord to hold the ſame a year and a day; and forthwith proclamation is to be made in the court, that if any man claims any title to the ſame tenement, he muſt appear within the year and day next following, and ſatisfy the lord of the ſaid rent and arrears: but if no appearance be made, and the rent not paid, the lord comes again to the court, and prays that, according to the cuſtom, the ſaid tenement be adjudged to him in his demeſne as of fee, which is done accordingly, ſo that the lord hath from thenceforth the ſaid tenement, with the appurtenances to him and his heirs.

SHOT, a denomination given to all ſorts of balls for fire-arms: thoſe for cannon being of iron, and thoſe for guns, piſtols, &c. of lead. See SHOOTING.

Caſe SHOT formerly conſiſted of all kinds of old iron, nails, muſket-balls, ſtones, &c. uſed as above.

SHOT *of a Cable*, on ſhip-board, is the ſplicing of two cables together, that a ſhip may ride ſafe in deep waters and in great roads; for a ſhip will ride eaſier by one ſhot of a cable, than by three ſhort cables out ahead.

Grape-SHOT. See GRAPE-*Shot*.

Patent-milled SHOT is thus made: Sheets of lead, whoſe thickneſs correſponds with the ſize of the ſhot required, are cut into ſmall pieces, or cubes, of the form of a die. A great quantity of theſe little cubes are put into a large hollow iron cylinder, which is mounted horizontally and turned by a winch; when by their friction againſt one another and againſt the ſides of the cylinder, they are rendered perfectly round and very ſmooth. The other patent ſhot is caſt in moulds, in the ſame way as bullets are.

SHOT *Flaggon*, a ſort of flaggon ſomewhat bigger than ordinary, which in ſome counties, particularly Derbyſhire, it is the cuſtom for the hoſt to ſerve his gueſts in, after they have drank above a ſhilling.

Small SHOT, or that uſed for fowling, ſhould be well ſized, and of a moderate bigneſs: for ſhould it be too great, then it flies thin, and ſcatters too much; or if too ſmall, then it hath not weight and ſtrength to penetrate far, and the bird is apt to fly away with it. In order, therefore, to have it ſuitable to the occaſion, it not being always to be had in every place fit for the purpoſe, we ſhall ſet down the true method of making all ſorts and ſizes under the name of *mould-ſhot*. Its principal good properties are to be round and ſolid.

Take any quantity of lead you think fit, and melt it down in an iron veſſel; and as it melts keep it ſtirring with an iron ladle, ſkimming off all impurities whatſoever that may ariſe at the top: when it begins to look of a greeniſh colour, ſtrew on it as much auripigmentum or yellow orpiment, finely powdered, as will lie on a ſhilling, to every 12 or 14 pound of lead; then ſtirring them together, the orpiment will flame.

The ladle ſhould have a notch on one ſide of the brim, for more eaſily pouring out the lead; the ladle muſt remain in the melted lead, that its heat may be the ſame with that of the lead, to prevent inconveniences which otherwiſe might happen by its being either too hot or too cold: then, to try your lead, drop a little of it into water, and if the drops prove round, then the lead is of a proper heat; if otherwiſe, and the ſhot have tails, then add more orpiment to increaſe the heat, till it be found ſufficient.

Then take a plate of copper, about the bigneſs of a trencher, which muſt be made with a hollowneſs in the middle, about three inches compaſs, within which muſt be bored about 40 holes according to the ſize of the ſhot which you intend to caſt: the hollow bottom ſhould be thin; but the thicker the brim, the better it will retain the heat. Place this plate on a frame of iron, over a tub or veſſel of water, about four inches from the water, and ſpread burning coals on the plate, to keep the lead melted upon it: then take ſome lead and pour it gently on the coals on the plate, and it will make its way through the holes into the water, and form itſelf into ſhot; do this till all your lead be run through the holes of the plate, taking care, by keeping your coals alive, that the lead do not cool, and ſo ſtop up the holes.

While you are caſting in this manner, another perſon with another ladle may catch ſome of the ſhot, placing the ladle four or five inches underneath the plate in the water, by which means you will ſee if they are defective, and rectify them.

Your chief care is to keep the lead in a juſt degree of heat, that it be not ſo cold as to ſtop up the holes in your plate, nor ſo hot as to cauſe the ſhot to crack: to remedy the heat, you muſt refrain working till it is of a proper coolneſs; and to remedy the coolneſs of your lead and plate, you muſt blow your fire; obſerving, that the cooler your lead is, the larger will be your ſhot; as the hotter it is, the ſmaller they will be.

After you have done caſting, take them out of the water, and dry them over the fire with a gentle heat, ſtirring them continually that they do not melt; when dry, you are to ſeparate the great ſhot from the ſmall, by the help of a ſieve made for that purpoſe, according to their ſeveral ſizes. But thoſe who would have very large ſhot, make the lead trickle with a ſtick out of the ladle into the water, without the plate.

If it ſtop on the plate, and yet the plate be not too cool, give but the plate a little knock, and it will run again; care muſt be had that none of your implements be greaſy, oily, or the like; and when the ſhot, being ſeparated, are found too large or too ſmall for your purpoſe, or otherwiſe imperfect, they will ſerve again at the next operation.

The ſizes of common ſhot for fowling are from N° 1 to 6, and ſmaller, which is called muſtard ſeed, or duſt ſhot; but N° 5 is ſmall enough for any ſhooting whatſoever. The N° 1 may be uſed for wild geeſe; the N° 2 for ducks, widgeons, and other water-fowl; the N° 3 for pheaſants, partridges after the firſt month, and all the fen-fowl; the N° 4 for partridges, woodcocks, &c.; and the N° 5 for ſnipes and all the ſmaller birds.

Tin-Caſe SHOT, in artillery, is formed by putting a great quantity of ſmall iron ſhot into a cylindrical tin-box called a canniſter, that juſt fits the bore of the gun. Leaden bullets are ſometimes uſed in the ſame manner; and it muſt be obſerved, that whatever number or ſizes of the ſhots are uſed, they muſt weigh with their caſes nearly as much as the ſhot of the piece.

SHOVEL, SIR CLOUDESLY, a diſtinguiſhed Britiſh admiral, was born about the year 1650, of parents in the lower rank of life. He was put apprentice to a ſhoemaker; but diſliking this profeſſion, he abandoned it a few years after, and went to ſea. He was at firſt a cabin boy with Sir Chriſtopher Mynns, but applying to the ſtudy of navigation with indefatigable induſtry, his ſkill as a ſeaman ſoon raiſed him above that ſtation.

The corſairs of Tripoli having committed great outrages on the Engliſh in the Mediterranean, Sir John Narborough was ſent in 1674 to reduce them to reaſon. As he had received orders to try the effects of negociation before he proceeded to hoſtilities, he ſent Mr

Shovel, who was at that time a lieutenant in his fleet, to demand ſatisfaction. The Dey treated him with a great deal of diſreſpect, and ſent him back without an anſwer. Sir John diſpatched him a ſecond time, with orders to remark particularly the ſituation of things on ſhore. The behaviour of the Dey was worſe than ever. Upon Mr Shovel's return, he informed Sir John that it would be poſſible, notwithſtanding their fortifications, to burn all the ſhips in the harbour. The boats were accordingly manned, and the command of them given to Lieut. Shovel, who ſeized the guardſhip, and burnt four others, without loſing a man. This action ſo terrified the Tripolins, that they ſued for peace.—Sir John Narborough gave ſo favourable an account of this exploit, that Mr Shovel was ſoon after made captain of the Sapphire, a fifth rate ſhip.

In the battle of Bantry-Bay, after the revolution, he commanded the Edgar, and, for his gallant behaviour in that action, was ſoon after knighted by King William. Next year he was employed in tranſporting an army into Ireland; a ſervice which he performed with ſo much diligence and dexterity, that the king raiſed him to the rank of rear-admiral of the blue, and delivered his commiſſion with his own hands. Soon after he was made rear-admiral of the red, and ſhared the glory of the victory at La Hogue. In 1694, he bombarded Dunkirk. In 1703, he commanded the grand fleet in the Mediterranean, and did every thing in his power to aſſiſt the Proteſtants who were in arms in the Cevennes.

Soon after the battle off Malaga, he was preſented by Prince George to Queen Anne, who received him graciouſly, and next year employed him as commander in chief.

In 1705 he commanded the fleet, together with the earl of Peterborough and Monmouth, which was ſent into the Mediterranean; and it was owing to him chiefly that Barcelona was taken. After an unſucceſsful attempt upon Toulon, he ſailed for Gibraltar, and from thence homeward with a part of the fleet. On the 22d of October, at night, his ſhip, with three others, was caſt away on the rocks of Scilly. All on board periſhed. His body was found by ſome fiſhermen on the iſland of Scilly, who ſtripped it of a valuable ring, and afterwards buried it. Mr Paxton, the purſer of the Arundel, hearing of this, found out the fellows, and obliged them to diſcover where they had buried the body. He carried it on board his own ſhip to Portſmouth, from whence it was conveyed to London, and interred with great ſolemnity in Weſtminſter Abbey. A monument was afterwards erected to his memory by the direction of the queen. He married the widow of his patron, Sir John Narborough, by whom he left two daughters, co-heireſſes.

SHOVELER, a ſpecies of ANAS. See ANAS, ORNITHOLOGY *Index*.

SHOULDER-BLADE, a bone of the ſhoulder, of a triangular figure, covering the hind part of the ribs, called by anatomiſts the *ſcapula* and *omoplata*. See ANATOMY.

SHOUT, CLAMOUR, in antiquity, was frequently uſed on eccleſiaſtical, civil, and military occaſions, as a ſign of approbation, and ſometimes of indignation.—Thus as Cicero, in an aſſembly of the people, was expoſing the arrogance of L. Antony, who had had the impudence to cauſe himſelf to be inſcribed the patron of the Romans, the people on hearing this raiſed a ſhout to ſhow their indignation. In the ancient military diſcipline, ſhouts were uſed, 1. Upon occaſion of the general's making a ſpeech or harangue to the army from his tribunal. This they did in token of their approving what had been propoſed. 2. Before an engagement, in order to encourage and ſpirit their own men, and fill the enemy with dread. This is a practice of great antiquity; beſides which, it wants not the authority of reaſon to ſupport it; for as mankind are endowed with two ſenſes, hearing and ſeeing, by which fear is raiſed in the mind, it may be proper to make uſe of the ear as well as the eye for that purpoſe. Shouts were alſo raiſed in the ancient theatre, when what was acted pleaſed the ſpectators. It was uſual for thoſe preſent at the burning of the dead to raiſe a great ſhout, and call the dead perſon by his name before they ſet fire to the pile.

SHOWER, in *Meteorology*, a cloud condenſed into RAIN.

SHREWMOUSE. See SOREX, MAMMALIA *Index*.

SHREWSBURY, the capital of Shropſhire in England. This town, the metropolis of the county, grew up out of the ruins of Uriconium, anciently a city, now a village called *Wroxeter*, about four miles from it. The Saxons called it *Scrobbes Berig*, from the ſhrubs that grew about it; and from thence the preſent name of *Shrewſbury* is ſuppoſed to have been formed. It is pleaſantly ſituated upon a hill near the Severn, over which there are two handſome bridges. It was a place of note in the Saxon times; after which it was granted by William the Conqueror, together with the title of *earl* and moſt of the county, to Roger de Montgomery, who built a caſtle upon the north ſide of it, where the Severn that encompaſſes it on all other ſides, leaves an opening. His ſon Robert built alſo a wall acroſs this neck of land, when he revolted from Henry I. We learn from doomſday-book, that at that time, when a widow of this town married, ſhe paid 20 ſhillings to the king, and a virgin 10. The above-mentioned Roger founded alſo, and endowed here, a Benedictine monaſtery and a collegiate church. When old age came upon him, he quitted the world, and ſpent the reſt of his days as a monk in the abbey, and when he died was interred in its church. From the hiſtory of this church and monaſtery, it appears that eccleſiaſtical benefices about that time were hereditary. The abbey became ſo rich afterwards, that the abbot was mitred, and ſat in parliament. Beſides this abbey, in after times there were three others, viz. a Franciſcan, Dominican, and Auguſtin; and likewiſe two collegiate churches, one dedicated to St Chad and the other to St Mary. In the conteſt between the empreſs Maud and Stephen, this town and its governor William Fitz-Allan ſided with the empreſs. In Henry III.'s time, a part of it was burnt down by the Welch; and in Richard II.'s reign a parliament was held in it. At a place called *Battlefield*, near this town, Henry Percy the younger, ſurnamed *Hotſpur*, was killed in an engagement with Henry IV. againſt whom he had rebelled. The king afterwards built a chapel upon the ſpot, and endowed it for the ſupport of two prieſts to pray for the ſouls of the ſlain. Two of Edward IV.'s ſons were born here; namely,

namely, Richard, duke of York, whom Perkin Warbeck afterwards perſonated, and who was murdered in the Tower; and George Plantagenet, who died before his brothers. Here firſt broke out the ſweating-ſickneſs, which carried off great numbers ſo ſuddenly, that thoſe who were ſeized with it either died or recovered in the ſpace of 24 hours. In the beginning of the civil wars, King Charles I. came hither, and formed an army, with which he marched towards London; but was met by the parliament's forces at Edgehill. He continued here from the 20th of September to the 12th of October, during which time he was joined by Prince Rupert, and many of the gentry and nobility of theſe parts. This town anciently gave title of earl to the Montgomeries, and afterwards to the Talbots, by whom it is ſtill retained. Here is a free grammar-ſchool, with three maſters, and ſeveral uſhers, well endowed by Edward VI. and Queen Elizabeth, and not inferior to many colleges in the univerſities. It has a good library and chapel, and there are ſeveral ſcholarſhips appropriated to it in the univerſity of Cambridge. Here are alſo ſeveral hoſpitals, alms-houſes, and charity-ſchools. This town is one of the moſt flouriſhing in England, having two great weekly markets for corn, cattle, and proviſions; and another for Welch cottons and flannels, of which great quantities are ſold. A great trade is carried on with the Welch, who bring their commodities hither, as to the common mart of both nations. The town is large and well-built, and the ſituation extremely pleaſant. There is a very beautiful walk called the *quarry*, between the town walls and the Severn, delightfully ſhaded with rows of lime-trees, ſo that it is not inferior to the Mall in St James's Park. The town is alſo noted for its gallantry and politeneſs, being full of gentry, for whom there are always balls and aſſemblies once a-week all the year round.—Here is a fine houſe and gardens, which belonged to the earl of Bradford; and in the neighbourhood, at Wroxeter, the Roman highway, called Watling-ſtreet, may be ſeen for ſeveral miles, where Roman coins are frequently found. In Shrewſbury are 12 incorporated trading companies; and the corporation has a power to try even capital cauſes of itſelf, except high treaſon. It is ſaid that thigh-bones of dead men have been found here a yard long, and teeth three inches round and three long.

SHRIKE. See LANIUS, ORNITHOLOGY *Index*.

SHRIMP. See CANCER, ENTOMOLOGY *Index*.

SHRINE, in *Eccleſiaſtical Hiſtory*, a caſe or box to hold the relics of ſome ſaint.

SHROPSHIRE, a county of England, bounded on the ſouth by Worceſterſhire, Herefordſhire, and Radnorſhire; on the north, by Cheſhire; on the eaſt, by Staffordſhire; on the weſt, by Montgomeryſhire and Denbighſhire, in Wales. Its length is between 49 and 50 miles, its breadth about 38, and its circumference about 210. It is an inland county, containing 890,000 acres, 167,639 inhabitants, and 15 hundreds, in which are 170 pariſhes, and 15 market towns. It makes a part of three biſhoprics, viz. Hereford, Coventry and Litchfield, and St Aſaph. Some part of it lies on the north, and ſome on the ſouth ſide of the Severn. Beſides the Severn, it is alſo watered by the *Temd* or *Tefidiauc*, as it is called in Welch, which flows from the mountains of Radnorſhire; and by the Tern, which has its riſe and name from one of thoſe pools called *tearnes*, in Staffordſhire. All theſe abound with fiſh, eſpecially trouts, pikes, lampreys, graylings, carp, and eels. The air, eſpecially upon the hills, with which the county abounds, is very wholeſome. There is as great a diverſity of ſoil as in moſt other counties. On the hills, where it is poor, is very good paſture for ſheep; and in the low grounds, where it is very rich, along the Severn in particular, there is plenty of graſs for bay and black cattle, with all ſorts of corn. This county is abundantly provided with fuel, having in it many extenſive mines of coal; it has alſo mines of lead and iron. Over moſt of the coal-pits in this county lies a ſtratum or layer of blackiſh porous rock, of which, by grinding and boiling, they make pitch and tar, which are rather better than the common ſort for caulking ſhips, as they do not crack, but always continue cloſe and ſmooth. Quarries of lime-ſtone and iron-ſtone are common in the county, and the ſoil in many places is a reddiſh clay. The abundance of coal and iron-ſtone in this county has given riſe to numerous manufactories.

As it lies upon the borders of Wales, it was anciently full of caſtles and walled towns. On the ſide next that country there was an almoſt continued line of caſtles, to guard the county againſt the inroads and depredations of the Welch. The borders here, as thoſe between England and Scotland, were called *marches*, and there were certain noblemen entitled *barones marchiæ*, *marchiones de marchia Walliæ*, "lords of the marches, or marquiſſes of the marches of Wales," who were veſted with a ſort of palatine juriſdiction, held courts of juſtice to determine controverſies, and enjoyed many privileges and immunities, the better to enable and encourage them to protect the county againſt the incurſions of the Welch, and to maintain order amongſt the borderers; but they often abuſed their power, and were the greateſt of tyrants.

As to the eccleſiaſtical government of the county, the far greater part, namely, all that belongs to the biſhoprics of Hereford, and of Litchfield and Coventry, is under the juriſdiction and viſitation of the archdeacon of Shrewſbury or Salop, and is divided into ſeveral deanries.

The Oxford circuit includes in it this county, which ſends 12 members to parliament, viz. two for the ſhire, and two for each of the following towns, Shrewſbury, Ludlow, Wenlock, and Biſhop's Caſtle.

SHROVE-TUESDAY, is the Tueſday after Quinquageſima Sunday, or the day immediately preceding the firſt of Lent; being ſo called from the Saxon word *ſhrive*, which ſignifies "to confeſs." Hence Shrove-Tueſday ſignifies Confeſſion-Tueſday; on which day all the people in every pariſh throughout England (during the Romiſh times) were obliged to confeſs their ſins, one by one, to their own pariſh prieſts, in their own pariſh-churches; and, that this might be done the more regularly, the great bell in every pariſh was rung at ten o'clock (or perhaps ſooner), that it might be heard by all, and that they might attend, according to the cuſtom then in uſe. And though the Romiſh religion has now given way to the Proteſtant religion, the cuſtom of ringing the great bell in our ancient pariſh-churches, at leaſt in ſome of them, ſtill remains, and obtains in and about London the name of Pancake bell; perhaps, becauſe after the confeſſion it was cuſtomary for the ſeveral perſons to dine on pancakes or fritters. Moſt churches, indeed, have rejected that cuſtom of ringing the bell on Shrove-Tueſday; but the uſage of dining on pancakes or fritters, and ſuch like proviſion, ſtill continues.

SHROUDS (*ſcrud* Sax.), a range of large ropes extending from the maſt-heads to the right and left ſide of the ſhip, to ſupport the maſts, and enable them to carry ſail, &c.

The ſhrouds as well as the ſails are denominated from the maſts to which they belong. Thus they are the main, fore, and mizen ſhrouds; the main-top-maſt, fore-top-maſt, or mizen-top maſt ſhrouds; and the main-top-gallant, fore-top-gallant, or mizen-top-gallant ſhrouds. The number of ſhrouds by which a maſt is ſuſtained, as well as the ſize of rope of which they are formed, is always in proportion to the ſize of the maſt and the weight of the ſail it is intended to carry.

Bowſprit ſhrouds are thoſe which ſupport the bowſprit. Bumkin ſhrouds are thoſe which ſupport the bumkins. Futtock ſhrouds are ſhrouds which connect the efforts of the topmaſt ſhrouds to the lower ſhrouds. Bentinck ſhrouds are additional ſhrouds to ſupport the maſts in heavy gales. Preventer ſhrouds are ſimilar to bentinck ſhrouds, and are uſed in bad weather to eaſe the lower rigging. See MAST and SAIL.

SHRUB, *frutex*, a little, low, dwarf tree, or a woody vegetable, of a ſize leſs than a tree; and which, inſtead of one ſingle ſtem, frequently from the ſame root puts forth ſeveral ſets or ſtems. See PLANT and TREE. Such are privet, phillyrea, holly, box, honey-ſuckle, &c. Shrubs and trees put forth in autumn a kind of buttons, or gems, in the axis of the leaves; theſe buttons are as ſo many little ova, which, coming to expand by the warmth of the following ſpring, open into leaves and flowers. By this, together with the height, ſome diſtinguiſh ſhrubs from *ſuffrutices*, or under ſhrubs, which are low buſhes, that do not put forth any of theſe buttons, as ſage, thyme, &c.

The two hardieſt ſhrubs we are poſſeſſed of are the ivy and box; theſe ſtand the ſeverity of our ſharpeſt winters unhurt, while other ſhrubs periſh, and trees have their ſolid bodies ſplit and torn to pieces. In the hard winter of the year 1683, theſe two ſhrubs ſuffered no injury any where; though the yews and hollies, which are generally ſuppoſed very hardy, were that winter in ſome places killed, and in others ſtripped of their leaves, and damaged in their bark. Furze-buſhes were found to be ſomewhat hardier than theſe, but they ſometimes periſhed, at leaſt down to the root. The broom ſeemed to occupy the next ſtep of hardineſs beyond theſe. This lived where the others died, and where even this died, the juniper ſhrubs were ſometimes found unhurt. This laſt is the only ſhrub that approaches to the hardineſs of the box and ivy, but even it does not quite come up to them; for while they ſuffer nothing in whatever manner they are expoſed, the juniper, though it bears cold well under the ſhelter of other trees, yet cannot bear the viciſſitudes of heat and cold; inſomuch that ſome juniper ſhrubs were found half dead and half vigorous; that ſide which faced the mid-day ſun having periſhed by the ſucceſſive thawings and freezings of its ſap; while that which was not expoſed to the viciſſitudes of heat had borne the cold perfectly well. Such ſhrubs as are not hardy enough to defy the winter, but appear half dead in the ſpring, may often be recovered by Mr Evelyn's method of beating their branches with a ſlender hazel-wand, to ſtrike off the withered leaves and buds, and give a free paſſage to the air to the internal parts. Where this fails, the method is to cut them down to the quick, and if no part of the trunk appears in a growing condition, they muſt be taken off down to the level of the ground. Philoſophical Tranſactions, N° 165.

SHUTTLE, in the manufactures, an inſtrument uſed by the weavers, which guides the thread it contains, either of woollen, ſilk, flax, or other matter, ſo as to make it form the woofs of ſtuffs, cloths, linens, ribbands, &c. by throwing the ſhuttle alternately from left to right, and from right to left, acroſs between the threads of the warp, which are ſtretched out lengthwiſe on the loom.

In the middle of the ſhuttle is a kind of cavity, called the *eye* or *chamber* of the ſhuttle; wherein is incloſed the ſpoul, which is a part of the thread deſtined for the woof; and this is wound on a little tube of paper, ruſh, or other matter.

The ribband-weaver's ſhuttle is very different from that of moſt other weavers, though it ſerves for the ſame purpoſe: it is of box, ſix or ſeven inches long, one broad, and as much deep; ſhod with iron at both ends, which terminate in points, and are a little crooked, the one towards the right, and the other towards the left, repreſenting the figure of an ∽ horizontally placed. See WEAVING.

SIALOGOGUES, medicines which promote the ſalivary diſcharge.

1 Boundaries and extent.

SIAM PROPER, by ſome called *Upper*, (to diſtinguiſh it from the *Lower* Siam, under which are often included Laos, Cambodia, and Malacca), is bounded on the north by the kingdoms of Pegu and Laos; on the eaſt by Cambodia and Cochin-China; on the ſouth by Malacca and the bay of Siam; and on the weſt by the ocean. But as the opinions of geographers are extremely various concerning the ſituation and extent of moſt of the inland countries of Aſia and Africa, neither the extent nor boundaries of Siam are yet accurately known. By ſome it is ſuppoſed to extend 550 miles in length, and 250 miles in breadth; in ſome places it is not above 50 miles broad.

2 Weather.

The winds blow here from the ſouth upon the coaſt of Siam, in March, April, and May; in April the rains begin, in May and June they fall almoſt without ceaſing. In July, Auguſt, and September, the winds blow from the weſt, and the rains continuing, the rivers overflow their banks nine or ten miles on each ſide, and for more than 150 miles up the ſtream. At this time, and more particularly in July, the tides are ſo ſtrong as to come up the river Menan as far as the city of Siam, which is ſituated 60 miles from its mouth; and ſometimes as far as Louvo, which is 50 miles higher. The winds blow from the weſt and north in October, when the rain ceaſes. In November and December the winds blow dry from the north, and the waters being in a few days reduced to their ancient channels, the tides become ſo inſenſible, that the water is freſh at the mouth of the river. At Siam there is never more than one flood and one ebb in the ſpace of 24 hours. In January the wind blows from the eaſt, and in February from the eaſt and ſouth. When the wind is at eaſt, the

the current ſets to the weſt; and, on the contrary, when the wind is at weſt, the currents run to the eaſtward.

As this country is ſituated near the tropic, it muſt neceſſarily be very hot; but yet, as in other places nearly of the ſame latitude, when the ſun is vertical and ſhines with a moſt intenſe heat, the inhabitants are ſo ſkreened by the clouds, and the air is ſo refreſhed by a deluge of rain that overflows the plains which the people chiefly inhabit, that the heat is very ſupportable. The cooleſt wind blows in December and January.

3 getable uc- ts.

The vegetable produce of this country is chiefly rice and wheat, beſides tropical and a few European fruits. The Siameſe prepare the land for tillage as ſoon as the earth is ſufficiently moiſtened by the floods. They plant their rice before the waters riſe to any conſiderable height, and, as they riſe ſlowly, the rice keeps pace with them, and the ear is always above the water. They reap their corn when the water retires, and ſometimes go in boats to cut it while the waters are upon the ground. They alſo ſow rice in ſeveral parts of the kingdom that are not overflowed, and this is thought better taſted, and will keep longer than the other; but they are forced to ſupply theſe fields conſtantly with water, while the rice is growing, from baſins and ponds that lie about them.

They have no European fruits except oranges, lemons, citrons, and pomegranates. They have bananas, Indian figs, jaques, durions, mangoes, mangoſtans, tamarinds, ananas, and cocoa nuts; they have alſo abundance of pepper and ſugar-canes. The mountains are covered with trees which make good maſts. The vegetable of greateſt uſe in the country is the bamboo, which grows chiefly in marſhy ſoils, and is often found of a prodigious ſize. Cotton trees are found in great numbers; and others that yield *capoc*, a very fine cotton wool, but ſo ſhort as to be unfit for ſpinning, though it anſwers very well for ſtuffing mattreſſes and pillows.

4 Animals.

There is no country where elephants abound more than in Siam, or where they are held in greater veneration. They have a few horſes, ſheep, and goats, beſides oxen and buffaloes; but they have no good animal food except the fleſh of hogs, their beef and mutton being of a very indifferent quality.

5 Description of the inhabitants.

The Siameſe are of ſmall ſtature, but well proportioned; their complexions are ſwarthy: the faces of both the men and women are broad, and their foreheads, ſuddenly contracting, terminate in a point, as well as their chins. They have ſmall black eyes, hollow jaws, large mouths, and thick pale lips. Their teeth are dyed black, their noſes are ſhort and round at the end, and they have large ears, which they think very beautiful. Their hair is thick and lank, and both ſexes cut it ſo ſhort that it reaches no lower than their ears; the women make it ſtand up on their foreheads; and the men ſhave their beards.

Dre

People of diſtinction wear a piece of calico tied about their loins, that reaches down to their knees.—The men bring up this cloth between their legs, and tuck it into their girdles, which gives it the appearance of a pair of breeches. They have alſo a muſlin ſhirt without a collar, with wide ſleeves, no wriſtbands, and the boſom open. In winter they wear a piece of ſtuff or painted linen over their ſhoulders, like a mantle, and wind it about their arms.

The king of Siam is diſtinguiſhed by wearing a veſt of brocaded ſatin, with ſtraight ſleeves that reach down to the wriſt, under ſuch a ſhirt as we have juſt deſcribed, and it is unlawful for any ſubject to wear this dreſs unleſs he receives it from the king. They wear ſlippers with piked toes turned up, but no ſtockings. The king ſometimes preſents a military veſt to the generals; this is buttoned before, and reaches to the knees; but the ſleeves are wide, and come no lower than the elbows. All the retinue of the king, either in war or in hunting, are clothed in red. The king wears a cap in the form of a ſugar-loaf, encompaſſed by a coronet or circle of precious ſtones, and thoſe of his officers have a circle of gold, ſilver, or of vermilion gilt, to diſtinguiſh their quality; and theſe caps are faſtened with a ſtay under the chin; they are only worn when they are in the king's preſence, or when they preſide in courts of juſtice, and on other extraordinary occaſions. They have alſo hats for travelling; but, in general, few people cover their heads notwithſtanding the ſcorching heat of the ſun.

The women alſo wrap a cloth about their middle, which hangs down to the calf of their legs. They cover their breaſts with another cloth, the ends of which hang over their ſhoulders. But they have no garment correſponding to a ſhift, nor any covering for their heads but their hair. The common people are almoſt naked, and wear neither ſhoes nor ſlippers. The women wear as many rings on the three laſt fingers of each hand as they can keep on, and bracelets upon their wriſts and ancles, with pendants in their ears ſhaped like a pear.

7 Manners and cuſtoms

For an inferior to ſtand before a ſuperior is deemed inſolent; and therefore ſlaves and people of inferior rank ſit upon their heels, with their heads a little inclined, and their joined hands lifted up to their foreheads. In paſſing by a ſuperior they bend their bodies, joining their hands, and lifting them towards their heads in proportion to the reſpect they would ſhow. When an inferior pays a viſit, he enters the room ſtooping, proſtrates himſelf, and then remains upon his knees, ſitting upon his heels without ſpeaking a word till he is addreſſed by the perſon whom he viſits; for he that is of the higheſt quality muſt always ſpeak firſt. If a perſon of rank viſits an inferior, he walks upright, and the maſter of the houſe receives him at the door, and waits on him ſo far when he goes away, but never farther.

The higheſt part of the houſe is eſteemed the moſt honourable, and no perſon cares to lodge under another's feet. The Siameſe indeed have but one ſtory, but the rooms riſe gradually, and the innermoſt, which are the higheſt, are always the moſt honourable. When the Siameſe ambaſſador came to the French court, ſome of his retinue were lodged in a floor over the ambaſſador's head; but they no ſooner knew it, than they were ſtruck with the greateſt conſternation, and ran down tearing their hair at the thoughts of being guilty of what they conſidered as ſo unpardonable a crime.

The Siameſe never permit ſuch familiarities as are practiſed by gentlemen in Europe. Eaſineſs of acceſs, and

Siam.

and affability to inferiors, is in that part of the world thought a ſign of weakneſs, and yet they take no notice of ſome things which may be looked upon as ill breeding among us; ſuch as belching in company, which no man endeavours to prevent or ſo much as holds his hand before his mouth. They have an extraordinary reſpect for the head, and it is the greateſt affront to ſtroke or touch that of another perſon; nay, their cap muſt not be uſed with too much familiarity; for when a ſervant carries it, it is put on a ſtick and held above his head; and when the maſter ſtands ſtill the ſtick is ſet down, it having a foot to ſtand upon. They alſo ſhow their reſpect by lifting their hands to the head; and therefore, when they receive a letter from any one for whom they have a great reſpect, they immediately hold it up to their heads, and ſometimes lay it upon their heads.

8
Genius and diſpoſitions.

They are eſteemed an ingenious people, and though rather indolent than active in diſpoſition, they are not addicted to the voluptuous vices which often accompany a ſtate of eaſe, being remarkably chaſte and temperate, and even holding drunkenneſs in abhorrence.—They are, however, accounted inſolent towards their inferiors, and equally obſequious to thoſe above them; the latter of which qualities appears to be particularly inculcated from their earlieſt youth. In general, their behaviour is extremely modeſt, and they are averſe to loquacity. Like the Chineſe, they avoid ſpeaking in the firſt perſon: and when they addreſs a lady, it is always with ſome reſpectful epithet, inſinuating perſonal accompliſhments.

No man in this country learns any particular trade, but has a general knowledge of all that are commonly practiſed, and every one works ſix months for the king by rotation; at which time, if he ſhould be found perfectly ignorant of the buſineſs he is ſet about, he is doomed to ſuffer the baſtinado. The conſequence of this burdenſome ſervice is, that no man endeavours to excel in his buſineſs, leſt he ſhould be obliged to practice it as long as he lives for the benefit of the crown.

9
Government.

The government of this country is extremely oppreſſive, the king being not only ſovereign but proprietor of all the lands, and chief merchant likewiſe; by which means he monopolizes almoſt the whole traffic, to the great prejudice of his ſubjects. The crown is ſaid to be hereditary, but it is often transferred by revolutions, on account of the exorbitant abuſe of power in thoſe who exerciſe the royal office. In his palace, the king is attended by women, who not only prepare his food, and wait on him at table, but even perform the part of valets, and put on all his clothes, except his cap, which is conſidered as too ſacred to be touched by any hand but his own. He ſhows himſelf to the people only twice a-year, when he diſtributes his alms to the talapoins or prieſts: and on thoſe occaſions he always appears in an elevated ſituation, or mounted on the back of an elephant. When he takes the diverſion of hunting, he is as uſual attended by his women on foot, preceded by a guard of 200 men, who drive all the people from the roads through which they are to paſs; and when the king ſtops, all his attendants fall upon their faces on the ground.

10
Forms of proceſs.

All their proceedings in law are committed to writing, and none is ſuffered to exhibit a charge againſt another, without giving ſecurity to proſecute it, and anſwer the damages if he does not prove the fact againſt the perſon accuſed. When a perſon intends to proſecute another, he draws up a petition, in which he ſets forth his complaint, and preſents it to the *nai*, or head of the band to which he belongs, who tranſmits it to the governor; and if the complaint appears frivolous, the proſecutor, according to the laws of the country, ſhould be puniſhed; but the magiſtrates generally encourage proſecutions on account of the perquiſites they bring to their office.

Every thing being prepared for hearing, the parties are ſeveral days called into court, and perſuaded to agree; but this appears to be only a matter of form. At length the governor appoints a day for all parties to attend; and being come into court, the clerk reads the proceſs and opinion of his aſſociates, and then the governor examines upon what reaſons their opinions are founded; which being explained to him, he proceeds to paſs judgment.

1
Trial b
deal.

When ſufficient proofs are wanting, they have recourſe to an ordeal trial, like that of our Saxon anceſtors: both the plaintiff and the defendant walk upon burning coals, and he that eſcapes unhurt is adjudged to be in the right: ſometimes the proof is made by putting their hands in boiling oil; and in both theſe trials, by ſome peculiar management, one or the other is ſaid to remain unhurt. They have alſo a proof by water, in which he who remains longeſt under it is eſteemed innocent. They have another proof, by ſwallowing pills, which their prieſts adminiſter with ſevere imprecations; and the party who keeps them in his ſtomach without vomiting is thought to be innocent.

All theſe trials are made in the preſence of the magiſtrates and people; and the king himſelf frequently directs them to be performed, when crimes come before him by way of appeal. Sometimes he orders both the informer and priſoner to be thrown to the tigers: and the perſon that eſcapes by his not being ſeized upon by thoſe beaſts, is ſufficiently juſtified.

12
Religio
opinion

They maintain the doctrine of tranſmigration, believing in a pre-exiſtent ſtate, and that they ſhall paſs into other bodies till they are ſufficiently purified to be received into paradiſe. They believe likewiſe that the ſoul is material, but not ſubject to the touch; that it retains the human figure after quitting a body of that ſpecies; and that when it appears to perſons with whom it was acquainted, which they ſuppoſe it to do, the wounds of one that has been murdered will then be viſible. They are of opinion that no man will be eternally puniſhed; that the good, after ſeveral tranſmigrations, will enjoy perpetual happineſs; but that thoſe who are not reformed will be doomed to tranſmigration to all eternity. They believe in the exiſtence of a Supreme Being; but the objects of their adoration are departed ſaints, whom they conſider as mediators or interceſſors for them; and to the honour of this numerous tribe both temples and images are erected.

1
Marria

The men of this country are allowed a plurality of women; but excepting one, who is a wife by contract, the others are only concubines, and their children deemed incapable of any legal inheritance. Previous to every nuptial contract, an aſtrologer muſt be conſulted, who calculates the nativity of the parties, and determines whether their union is likely to prove fortunate or or otherwiſe. When his prognoſtication is favourable, the lover is permitted to viſit his miſtreſs three times, at the laſt of which interviews the relations being preſent, the marriage portion is paid, when, without any religious ceremony performed, the nuptials are reckoned complete, and ſoon after conſummated. A few days after the talapoin viſits the married couple, ſprinkles them with water, and repeats a prayer for their proſperity.

14 unerals. The practice in Siam reſpecting funerals, is both to burn and bury the dead. The corpſe being laid upon the pile, it is ſuffered to burn till a conſiderable part is conſumed, when the remainder is interred in a burying-place contiguous to ſome temple. The reaſon which they give for not burning it entirely to aſhes is, that they ſuppoſe the deceaſed to be happy when part of his remains eſcapes the fire. Inſtead of a tombſtone, they erect a pyramid over the grave. It was formerly the cuſtom to bury treaſure with the corpſe; but longer experience evincing, that the ſacrilegious light in which robbing the graves was conſidered did not prevent the crime, they now diſcontinue the ancient practice, and inſtead of treaſure bury only painted papers and other trifles.

15 ivers. The two principal rivers are the Menan and the Mecon, which riſe in the mountains of Tartary, and run to the ſouth; the former paſſing by the city of Siam, falls into the bay of the ſame name, in the 13th degree of north latitude; and the latter running through Laos and Cambodia, diſcharges itſelf into the Indian ocean in the 9th degree of north latitude.

16 eſcrip- on of the pital. The capital of the country is Siam, called by the natives *Siyothoya*, ſituated in the 101ſt degree of eaſt longitude, and in the 14th degree of north latitude, being almoſt encompaſſed by the branches of the river Menan. It is about 10 miles in circumference within the walls, but not a ſixth part of the ground is occupied by buildings. In the vacant ſpaces there are near 300 pagodas or temples, round which are ſcattered the convents of the prieſts and their burying-places. The ſtreets of the city are ſpacious, and ſome have canals running through them, over which is a great number of bridges. The houſes ſtand on pillars of the bamboo cane, and are built of the ſame materials: the communication between different families, during the winter ſeaſon, being carried on as in other tropical countries by means of boats. The grounds belonging to the ſeveral tenements are ſeparated by a paliſado, within which the cattle are houſed in barns, erected likewiſe upon pillars, to preſerve them from the annual inundation.

SIBBALDIA, a genus of plants belonging to the claſs of pentandria, and to the order of pentagynia; and in the natural ſyſtem arranged under the 35th order, *Senticoſæ*. See BOTANY *Index*.

SIBENICO, or SEBENICO, the name of a city and province of Dalmatia. The province of Sibenico runs along the ſea for more than 30 miles; reaches in ſome places above 20 miles within land, and comprehends above 70 iſlands. The city of Sibenico is ſituated near the mouth of the river Cherca, in the gulf of Venice, 55 miles north of Spalatto, and 25 ſouth-eaſt of Zara. E. Long. 16° 46′, N. Lat. 44° 17′. It belongs to the Venetians. It is defended on one ſide by a caſtle, which held out againſt repeated attacks of the Turks, and towards the ſea by a fort.

SIBERIA, a large country, comprehending the moſt northerly parts of the Ruſſian empire in Aſia. It is bounded on the eaſt by the eaſtern ocean; on the ſouth by Great Tartary; on the weſt by Ruſſia; and on the north by the Frozen ocean. It is about 2000 miles in length from eaſt to weſt, and 750 miles in breadth from north to ſouth. 1 Boundaries and extent.

At what time this country was firſt inhabited, or by whom it was peopled, we are entirely ignorant; but writings have been found in it when it was diſcovered, which ſhows that it muſt have been early known to a civilized people *. The Ruſſians, from whom we have received our knowledge, knew nothing of it before the middle of the 16th century. In the reign of John Baſilowitz I. indeed, an incurſion had been made into Siberia, and ſome Tartar tribes ſubdued: but theſe conqueſts were not permanent; and we hear of no further communication between Ruſſia and Siberia till the time of John Baſilowitz II. It was opened again at that time by means of one Anika Strogonoff, a Ruſſian merchant, who had eſtabliſhed ſome ſalt-works at a town in the government of Archangel. This man carried on a trade with the inhabitants of the north-weſt parts of Siberia, who brought every year to the town above mentioned large quantities of the fineſt furs. Thus he acquired a very conſiderable fortune in a ſhort time; when at laſt the czar, perceiving the advantages which would accrue to his ſubjects from having a regular intercourſe with Siberia, determined to enlarge the communication which was already opened. With this view he ſent into Siberia a body of troops, which croſſed the Yugorian mountains, that form part of the north-eaſtern boundary of Europe. They ſeem, however, not to have paſſed the Irtiſh, or to have penetrated farther than the weſtern branch of the river Oby. Some Tartar tribes were laid under contribution, and a chief named *Yediger* conſented to pay an annual tribute of 1000 ſables. But this produced no laſting advantage to Ruſſia; for, ſoon after, Yediger was defeated and taken priſoner by Kutchum Khan, a deſcendant of the great Jenghiz Khan: and thus the allegiance of this country to Ruſſia was diſſolved. 2 Conquered by the Ruſſians.

For ſome time we hear of no further attempts made by the Ruſſians on Siberia; but in 1577 the foundation of a permanent conqueſt was laid by one Yermac Temofeeff, a Coſſack of the Don. This man was at firſt the head of a party of banditti who infeſted the Ruſſians in the province of Caſan; but being defeated by the troops of the czar, he retired with 6000 of his followers into the interior parts of that province. Continuing his courſe ſtill eaſtward, he came to Orel, the moſt eaſterly of all the Ruſſian ſettlements. Here he took up his winter-quarters: but his reſtleſs genius did not ſuffer him to continue for any length of time in a ſtate of inactivity; and from the intelligence he procured concerning the ſituation of the neighbouring Tartars of Siberia, he turned his arms towards that quarter.

3 State of Siberia at the time of the Ruſſian conqueſt. Siberia was at that time partly divided among a number of ſeparate princes, and partly inhabited by the various tribes of independent Tartars. Of the former Kutchum Khan was the moſt powerful ſovereign. His dominions conſiſted of that tract of country which now forms the ſouth-weſtern part of the province of Tobolſk; and ſtretched from the banks of the Irtiſh and Oby to

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* *Bell's Travels.*

thoſe of the Tobol and Tura. His principal reſidence was at Sibir, a ſmall fortreſs upon the river Irtiſh, not far from the preſent town of Tobolſk, and of which ſome ruins are ſtill to be ſeen. After a courſe of unremitted fatigue, and a ſeries of victories which almoſt exceed belief, but of which we have not room to give the detail, our intrepid adventurer diſpoſſeſſed this prince of his dominions, and ſeated himſelf on the throne of Sibir. The number of his followers, however, being greatly reduced, and perceiving he could not depend on the affection of his new ſubjects, he had recourſe to the czar of Muſcovy, and made a tender of his new acquiſitions to that monarch, upon condition of receiving immediate and effectual ſupport. This propoſal was received with the greateſt ſatisfaction by the czar, who granted him a pardon for all former offences, and ſent him the required ſuccours. Yermac, however, being ſoon after drowned in an unſucceſsful excurſion, the Ruſſians began to loſe their footing in the country. But freſh reinforcements being ſeaſonably ſent, they not only recovered their ground, but puſhed their conqueſts far and wide; whereever they appeared, the Tartars were either reduced or exterminated. New towns were built, and colonies were planted on all ſides. Before a century had well elapſed, all that vaſt tract of country now called *Siberia*, which ſtretches from the confines of Europe to the Eaſtern ocean, and from the Frozen ſea to the preſent frontiers of China, was annexed to the Ruſſian dominions.

4 Climate.

The air of Siberia is, in general, extremely piercing, the cold there being more ſevere than in any other part of the Ruſſian dominions. The Siberian rivers are frozen very early, and it is late in the ſpring before the ice is thawed (A). If the corn does not ripen in Auguſt, there is little hope of a harveſt in this country; and in the

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(A) M. Gmelin, M. Muller, and two other philoſophers, ſet out in the year 1733 to explore the dreary regions of Siberia, by deſire of the empreſs Anne of Ruſſia. After ſpending nine years and a half in obſerving every thing that was remarkable, they returned to Peterſburgh; and an account of this journey was publiſhed by M. Gmelin. In order to examine how far the froſt had penetrated into the ground, M. Gmelin, on the 18th of June, at a place called Jacutia, ordered the earth to be dug in high ground; they found mould to the depth of 11 inches, under which they met with looſe ſand to two feet and a half further, after which it grew harder, and at half a foot deeper ſo hard as ſcarcely to give way to the tools; ſo that the ground ſtill remained unthawed at not leſs than the depth of four feet. He made the ſame experiment in a lower ſituation; the ſoil was 10 inches deep, after that a looſe ſand for two feet and ten inches, below which all was frozen and hard. At Jacutia the inhabitants preſerve in cellars ſeveral ſorts of berries, which they reckon among their dainties, perfectly good and freſh the whole year, though theſe cellars are ſcarcely a fathom deep. At the fortreſs of Argun, in little more than 50 degrees of latitude, the inhabitants relate that the earth in many places is never thawed above a yard and a half, and that the internal cold of the earth will ſcarcely permit a well to be dug, of which they bring an inſtance that happened not long before the author's arrival at that place. They deſigned to ſink a well near a houſe at ſome diſtance from the river Argun, for which purpoſe they thawed the earth by degrees, and dug ſome fathoms till they had penetrated a fathom and half below the level of the river, but found no ſpring. Hence perhaps we may venture to aſſert, that beſides the great elevation of the earth in theſe countries, there is another cauſe, perhaps latent in the earth itſelf, of this extraordinary cold, naturally ſuggeſted to us by conſidering the cavity of an old ſilver mine at Argun, which being exhauſted of its ore, now ſerves the inhabitants in ſummer time for a cellar to keep their proviſions: this place is ſo extremely cold as to preſerve fleſh meats from putrefaction in the hotteſt ſummers, and to ſink the mercury in De Liſle's theremometer to 146 and 147. The author travelling from Nerſchoi towards Argun, to viſit the works of the ſilver mines in that place, Auguſt 1735, came to the river Orkija, near Soloniſchaia, on July the firſt, from whence he arrived a little before dark at the village of Seventua, diſtant from the river 27 leagues. In this journey he and his fellow travellers for more than four leagues felt it vaſtly cold; ſoon after they came into a warm air, which continued ſome leagues; after which the cold returned; and thus are travellers ſubjected to perpetual viciſſitudes of warmth and cold. But it is obſerved in general, that the eaſtern parts are colder than the weſtern, though ſituated in the ſame latitude; for as in thoſe eaſtern regions ſome tracts of land are much colder than the reſt, their effects muſt be felt by the neighbouring parts. And this conjecture is favoured by the thermometrical obſervations made with M. de L'Iſle's inſtrument in all parts of Siberia, in which the mercury was depreſſed to the 226th degree, even in thoſe parts that lie very much towards the ſouth, as in the territory of Selinga, which ſaid degree anſwers in Fahrenheit's thermometer to about 55.5 below 0, but the ſame thermometer ſometimes indicated a much greater cold. At the fort of Kiringa, on February 10. 1738, at 8 in the morning, the mercury ſtood at 240, which anſwers nearly to 72 below 0 in Fahrenheit's. On the 23d of the ſame month it was a degree lower. At the ſame place, December 11. at three in the afternoon, it ſtood at 254 in De Liſle's thermometer, and very near 90 in Fahrenheit's; on December 29. at four in the afternoon, at 263; on November 27. at noon, at 270; January 9. at 275, which ſeveral depreſſions anſwer in Fahrenheit's to 99.44, 107.73, and 113.65; on January 5. at five in the morning, at 262; an hour after at 281, but at eight o'clock it returned to 250, and there remained till ſix in the afternoon, and then roſe by degrees till an hour before midnight, when it ſtood at 202. So that the greateſt depreſſion of the mercury anſwers in Fahrenheit's thermometer to 120.76 degrees below 0, which is indeed very ſurpriſing, and what nobody ever imagined before. While this cold laſted at Jeniſea, the ſparrows and magpies fell to the ground, ſtruck dead, as it were, with the froſt, but revived if they were ſoon brought into a warm room. The author was told alſo that numbers of wild beaſts were found in the woods dead and ſtiff with the froſt, and ſeveral travellers had their blood and juices quite frozen in their veſſels. The air itſelf at that time was ſo diſmal, that you would think it changed to ice, as it was a thick fog, which was not diſſipable by any exhalations, as in the ſpring and autumn, and the author could ſcarcely ſtand three minutes in the porch of his houſe for the cold.

the province of Jeniſeiſk it is ſometimes covered with ſnow before the peaſants can reap it. To defend the inhabitants againſt this extreme ſeverity of the climate, Providence ſeems more liberally to have dealt out to them wood for fuel and furs for clothing. As the winter days in the north parts of Siberia laſt but a few hours, and the ſtorms and flakes of ſnow darken the air ſo much, that the inhabitants, even at noon, cannot ſee to do any thing without artificial lights, they ſleep away the greateſt part of that ſeaſon.

Theſe ſevere winters are rapidly ſucceeded by ſummers, in which the heat is ſo intenſe that the Tunguſians, who live in the province of Jakutſk, go almoſt naked. Here is ſcarcely any night during that ſeaſon; and towards the Frozen ocean the ſun appears continually above the horizon. The vegetables and fruits of the earth are here extremely quick in their growth.

5 il and oduce. The whole tract of land beyond the 60th degree of north latitude is a barren waſte; for the north part of Siberia yields neither corn nor fruits; though barley is known frequently to come to perfection in Jakutſk.—For this reaſon, the inhabitants of the northern parts are obliged to live on fiſh and fleſh, but the Ruſſians are ſupplied with corn from the ſouthern parts of Siberia, where the ſoil is ſurpriſingly fertile. The countries beyond the lake of Baikal, eſpecially towards the eaſt, as far as the river Argun, are remarkably fruitful and pleaſant; but ſuch is the indolence of the inhabitants, that ſeveral fine tracts of land, which would make ample returns to the peaſant for cultivating them, lie neglected. The paſtures are excellent in this country, which abounds in fine horned cattle, horſes, goats, &c. on which the Tartars chiefly depend for ſubſiſtence. However, there are ſeveral ſteppes, or barren waſtes, and unimprovable tracts in theſe parts; and not a ſingle fruit tree is to be ſeen. There is great variety of vegetables, and in ſeveral places, particularly near Kraſnoia Sloboda, the ground is in a manner overrun with aſparagus of an extraordinary height and delicious flavour. The bulbs of the Turkiſh bundes, and other ſorts of lilies, are much uſed by the Tartars inſtead of bread. This want of fruit and corn is richly compenſated by the great quantities of wild and tame beaſts, and fowls, and the infinite variety of fine fiſh which the country affords (B).

In that part of Siberia which lies near the Icy ſea, as well as in ſeveral other places, are woods of pine, larch, and other trees; beſides which, a conſiderable quantity of wood is thrown aſhore by the waves of the Icy ſea; but whence it comes is not yet aſcertained.

6 ild aſts. Beſides the wild fowl with which Siberia abounds, there is a prodigious number of quadrupeds, ſome of which are eatable, and others valuable for their ſkins or furs.

The animals moſt valued for their ſkins are the black fox, the ſable, the hyena, the ermine, the ſquirrel, the beaver, and the lynx. The ſkin of a real black fox is more eſteemed than even that of a ſable. In the country near the Frozen ocean are alſo blue and white foxes. The fineſt ſables come from Nertſhinſk and Jakutſk, the inhabitants of which places catch them in the mountains of Stannowoi Krebet. The tributary nations were formerly obliged to pay their taxes in the ſkins of foxes and ſables only. But now the ſkins of ſquirrels, bears, rein-deer, &c. and ſometimes money, are received by way of tribute; and this not only from thoſe who live near the Lena, but alſo in the governments of Ilinſk, Irkutzk, Selenginſk, and Nertſhinſk. When the Tartars firſt became tributary to Ruſſia, they brought their furs indiſcriminately as they caught them, and among them were often ſables of extraordinary value; and formerly, if any trader brought with him an iron kettle, they gave him in exchange for it as many ſables as it would hold. But they are now better acquainted with their value. They ſell their ſables to ſmugglers at a very high price, and pay only a ruble inſtead of a ſkin to the revenue officers, who now receive more ready money than ſables by way of tribute. The ſubjects plead the ſcarcity of furs, and indeed not without ſome appearance of truth.

7 Minerals. Siberia has ſtill other and more valuable treaſures than thoſe we have yet mentioned. The ſilver mines of Argun are extremely rich; the ſilver they produce yields ſome gold, and both of theſe are found among the copper ore of Koliwan. This country is alſo particularly rich in copper and iron ore. The former lies even upon the ſurface of the earth; and conſiderable mines of it are found in the mountains of Pictow, Koliwan, Ploſkau, Woſkereſenſk, Kuſwi, Alepaik, and ſeveral others, and in the government of Kraſnoiarſk (C). Iron is ſtill more plentiful in all theſe places, and very good; but that of Kamenſki is reckoned the beſt. Several hundred thouſand puds of theſe metals are annually exported from the ſmelting houſes, which belong partly to the crown, and partly to private perſons. Moſt of them lie in the government of Catharinenburg. The Tartars alſo extract a great quantity of iron from the ore.

Precious ſtones. The topazes of Siberia have a fine luſtre; and in open ſandy places, near the river Argun, as well as on the banks of other rivers and lakes, are found ſingle ſmall pieces of agate. Here are alſo carnelians and green jaſper with red veins. The latter is chiefly met with in the deſerts of Gobiſkoi.

Marienglas. The famous marienglas, or lapis ſpecularis, great

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(B) The oak, though frequent in Ruſſia, it is ſaid, is not to be found through this vaſt region nearer than the banks of the Argun and Amur, in the dominions of China. The white poplar, the aſpen, the black poplar, the common ſallow, and ſeveral ſpecies of the willow, are very common. The Norway and ſilver fir form great foreſts; but the former does not grow beyond the 60th degree of north latitude, and the latter not beyond 58 degrees. To this dreary region of Siberia, Europe is indebted for that excellent ſpecies of oats called *Avena Sibirica;* and our gardens are enlivened with the gay and brilliant flowers brought from the ſame country.

(C) The copper mines of Koliwan, from which gold and ſilver are extracted, employ above 40,000 people. The ſilver mines of Nertſhinſk, beyond Lake Baikal, employ above 14,000. The whole revenue ariſing from theſe mines, according to Mr Coxe, is not leſs than 679,182l. 13s.

quantities of which are dug up in Siberia, is by ſome called Muſcovy or Ruſſian glaſs. It is a particular ſpecies of tranſparent ſtone, lying in ſtrata like ſo many ſheets of paper. The matrix or ſtone in which it is found, is partly a light yellow quartz, or marcaſſia, and partly a brown indurated fluid; and this ſtone contains in it all the ſpecies of the marienglas. To render the marienglas fit for uſe, it is ſplit with a thin two-edged knife; but care is taken that the laminæ be not too thin. It is uſed for windows and lanterns all over Siberia, and indeed in every part of the Ruſſian empire, and looks very beautiful; its luſtre and clearneſs ſurpaſſing that of the fineſt glaſs, to which it is particularly preferable for windows and lanterns of ſhips, as it will ſtand the exploſion of cannon. It is found in the greateſt plenty near the river Witim.

10 Magnets.

Siberia affords magnets of an extraordinary ſize, and even whole mountains of loadſtone. Pit-coal is alſo dug up in the northern parts of this country. The kamennoe maſlo, a yellowiſh kind of alum, unctuous and ſmooth to the touch, like tophus, is found in the mountains of Kraſnoiarſk, Ural, Altaiſh, Jeniſea, Baikal, Barguſik, Lena, and ſeveral others in Siberia.

11 Salt lakes and ſprings.

In this country are not only a great number of freſh water lakes, but likewiſe ſeveral whoſe waters are ſalt; and theſe reciprocally change their nature, the ſalt ſometimes becoming freſh, and the freſh changing into ſaline. Some lakes alſo dry up, and others appear where none were ever ſeen before. The ſalt lake of Yamuſha, in the province of Tobolſk, is the moſt remarkable of all, for it contains a ſalt as white as ſnow, conſiſting entirely of cubic cryſtals. One finds alſo in Siberia ſaline ſprings, ſalt water brooks, and a hill of ſalt.

12 Curioſities.

Siberia affords many other things which deſerve notice. That uſeful root called rhubarb grows in vaſt quantities near the city of Seleginſk. The curious mammuth's bones and horns, as they are called, which are found along the banks of the Oby, Jeneſei, Lena, and Irtiſh, are unqueſtionably the teeth and bones of elephants. But whether theſe elephants teeth and bones were conveyed to theſe northern regions by the general deluge, or by any other inundation, and were by degrees covered with earth, is a point which might lead us into long and very fruitleſs diſquiſitions; we ſhall therefore only obſerve, that ſuch bones have likewiſe been found in Ruſſia, and even in ſeveral parts of Germany. A kind of bones of a ſtill larger ſize than theſe have alſo been dug up in Siberia, and ſeem to have belonged to an animal of the ox kind. The horn of the whale called *narwhal* has been found in the earth near the rivers Indigirka and Anadir; and the teeth of another ſpecies of whales, called *wolroſs*, about Anadirſkoi. The latter are larger than the common ſort, which are brought from Greenland, Archangel, and Kola.

13 Mountains

The chain of Siberian mountains reaches from that of Werchoturie towards the ſouth as far as the neighbourhood of the city of Orienburg, in a continued ridge, under the name of the Uralian mountains; but from thence it alters its direction weſtward. Theſe mountains are a kind of boundary between Ruſſia Proper and Siberia. Another chain of hills divides Siberia from the country of the Calmucks and Mongolians.—Theſe mountains, between the rivers Irtiſh and Oby, are called the Altaic or Golden Mountains, which name they afterwards loſe, particularly between the river Jeneſei and the Baikal lake, where they are called the Sayanian mountains.

14 Inhabitant

The inhabitants of Siberia conſiſt of the Aborigines or ancient inhabitants, the Tartars, and Ruſſians, computed at 3,500,000.

Some of theſe nations have no other religion but that of nature; others are Pagans or Mahometans, and ſome of them have been converted to Chriſtianity, or rather only baptiſed by the Ruſſian miſſionaries.

SIBTHORPIA, a genus of plants belonging to the claſs of didynamia, and to the order of angioſpermia; and in the natural ſyſtem claſſed with thoſe the order of which is doubtful. See BOTANY *Index*.

Lempriere's Dictionary.

SIBYLS, in pagan antiquity, certain women ſaid to have been endowed with a prophetic ſpirit, and to have delivered oracles, ſhowing the fates and revolutions of kingdoms. Their number is unknown. Plato ſpeaks of one, others of two, Pliny of three, Ælian of four, and Varro of ten; an opinion which is univerſally adopted by the learned. Theſe ten Sibyls generally reſided in the following places, Perſia, Libya, Delphi, Cumæ in Italy, Erythræa, Samos, Cumæ in Æolia, Marpeſſa on the Helleſpont, Ancyra in Phrygia, and Tiburtis. The moſt celebrated of the Sibyls is that of Cumæ in Italy, whom ſome have called by the different names of Amalthæa, Demiphile, Herophile, Daphne, Manto, Phemonoe, and Deiphobe. It is ſaid, that Apollo became enamoured of her, and that to make her ſenſible of his paſſion he offered to give her whatever ſhe ſhould aſk. The Sibyl demanded to live as many years as ſhe had grains of ſand in her hand, but unfortunately forgot to aſk for the enjoyment of the health, vigour, and bloom, of which ſhe was then in poſſeſſion. The god granted her requeſt, but ſhe refuſed to gratify the paſſion of her lover though he offered her perpetual youth and beauty. Some time after ſhe became old and decrepit, her form decayed, melancholy paleneſs and haggard looks ſucceeded to bloom and cheerfulneſs. She had already lived about 700 years when Æneas came to Italy, and, as ſome have imagined, ſhe had three centuries more to live before her years were as numerous as the grains of ſand which ſhe had in her hand. She gave Æneas inſtructions how to find his father in the infernal regions, and even conducted him to the entrance of hell. It was uſual for the Sibyl to write her prophecies on leaves, which ſhe placed at the entrance of her cave; and it required particular care in ſuch as conſulted her to take up theſe leaves before they were diſperſed by the wind, as their meaning then became incomprehenſible. According to the moſt authentic hiſtorians of the Roman republic, one of the Sibyls came to the palace of Tarquin the Second, with nine volumes, which ſhe offered to ſell for a very high price. The monarch diſregarded her, and ſhe immediately diſappeared, and ſoon after returned, when ſhe had burned three of the volumes. She aſked the ſame price for the remaining ſix books; and when Tarquin refuſed to buy them, ſhe burned three more, and ſtill perſiſted in demanding the ſame ſum of money for the three that were left.—This extraordinary behaviour aſtoniſhed Tarquin; he bought the books, and the Sibyl inſtantly vaniſhed, and never after appeared to the world. Theſe books were preſerved with great care by the monarch, and called the Sibylline verſes. A college of prieſts was appointed to have the care of them; and ſuch reverence did the

Romans entertain for theſe prophetic books, that they were conſulted with the greateſt ſolemnity, and only when the ſtate ſeemed to be in danger. When the capitol was burnt in the troubles of Sylla, the Sibylline verſes which were depoſited there periſhed in the conflagration; and to repair the loſs which the republic ſeemed to have ſuſtained, commiſſioners were immediately ſent to different parts of Greece to collect whatever verſes could be found of the inſpired writings of the Sibyls. The fate of theſe Sibylline verſes which were collected after the conflagration of the capitol is unknown. There are now many Sibylline verſes extant, but they are reckoned univerſally ſpurious; and it is evident that they were compoſed in the ſecond century by ſome of the followers of Chriſtianity, who wiſhed to convince the heathens of their error, by aſſiſting the cauſe of truth with the arms of pious artifice.

SICERA, a name given to any inebriating liquor by the Helleniſtic Jews. St Chryſoſtom, Theodoret, and Theophilus of Antioch, who were Syrians, and who therefore ought to know the ſignification and nature of "ſicera," aſſure us, that it properly ſignifies palm-wine. Pliny acknowledges, that the wine of the palm-tree was very well known through all the eaſt, and that it was made by taking a buſhel of the dates of the palm-tree, and throwing them into three gallons of water; then ſqueezing out the juice, it would intoxicate like wine. The wine of the palm-tree is white: when it is drunk new, it has the taſte of the cocoa, and is ſweet as honey. When it is kept longer, it grows ſtronger, and intoxicates. After long keeping, it becomes vinegar.

SICILIAN, in *Muſic*, denotes a kind of gay ſprightly air, or dance, probably invented in Sicily, ſomewhat of the nature of an Engliſh jig; uſually marked with the characters $\frac{6}{8}$, or $\frac{12}{8}$. It conſiſts of two ſtrains; the firſt of four, and the ſecond of eight, bars or meaſures.

1 undaries d extent.

SICILY, is a large iſland in the Mediterranean ſea, adjoining to the ſouthern extremity of Italy, and extends from latitude 36° 25′ to latitude 38° 25′, and from longitude 12° 50′ to longitude 16° 5′ eaſt from London. Its greateſt length 210 miles, breadth 133, circumference 600; its form triangular, the three angles being the promontories of Pelorum, Pachynum, and Lilybæum, or, as they are now called, the Faro, Capo Paſſaro, and Capo Boco. It is divided from Italy by the ſtraits of Meſſina, reaching from the tower of Faro, which is the moſt northerly part of the iſland, to the *Capo dell' Armi*, or the Cape of Arms, the moſt ſouthern part of Calabria. Theſe ſtraits, by the Latins called *Fretum Siculum*, by the Italians *Il Faro di Meſſina*, and by us the *Faro of Meſſina*, are between 12 and 15 miles over in the broadeſt places, and in the narroweſt about a mile and a half; inſomuch that when Meſſina was taken by the Carthaginians, many of the inhabitants are ſaid to have ſaved themſelves by ſwimming to the oppoſite coaſt of Italy. Hence has ariſen an opinion that the iſland of Sicily was originally joined to the continent, but afterwards ſeparated by an earthquake or ſome other natural cauſe. This ſeparation, however, is reckoned by the moſt judicious among the ancients to be fabulous; and they content themſelves with ſpeaking of it as a thing ſaid to have happened.

2 iſtory du- g the fa- lous es.

Anciently this iſland was called *Sicania*, *Sicilia*, and *Trinacria* or *Triquetra*; the two former it had from the Sicani and Siculi, who peopled a conſiderable part of the country; the two latter from its triangular figure. Its firſt inhabitants, according to the moſt reſpectable ancient authors, were the Cyclopes and Læſtrigones, who are ſaid to have ſettled in the countries adjoining to Mount Etna; but of their origin we know nothing, except what is related by the poets. After them came the Sicani, who called themſelves the original inhabitants of the country; but ſeveral ancient hiſtorians inform us that they came from a country in Spain watered by the river Siconus. Diodorus, however, is of opinion, that the Sicani were the moſt ancient inhabitants of this iſland. He tells us that they were in poſſeſſion of the whole, and applied themſelves to cultivate and improve the ground in the neighbourhood of Etna, which was the moſt fruitful part of the iſland: they built ſeveral ſmall towns and villages on the hills to ſecure themſelves againſt thieves and robbers; and were governed, not by one prince, but each city and diſtrict by its own king. Thus they lived till Etna began to throw out flames, and forced them to retire to the weſtern parts of the iſland, which they continued to inhabit in the time of Thucydides. Some Trojans, after the deſtruction of their city, landed in the iſland, ſettled among the Sicani, and built the cities of Eryx and Egeſta, uniting themſelves with them, and taking the general name of Elymi or Elymæi. They were afterwards joined by ſome Phocenſes, who ſettled here on their return from the ſiege of Troy.

After the Sicani had for many ages enjoyed an undiſturbed poſſeſſion of the whole of Sicily, or ſuch parts of it as they choſe to inhabit, they were viſited by the Siculi, who were the ancient inhabitants of Auſonia properly ſo called; but being driven out from thence by the Opici, they took refuge in the iſland of Sicily. Not being contented with the narrow bounds allowed them by the Sicani, they began to encroach upon their neighbours; upon which a war enſuing, the Sicani were utterly defeated, and confined to a corner of the iſland, the name of which was now changed from *Sicania* into that of *Sicilia*.

About 300 years after the arrival of the Siculi, the iſland firſt began to be known to the Greeks, who eſtabliſhed various colonies, and built many cities in different parts of the iſland; and it is only from the time of their arrival that we have any hiſtory of the iſland. The firſt of the Greeks that came into Sicily were the Chalcidians of Eubœa, under the conduct of Thucles, who built Naxus, and a famous altar of Apollo, which, as Thucydides tells us, was ſtill ſtanding in his time without the city. The year after, which was, according to Dionyſius Halicarnaſſenſis, the third of the 17th Olympiad, Archias the Corinthian, one of the Heraclidæ, laid the foundations of Syracuſe. Seven years after, a new colony of Chalcidians founded Leontini and Catana, after having driven out the Siculi, who inhabited that tract. About the ſame time Lamis, with a colony from Megara, a city of Achaia, ſettled on the river Pantacius, at a place called *Trotilum*, where his adventurers lived ſome time in common with the Chalcidians of Leontini; but being driven from thence by the Leontines, he built the city of Thapſus, where he died. Upon his death, the colony left Thapſus; and under the conduct of Hyblon king of the Siculi, founded Megara Hyblæa, where they reſided 245 years, till they

they were driven out by Gelon tyrant of Syracuſe. During their abode at Megara, they ſent one Pamilus, who was come from Megara in Achaia, their original city, to build Selinus. This city was founded about 100 years after the foundation of Megara. Antiphemus and Entimus, the former a Rhodian, the other a Cretan, led each a colony of their countrymen, and jointly built the city of Gela on a river of the ſame name, eſtabliſhing in their new ſettlement the Doric cuſtoms, about 45 years after the founding of Syracuſe. The inhabitants of Gela founded Agrigentum 108 years after their arrival in Sicily, and introduced the ſame cuſtoms there. A few years after, Zancle was built by the pirates of Cumæ in Italy; but chiefly peopled by the Chalcidians, Samians, and Ionians, who choſe rather to ſeek new ſettlements than live under the Perſian yoke. Some time after, Anaxales, tyrant of Rhegium, drove out the ancient proprietors; and, dividing his lands amongſt his followers, called the city *Meſſana* or *Meſſene*, which was the name of his native city in Peloponneſus. The city of Himera was founded by the Zancleans under the direction of Eucleides, Simus, and Sacon; but peopled by the Chalcidians and ſome Syracuſan exiles, who had been driven out by the contrary faction.

The Syracuſans built Acræ, Chaſmenæ, and Camarina; the firſt 70 years, the ſecond 90, and the third 135, after the foundation of their own city. This is the account which Thucydides, a moſt judicious and exact writer, gives us of the various nations, whether Greeks or Barbarians, who ſettled in Sicily. Strabo counts among the ancient inhabitants of Sicily the Morgetes, who being driven out of Italy by the Oenotrians, ſettled in that part of the iſland where the ancient city of Morgantium ſtood. The Campani, who aſſumed the name of *Mamertini*, that is, *invincible warriors*, and the Carthaginians, who ſettled very early in Sicily, ought likewiſe to be counted among the ancient inhabitants of the iſland.

Before this period the hiſtory of Sicily is blended with fables like the early hiſtory of almoſt every other country. After the ſettlement of the Greeks in the iſland, its various revolutions have been traced from their ſeveral ſources by many writers; but by none with greater accuracy than Mr Swinburne. From his account of his Travels in the Two Sicilies, we have therefore taken the following conciſe hiſtory of this kingdom, which will at once gratify ſuch of our readers as intereſt themſelves in the fate of a generous people who long ſtruggled in vain for freedom; and at the ſame time afford them a ſpecimen of the entertainment they may receive from the very elegant work of the author.

Swinburne's Travels in the Two Sicilies, vol. ii. p. 176

3
Grecian colonies in Sicily.

“ Ariſtocracy prevailed at firſt in the Greek ſettlements, but ſoon made way for tyranny; which in its turn was expelled by democracy. One of the earlieſt deſtroyers of common liberty was Phalaris of Agrigentum, who reigned 600 years before Chriſt: his example was contagious; a legion of tyrants ſprung up, and not a commonwealth in the iſland eſcaped the laſh of an uſurper. Syracuſe was moſt oppreſſed and torn to pieces by diſſenſion; as its wealth and preponderance in the general ſcale held out a greater temptation than other cities to the ambition of wicked men. It requires the combined teſtimony of hiſtorians to enforce our belief of its wonderful proſperity, and the no leſs extraordinary tyranny of ſome of its ſovereigns. Theſe Grecian colonies attained to ſuch excellence in arts and ſciences as emboldened them frequently to vie with the learned and ingenious in the mother country; nay, often enabled them to bear away the palm of victory: there needs no ſtronger proof of their literary merits than a bare recital of the names of Archimedes, Theocritus, Gorgias, and Charondas.

4
Carthaginians conquer great part of it.

“ But the Sicilian Greeks were not deſtined to enjoy the ſweets of their ſituation without moleſtation. Very ſoon after their arrival, the inhabitants of the neighbouring coaſt of Africa began to aſpire to a ſhare of Sicily. Carthage ſent large bodies of forces at different times to eſtabliſh their power in the iſland, and about 500 years before the Chriſtian era had made themſelves maſters of all the weſtern parts of it. The Siculi retained poſſeſſion of the midland country, and the ſouthern and eaſtern coaſts were inhabited by the Greeks.

5
Gelo choſen king.

“ About that time Gelo was choſen prince of Syracuſe on account of his virtues, which grew ſtill more conſpicuous after his exaltation: had the example he ſet been followed by his ſucceſſors, the advantages of freedom would never have been known or wiſhed for by the Syracuſans. The Carthaginians found in him a vigorous opponent to their project of enſlaving Sicily, a project invariably purſued but never accompliſhed.

6
Is ſucceeded by Hiero.

“ Hiero ſucceeded his brother Gelo, and, contrary to the uſual progreſſion, began his reign by a diſplay of bad qualities. Senſible of his error, and improved by experience, he afterwards adopted more equitable meaſures. At his death the Syracuſans threw off the yoke, and for ſixty years revelled in all the joys of freedom. Their peace was, however, diſturbed by the Athenians and the Carthaginians. The latter plundered Agrigentum, and threatened ruin to the reſt of the Grecian ſtates; but a treaty of peace averted that ſtorm. The Athenians, under pretence of ſupporting their allies the people of Segeſta, but in reality from a thirſt of dominion, inveſted Syracuſe with a formidable land and naval armament under the command of Nicias; in conſequence of a raſh indigeſted plan, ill conducted attacks, and inadequate ſupplies, their whole hoſt was cut to pieces or led away into captivity.

7
Dionyſius the elder and younger.

“ Syracuſe had ſcarcely time to breathe after her victory ere inteſtine wars broke out, and raiſed Dionyſius to ſupreme command. Avarice, deſpotiſm, and cruelty, marked every day of his reign; but his military enterpriſes were crowned with conſtant ſucceſs. He died in peace, and bequeathed a powerful ſovereignty to a ſon of his name tainted with the ſame and worſe vices, but not endowed with equal capacity and martial ability: in ſuch hands the rod of tyranny ceaſed to be formidable, and the tyrant was driven out of Sicily by the patriotic party; but matters were not ſufficiently ſettled for popular government, and Dionyſius reſumed the ſceptre for a while, till Timoleon forced him into perpetual exile.”

8
Agathocles the tyrant.

Liberty ſeemed now to be eſtabliſhed on a permanent baſis; but in Syracuſe ſuch proſpects always proved illuſory. Agathocles, a tyrant more inhuman than any preceding uſurper, ſeized the throne, and deluged the country with blood. He was involved in a perilous conteſt with the Carthaginians, who obtained many advantages

vantages over him, drove his troops from poſt to poſt, and at laſt blocked up his capital. In this deſperate ſituation, when all foreign helps were precluded, and hardly a reſource remained at home, the genius of Agathocles compaſſed his deliverance by a plan that was imitated among the ancients by Hannibal, and among the moderns by the famous Cortes. He embarked with the flower of his army; forced his way through innumerable obſtacles; landed in Africa; and, having burnt his fleet, routed the Carthaginians in a pitched battle, and laid their territory waſte. Carthage ſeemed to be on the brink of ruin, and that hour might have marked her downfal had the Sicilian hoſt been compoſed of patriotic ſoldiers, and not of ungovernable aſſaſſins; diſcord pervaded the victorious camp, murder and riot enſued; and the tyrant, after beholding his children and friends butchered before his face, eſcaped to Sicily, to meet a death as tragical as his crimes deſerved.

9
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Anarchy now raged throughout the iſland, and every faction was reduced to the neceſſity of calling in the aſſiſtance of foreign powers; among whom Pyrrhus king of Epirus took the lead, and reduced all parties to ſome degree of order and obedience. But ambition ſoon prompted him to invade thoſe rights which he came to defend; he caſt off the maſk, and made Sicily feel under his ſway as heavy a hand as that of its former oppreſſors; but the Sicilians ſoon aſſumed courage and ſtrength enough to drive him out of the iſland.

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About this period the Mamertini, whom Mr Swinburne indignantly ſtyles a crew of miſcreants, ſurpriſed Meſſina, and, after a general maſſacre of the citizens, eſtabliſhed a republican form of government. Their commonwealth became ſo troubleſome a neighbour to the Greeks, that Hiero II. who had been raiſed to the chief command at Syracuſe in conſideration of his ſuperior wiſdom and warlike talents, found himſelf neceſſitated to form a league with Carthage, in order to deſtroy this neſt of villains. In their diſtreſs the Mamertini implored the aſſiſtance of Rome, though the ſenate had recently puniſhed with exemplary ſeverity one of their own legions for a ſimilar outrage committed at Rhegium. The virtue of the Romans gave way to the temptation, and the deſire of extending their empire beyond the limits of Italy, caſt a veil over every odious circumſtance attending this alliance. A Roman army croſſed the Faro, relieved Meſſina, defeated the Carthaginians, and humbled Hiero into an ally of the republic.

11
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Thus began the firſt Punic war, which was carried on for many years in Sicily with various ſucceſs. The genius of Hamilcar Barcas ſupported the African cauſe under numberleſs diſappointments and the repeated overthrows of his colleagues; at laſt, finding his exertions ineffectual, he adviſed the Carthaginian rulers to purchaſe peace at the price of Sicily. Such a treaty was not likely to be obſerved longer than want of ſtrength ſhould curb the animoſity of the vanquiſhed party: when their vigour was recruited, Hannibal ſon of Hamilcar eaſily perſuaded them to reſume the conteſt, and for 16 years waged war in the heart of the Roman territories. Meanwhile Hiero conducted himſelf with ſo much prudence, that he retained the friendſhip of both parties, and preſerved his portion of Sicily in perfect tranquillity. He died in extreme old age, beloved and reſpected both at home and abroad.

12
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nibal.

His grandſon Hieronymus, forſaking this happy line of politics, and contracting an alliance with Carthage, fell an early victim to the troubles which his own folly had excited. Once more, and for the laſt time, the Syracuſans found themſelves in poſſeſſion of their independence: but the times were no longer ſuited to ſuch a ſyſtem; diſſenſions gained head, and diſtracted the public councils. Carthage could not ſupport them, or prevent Marcellus from undertaking the ſiege of Syracuſe, immortalized by the mechanical efforts of Archimedes, and the immenſity of the plunder. See SYRACUSE.

13
Sicily conquered by the Saracens, and afterwards by the Normans.

The Sicilians after this relinquiſhed all martial ideas, and during a long ſeries of generations turned their attention ſolely to the arts of peace and the labours of agriculture. Their poſition in the centre of the Roman empire preſerved them both from civil and foreign foes, except in two inſtances of a ſervile war. The rapacity of their governors was a more conſtant and inſupportable evil. In this ſtate of apathy and opulence Sicily remained down to the 7th century of our era, when the Saracens began to diſturb its tranquillity. The barbarous nations of the north had before invaded and ravaged its coaſts, but had not long kept poſſeſſion. The Saracens were more fortunate. In 827 they availed themſelves of quarrels among the Sicilians to ſubdue the country. Palermo was choſen for their capital, and the ſtandard of Mahomet triumphed about 200 years. In 1038 George Maniaces was ſent by the Greek emperor with a great army to attack Sicily. He made good his landing, and puſhed his conqueſts with vigour: his ſucceſs aroſe from the valour of ſome Norman troops, which were at that time unemployed and ready to ſell their ſervices to the beſt bidder. Maniaces repaid them with ingratitude; and by his abſurd conduct gave the Muſſelmans time to breathe, and the Normans a pretext and opportunity of invading the Imperial dominions in Italy. Robert and Roger of Hauteville afterwards conquered Sicily on their own account, not as mercenaries; for having ſubſtantially ſettled their power on the continent, they turned their arms againſt this iſland in obedience to the dictates of zeal and ambition. After ten years ſtruggle, the Saracens yielded up the rich prize, and Robert ceded it to his brother Roger, who aſſumed the title of Great Earl of Sicily, ruled the ſtate with wiſdom, and ranks deſervedly among the greateſt characters in hiſtory. He raiſed himſelf from the humble ſtation of a poor younger ſon of a private gentleman, to the exalted dignity of a powerful monarch, by the ſole force of his own genius and courage; he governed a nation of ſtrangers with vigour and juſtice, and tranſmitted his poſſeſſions undiſputed to his poſterity. Such an aſſemblage of great qualities is well intitled to our admiration.

14
Under the dominion of different monarchs.

He was ſucceeded by his ſon Simon, whoſe reign was ſhort, and made way for a ſecond ſon called Roger. In 1127 this prince joined to his Sicilian poſſeſſions the whole inheritance of Robert Guiſcard (ſee NAPLES, N° 23.), and aſſumed the regal ſtyle. The greateſt part of his reign was taken up in quelling revolts in Italy, but Sicily enjoyed profound peace. In 1154 his ſon William aſcended the throne, and paſſed his life in war and confuſion. William II. ſucceeded his father, and died without iſſue. Tancred, though baſely born, was elected his ſucceſſor, and after him his ſon William III. who was vanquiſhed by Henry of Swabia. During the

the troubles that agitated the reign of his ſon the emperor Frederic, peace appears to have been the lot of Sicily. A ſhort-lived ſedition, and a revolt of the Saracens, are the only commotions of which we read. For greater ſecurity, the Saracens were removed to Puglia 400 years after the conqueſt of Sicily by their anceſtors. Under Conrad and Manfred Sicily remained quiet; and from that time the hiſtory of Sicily is related under the article NAPLES, N° 20, &c.

15 Is at length conquered by the Spaniards.

At the death of Charles II. of Spain, his ſpoils became an object of furious contention; and at the peace of Utrecht, Sicily was ceded to Victor duke of Savoy, who, not many years after, was forced by the emperor Charles VI. to relinquiſh that fine iſland, and take Sardinia as an equivalent. But as the Spaniards had no concern in theſe bargains, they made a ſudden attempt to recover Sicily, in which they failed through the vigilance of the Engliſh admiral Byng. He deſtroyed their fleet in 1718, and compelled them to drop their ſcheme for a time. In 1734 the Spaniſh court reſumed their deſign with ſucceſs. The infant Don Carlos drove the Germans out, and was crowned king of the two Sicilies at Palermo. When he paſſed into Spain to take poſſeſſion of that crown, he tranſferred the Sicilian diadem to his ſon Ferdinand III. of Sicily, and IV. of Naples, and it has ever ſince remained in the poſſeſſion of the ſame family.

16 Account of the ſtraits of Meſſina.

Sicily is ſeparated, as we have already obſerved, from Italy by a narrow ſtrait called the *Faro of Meſſina.* This ſtrait is ſtill remarkable for the rapidity of its currents and the irregular ebbing and flowing of the ſea, which ſometimes ruſhes in with ſuch violence as to endanger ſhips riding at anchor. Anciently it was much more remarkable for Scylla and Charybdis, the one a rock, and the other a whirlpool, between which it was very dangerous to ſteer, and concerning which ſo many fables have been related by the ancients. Scylla is a rock on the Italian ſide, oppoſite to Cape Pylores, which runs out into the ſea on the Sicilian ſide. Mr Brydone informs us, that the navigation of the ſtraits is not even yet performed without danger. He alſo informs us, that the noiſe of the current which ſets through the ſtraits may be heard for ſeveral miles, like the roaring of ſome large impetuous river confined between narrow banks. In many places the water roſe into whirlpools and eddies, which are dangerous to ſhipping. The current ſet exactly for the rock of Scylla, and would certainly have carried any thing thrown into it againſt that point. Our author, however, is by no means of opinion that the ſtrait is ſo dangerous as the ancients have repreſented it; though he thinks that the ſtrait is now probably much wider than formerly, which may have diminiſhed the danger. There are many ſmall rocks, which ſhow their heads near the baſe of the large ones. Theſe are probably the dogs deſcribed by the ancient poets as howling round Scylla. The rock is near 200 feet high, and has a kind of a caſtle or fort built on its ſummit with a town called *Scylla* or *Sciglio*, containing 300 or 400 inhabitants on its ſouth ſide, which gives the title of prince to a Calabreſe family.

The following account of theſe rocks and whirlpools is given by the celebrated naturaliſt Spallanzani. He informs us, that Scylla is a lofty rock, 12 miles from Meſſina, riſing almoſt perpendicular from the ſea on the ſhore of Calabria, beyond which is the ſmall city of the ſame name. Though there was ſcarcely any wind, Spallanzani heard, about two miles diſtant from the rock, a noiſe like a confuſed barking of dogs, and on a nearer approach he diſcovered the cauſe. This rock contains a number of caverns, one of the largeſt of which is called by the people *Dragara.* The waves, when in the leaſt agitated, ruſhing into theſe caverns, break, daſh, throw up frothy bubbles, and thus occaſion theſe various and multiplied ſounds. He then perceived with how much truth and reſemblance of nature Homer and Virgil, in their perſonifications of Scylla, had pourtrayed this ſcene, by deſcribing the monſter they drew as lurking in the darkneſs of a vaſt cavern, ſurrounded by ravenous barking maſtiffs, together with wolves, to increaſe the horror.

Though the tide is almoſt imperceptible in the open parts of the Mediterranean, it is very ſtrong in the ſtrait of Meſſina, owing to the narrowneſs of the channel, and regulated by the periodical elevations and depreſſions of the water. Where the current is accompanied by a wind blowing the ſame way, veſſels have nothing to fear, ſince they either do not enter the ſtrait, both the wind and ſtream oppoſing them; or, if both are favourable, enter on full ſail, and paſs with ſuch rapidity that they ſeem to fly over the water. When the current runs from ſouth to north, and the north wind blows hard at the ſame time, the ſhip is reſiſted by the oppoſite current, and impelled by two forces in contrary directions, is daſhed on the rock of Scylla, or driven on the neighbouring ſands. The current, where it is ſtrongeſt, does not extend over the whole ſtrait, but winds through it in intricate meanders, with the courſe of which the ſailors ſtationed to give ſtrangers aſſiſtance are well acquainted, and thus able to guide the ſhip in ſuch a manner as to avoid it. Should the pilot, however, confiding in his own ſkill, neglect ſuch aſſiſtance, he would run the moſt imminent riſk of being ſhipwrecked. In this conflict of the waters, it is uſeleſs to throw the line to diſcover the depth of the bottom, the violence of the current frequently carrying the lead almoſt on the ſurface of the water. The ſtrongeſt cables, though ſome feet in circumference, break like ſmall cords. Every expedient afforded by the art of navigation, is uſeleſs here. The only means of avoiding being daſhed againſt the rocks, or driven upon the ſands in the midſt of this perilous conteſt of the winds and waves, is to have recourſe to the ſkill and courage of the Meſſineſe ſeamen.

Charybdis is diſtant from the ſhore of Meſſina about 750 feet, and is called by the people of the country *Calofaro*, not from the agitation of the waves, but from καλος and φαρος, *beautiful tower*, from the lighthouſe erected near it for the guidance of veſſels. When the current ſets in from the north, the pilots call it the *deſcending rema*, or current; and when it runs from the ſouth, the *aſcending rema.* The current aſcends or deſcends at the riſing or ſetting of the moon, and continues for ſix hours. In the interval between each aſcent or deſcent, there is a calm which laſts at leaſt 15 minutes, but not longer than an hour. Afterwards, at the riſing or ſetting of the moon, the current enters from the north, making various angles of incidence with the ſhore, and at laſt reaches the Calofaro. This delay ſometimes continues two hours; ſometimes it immediately falls into the Calofaro; and then experience regards it as a certain indication of bad weather.

When Spallanzani obſerved Charybdis from the ſhore, it appeared like a group of tumultuous waters, which group as he approached became more extenſive and more agitated. He was carried to the edge, where he ſtopped ſome time to make the requiſite obſervations; and was then convinced beyond the ſhadow of a doubt, that what he ſaw was by no means a vortex or whirlpool.

Though he was convinced that there was no gulf under the Calofaro, as otherwiſe there would have been a whirlpool, which would have carried down into it the floating ſubſtances; he determined to ſound the bottom with a plummet, and found its greateſt depth did not exceed 500 feet. He was alſo informed, to his great ſurpriſe, that beyond the Calofaro, towards the middle of the ſtrait, the depth was double.

When the wind and current are contrary to each other, and both in their greateſt violence, the ſwelling and daſhing of the waves within the Calofaro is much ſtronger, more impetuous, and more extenſive. It then contains three or four ſmall whirlpools, or even more, according to the greatneſs of its extent and violence. If at this time ſmall veſſels are driven into the Calofaro by the current or the wind, they are ſeen to whirl round, rock, and plunge, but are never drawn down into the vortex. They only ſink when filled with water, by the waves beating over them. When veſſels of a larger ſize are forced into it, whatever wind they have they cannot extricate themſelves; their ſails are uſeleſs; and after having been for ſome time toſſed about by the waves, if they are not aſſiſted by the pilots of the country, who know how to bring them out of the courſe of the current, they are furiouſly driven upon the neighbouring ſhore of the Lanterna, where they are wrecked, and the greater part of their crews periſh in the waves.

If a ſhip be extricated from the fury of Charybdis, and carried by a ſtrong ſoutherly wind along the ſtrait towards the northern entrance, it will indeed paſs out ſafely; but ſhould it meet with a wind in a nearly oppoſite direction, it would become the ſport of both theſe winds, and, unable to advance or recede, be driven in a middle courſe between their two directions, that is to ſay, full upon the rock of Sylla, if it be not immediately aſſiſted by the pilots. It is likewiſe obſerved, that in theſe hurricanes a land wind frequently riſes, which deſcends from a narrow paſs in Calabria, and increaſes the force with which the ſhip is impelled towards the rock. Thus, the ſaying which became proverbial among the ancients;—that "he who endeavours to avoid Charybdis, daſhes upon Scylla," is, in a great meaſure, true.

In the ſtraits, Mr Brydone informs us, a moſt ſurpriſing phenomenon is to be obſerved. In the heat of ſummer, after the ſea and air have been much agitated, there appears in the heavens over the ſtraits a great variety of ſingular forms, ſome at reſt and others moving with great velocity. Theſe forms, in proportion as the light increaſes, ſeem to become more aerial, till at laſt, ſome time before ſunriſe, they totally diſappear. The Sicilians repreſent this as the moſt beautiful ſight in nature. Leonti, one of the beſt Sicilian writers, ſays, that the heavens appear crowded with a variety of objects, ſuch as palaces, woods, gardens, &c. beſides the figures of men and other animals that are ſeen in motion among them. Some treatiſes have been written concerning this phenomenon; but nothing ſatisfactory has been delivered concerning its cauſe.

17
Climate and produce.

Watkin's Travels through Switzerland, Italy, Sicily, &c.

Though Sicily lies in a warm climate, the air is healthful, being refreſhed with ſea-breezes on every ſide. It has at all times been remarkably fertile; but the era of its greateſt proſperity was from the ſiege of Syracuſe by the Athenians to the Carthaginian conqueſts. Then and long after it ſupplied with grain, in years of ſcarcity, all the countries upon the Mediterranean except Egypt and the coaſts of Aſia, and Rome and Carthage continually. Even now, under all the impediments of ſuperſtition and bad government, its productions are, in quantity and quality, the beſt in Europe. Of the vegetable are grain, wines, oil, fruits, tobacco, mulberry trees for the ſilkworm, cotton, medicinal roots, and ſugar canes. The laſt of theſe flouriſh near Avola and Merilli. They are of an inferior quality to thoſe of the Weſt Indies, but their ſugar is ſweeter than any other. The animal production is ſimilar to that of Italy, but the horned cattle are a ſmaller breed. The coaſts abound with fiſh, particularly with tunney and anchovies; the export of which forms a very lucrative branch of commerce. There are mines of ſilver, copper, and lead, but none are worked. Near Palma are beds of the beſt ſulphur; at the mouth of the river Giaretta is found a yellow amber, preferable to that of the Baltic: and in every part of the iſland quarries of marbles, that have furniſhed materials for all the noble edifices of Sicily. The moſt beautiful are in the neighbourhood of Palermo, particularly the yellow, and thoſe that reſemble the verde antique, porphyry, and lapis lazuli. The population of the iſland amounts to 1,300,000 ſouls; not as much again as the ſingle city of Syracuſe formerly contained.

18
Rivers and mountains.

Here are ſeveral rivers and good ſprings; but few of the rivers are navigable, having but a ſhort courſe, and deſcending precipitately from the mountains. The chief are the Bantera, the Jaretta, and the Salſo; of which, the two former run from weſt to eaſt, and the third from north to ſouth.

Of the mountains in this iſland the moſt noted is Mount Etna, now called *Monte Gibello*, or *Mongibello*, a volcano whoſe eruptions have often proved fatal to the neighbouring country. See Etna.

19
Conſtitution and government.

Munter's Memoirs relative to Naples and Sicily.

Were the Sicilians a cultivated people, among whom thoſe arts were encouraged which not only promote the wealth and comfort of a nation, but alſo exerciſe the nobler faculties and extend the views of mankind, the circumſtances of their government are ſuch, that it might gradually be improved into a free conſtitution: but to this, the ignorance, ſuperſtition, and poverty, of the people ſeem to be invincible obſtacles. The monarchical power in Sicily is far from being abſolute; and the parliament claims a ſhare of public authority independently of the will of the king, deduced from a compact made between Roger and the Norman barons after the expulſion of the Saracens. This claim is denied by the king, who wiſhes the nobles to conſider their privileges as derived ſolely from his favour. Hence the government is in a ſituation which greatly reſembles that of our own and the other kingdoms of Europe in the feudal times; there are continual jealouſies and oppoſitions between the king and the barons, of which an enlightened people might eaſily take advantage, and obtain that ſhare in the conſtitution which might ſecure them

them from future oppreſſion. In theſe diſputes, the king has the advantage at leaſt of power, if not of right; and ſeveral works, in which the claims of the Sicilian barons have been aſſerted, were publicly burned not many years ago.

As the ſovereign holds his court at Naples, Sicily is governed by a viceroy, who is appointed only for three years, though at the end of that term his commiſſion is ſometimes renewed. He lives in great ſtate, and, as the repreſentative of the king, his power is very conſiderable. He preſides in all the courts and departments of government, and is commander in chief of all the forces: he calls or diſſolves the parliament when he pleaſes; and by him all orders, laws, and ſentences, muſt be ſigned; but his office is far from being deſirable, as it generally renders him the object either of the jealouſy of the court of Naples, or of the hatred of the Sicilians.

20 Inquiſition,

21 aboliſhed by Caraccioli.

The parliament conſiſts of the nobles, the biſhops, and abbots, and the repreſentatives of 43 cities, which are immediately ſubject to the crown. Thoſe cities which are ſubject to any of the nobles ſend no members to the parliament; in theſe the king has not much authority, and derives little advantage from them. According to the laws, the parliament ought to be aſſembled at the end of every three years: but the government pays little attention to this rule. The common people are in general very much attached to the nobles, and are inclined to take their part in all their differences with the court: but the magiſtrates and principal inhabitants of the cities which belong to theſe feudal lords, wiſh to get rid of their authority, and imagine that they ſhould be leſs oppreſſed, if immediately ſubject to the king: theſe inclinations are not diſagreeable to the court, and are encouraged by moſt of the lawyers, who are of great ſervice to government in conteſting the privileges of the nobles. Many of theſe privileges are now abridged; and the power of the barons, with reſpect to the adminiſtration of juſtice in their domains, was very properly limited by the viceroy Caraccioli, in the year 1785. The government of this nobleman was very beneficial to Sicily, as he, in a great meaſure, cleared the iſland of the banditti that uſed to infeſt it, and made ſeveral excellent regulations for the eſtabliſhment of ſocial order and perſonal ſecurity. He deſerves the thanks of every well-wiſher to mankind for having aboliſhed the court of inquiſition, which had been eſtabliſhed in this country by Ferdinand the Catholic, and made dependent on the authority of the grand inquiſitor of Spain. Its laſt *auto da fe* was held in the year 1724, when two perſons were burned. At length Charles III. rendered it independent of the Spaniſh inquiſitor, and abridged its power, by forbidding it to make uſe of the torture, and to inflict public puniſhments. The Marcheſe Squillace, and his ſucceſſor the Marcheſe Tanucci, were both enemies to the hierarchy; and, during their viceroyalties, took care to appoint ſenſible and liberal men to the office of inquiſitor: the laſt of whom was Ventimiglia, a man of a moſt humane and amiable character, who heartily wiſhed for the abolition of this diabolical court, and readily contributed toward it. While he held the office of inquiſitor, he always endeavoured to procure the acquittal of the accuſed; and when he could ſucceed no other way, would pretend ſome informality in the trial. The total annihilation of this inſtrument of the worſt of tyranny was reſerved for Caraccioli. A prieſt being accuſed to the inquiſition, was dragged out of his houſe and thrown into the dungeon. He was condemned; but, on account of informality, and a violation of juſtice in the trial, he appealed to the viceroy, who appointed a committee of juriſts to examine the proceſs. The inquiſitor refuſed to acknowledge the authority of this commiſſion; pretending that to expoſe the ſecrets of the holy office, and to ſubmit its deciſions to the examination of lay judges, would be ſo inconſiſtent with his duty, that he would ſee the inquiſition aboliſhed rather than conſent to it. Caraccioli took him at his word, and procured a royal mandate by which the holy office was at once annihilated. He aſſembled all the nobility, judges, and biſhops, on the 27th of March 1782, in the palace of the inquiſition, and commanded the king's order to be read; after which he took poſſeſſion of the archives, and cauſed all the priſons to be ſet open: in theſe were at that time only two priſoners, who had been condemned to perpetual confinement for witchcraft. The papers relating to the finances were preſerved; but all the reſt were publicly burned. The poſſeſſions of the holy office were aſſigned to the uſe of churches and charitable inſtitutions: but the officers then belonging to it retained their ſalaries during their lives. The palace itſelf is converted into a cuſtomhouſe, and the place where heretics were formerly roaſted alive for the honour of the Catholic faith, is now changed into a public garden. The cognizance of offences againſt orthodoxy is committed to the biſhops: but they cannot cite any one to appear before them without permiſſion from the viceroy; neither can they confine any perſon to a ſolitary priſon, nor deny him the privilege of writing to his friends, and converſing freely with his advocate. The nobility are ſo numerous in this iſland, that Labat ſays it is paved with noblemen. The general aſſembly of parliament is compoſed of 66 archbiſhops, biſhops, abbots, and priors, which form the Bracchio eccleſiaſtico. Fifty-eight princes, 27 dukes, 37 marquiſſes, 27 counts, one viſcount, and 79 barons, form the militaire; and the demaniale conſiſts of 43 repreſentatives of free towns. Out of each bracchio four deputies are choſen to conduct public buſineſs. But the viceroy, the prince of Butera, and the prætor of Palermo, are always the three firſt. Such was the government of Sicily while the Neapolitan monarchy remained entire; but ſince the latter was uſurped by the French, Sicily is all that is left to its former poſſeſſor.

SICINIUS DENTATUS, a tribune of the people, lived a little after the expulſion of the kings from Rome. He was in 120 battles and ſkirmiſhes, beſides ſingle combats, in all of which he came off conqueror. He ſerved under nine generals, all of whom triumphed by his means. In theſe battles he received 45 wounds in the forepart of his body, and not one in his back. The ſenate made him great preſents, and he was honoured with the name of the Roman Achilles.

SICYOS, a genus of plants belonging to the claſs of monœcia, and to the order of ſyngeneſia; and in the natural ſyſtem arranged under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

SIDA, *Yellow* or *Indian MALLOW*, a genus of plants belonging to the claſs of monadelphia, and to the order of polyandria; and in the natural ſyſtem ranging under the 37th order, *Columniferæ*. See BOTANY *Index*.

SIDDEE, or SEDEE, an Arabic title, by which the Abyſſinians or Habaſhys are always diſtinguiſhed in the courts of Hindoſtan; where, being in great repute for firmneſs and fidelity, they are generally employed as commanders of forts or in poſts of great truſt.

SIDEREAL YEAR. See ASTRONOMY *Index*.

SIDERIA, in *Natural Hiſtory*, the old name of a genus of cryſtals, uſed to expreſs thoſe altered in their figure by particles of iron. Theſe are of a rhomboidal figure, and compoſed only of ſix planes. Of this genus there are four known ſpecies. 1. A colourleſs, pellucid, and thin one; found in conſiderable quantities among the iron ores of the foreſt of Dean in Glouceſterſhire, and in ſeveral other places. 2. A dull, thick, and brown one; not uncommon in the ſame places with the former. And, 3. A black and very gloſſy kind, a foſſil of great beauty; found in the ſame place with the others, as alſo in Leiceſterſhire and Suſſex.

SIDERITE, a ſubſtance ſuppoſed by Meyer to be a new metal; but according to Bergman and Kirwan it is nothing elſe than a natural combination of phoſphoric acid with iron.

SIDERITIS, IRONWORT; a genus of plants belonging to the claſs of didynamia, and to the order of gymnoſpermia; and in the natural ſyſtem ranging under the 42d order, *Verticillatæ*. See BOTANY *Index*.

SIDEROXYLON, IRON-WOOD; a genus of plants belonging to the claſs of pentandria, and to the order of monogynia; and in the natural ſyſtem ranging under the 53d order, *Dumoſæ*. See BOTANY *Index*.

SIDNEY, SIR PHILIP, was born, as is ſuppoſed, at Penſhurſt in Kent in the year 1554: His father was Sir Henry Sidney, an Iriſh gentleman, and his mother Mary the eldeſt daughter of John Dudley duke of Northumberland. He was ſent when very young to Chriſt-church college at Oxford, but left the univerſity at 17 to ſet out on his travels. After viſiting France, Germany, Hungary, and Italy, he returned to England in 1575, and was next year ſent by Queen Elizabeth as her ambaſſador to Rodolph emperor of Germany. On his return he viſited Don John of Auſtria, governor of the Netherlands, by whom he was received with great reſpect. In 1579, when Queen Elizabeth ſeemed on the point of concluding her long projected marriage with the duke of Anjou, Sir Philip wrote her a letter, in which he diſſuaded her from the match with unuſual elegance of expreſſion, as well as force of reaſoning. About this time a quarrel with the earl of Oxford occaſioned his withdrawing from court; during which retirement he is ſuppoſed to have written his celebrated romance called *Arcadia*.

In 1585, after the queen's treaty with the United States, he was made governor of Fluſhing and maſter of the horſe. Here he diſtinguiſhed himſelf ſo much both by his courage and conduct, that his reputation roſe to the higheſt pitch. He was named, it is pretended, by the republic of Poland as one of the competitors for that crown, and might even have been elected had it not been for the interference of the queen. But his illuſtrious career was ſoon terminated; for in 1586 he was wounded at the battle of Zutphen, and carried to Arnheim, where he ſoon after died. His body was brought to London, and buried in St Paul's cathedral. He is deſcribed by the writers of that age as the moſt perfect model of an accompliſhed gentleman that could be formed even by the wanton imagination of poetry or fiction. Virtuous conduct, polite converſation, heroic valour, and elegant erudition, all concurred to render him the ornament and delight of the Engliſh court: and as the credit which he enjoyed with the queen and the earl of Leiceſter was wholly employed in the encouragement of genius and literature, his praiſes have been tranſmitted with advantage to poſterity. No perſon was ſo low as not to become an object of his humanity. After the battle of Zutphen, while he was lying on the field mangled with wounds, a bottle of water was brought him to relieve his thirſt; but obſerving a ſoldier near him in a like miſerable condition, he ſaid, *This man's neceſſity is ſtill greater than mine;* and reſigned to him the bottle of water. Beſides his *Arcadia*, he wrote ſeveral ſmaller pieces both in proſe and verſe, which have been publiſhed.

SIDNEY, *Algernon*, was the ſecond ſon of Robert earl of Leiceſter, and of Dorothy eldeſt daughter of the earl of Northumberland. He was born about the year 1617. During the civil wars he took part againſt the king, and diſtinguiſhed himſelf as a colonel in the army of the parliament. He was afterwards appointed one of King Charles's judges, but declined appearing in that court. During the uſurpation of Cromwell, Sidney, who was a violent republican, retired to the country, and ſpent his time in writing thoſe diſcourſes on government which have been ſo deſervedly celebrated. After the death of the Protector, he again took part in the public tranſactions of his country, and was abroad on an embaſſy to Denmark when King Charles was reſtored. Upon this he retired to Hamburgh, and afterwards to Francfort, where he reſided till 1677, when he returned to England and obtained from the king a pardon. It has been affirmed, but the ſtory deſerves no credit, that during his reſidence abroad King Charles hired ruffians to aſſaſſinate him. After his return he made repeated attempts to procure a ſeat in parliament, but all of them proved unſucceſsful. After the intention of the commons to ſeclude the duke of York from the throne had been defeated by the ſudden diſſolution of parliament, Sidney joined with eagerneſs the councils of Ruſſel, Eſſex, and Monmouth, who had reſolved to oppoſe the duke's ſucceſſion by force of arms. Frequent meetings were held at London; while, at the ſame time, a ſet of ſubordinate conſpirators, who were not, however, admitted into their confidence, met and embraced the moſt deſperate reſolutions. Keiling, one of theſe men, diſcovered the whole conſpiracy; and Algernon Sidney, together with his noble aſſociates, was immediately thrown into priſon, and no art was left unattempted in order to involve them in the guilt of the meaner conſpirators.

Howard, an abandoned nobleman, without a ſingle ſpark of virtue or honour, was the only witneſs againſt Sidney; but as the law required two, his diſcourſes on government, found unpubliſhed in his cloſet, were conſtrued into treaſon, and declared equivalent to another witneſs. It was in vain for Sidney to plead that papers were no legal evidence; that it could not be proved they were written by him; and that if they were, they contained nothing treaſonable. The defence was overruled; he was declared guilty, condemned, and executed! His attainder was reverſed in the firſt year of King William.

He was a man of extraordinary courage; ſteady even to obſtinacy; of a ſincere but rough and boiſterous temper. Though he profeſſed his belief in the Chriſtian religion, he was an enemy to an eſtabliſhed church, and even, according to Burnet, to every kind of public worſhip. In his principles he was a zealous republican: government was always his favourite ſtudy; and his eſſays on that ſubject are a proof of the progreſs which he made.

SIDON, in *Ancient Geography*, a city of Phœnicia in Aſia, famous in Scripture for its riches, ariſing from the extenſive commerce carried on by its inhabitants. Heavy judgments were denounced againſt the Sidonians on account of their wickedneſs, which were accompliſhed in the time of Ochus king of Perſia: for that monarch having come againſt them with an army on account of their rebellion, the city was betrayed by its king; upon which the wretched inhabitants were ſeized with deſpair; they ſet fire to their houſes, and 40,000 with their wives and children, periſhed in the flames.

This city is now called *Saide*, and, according to Mr Bruce's account, not only its harbour is filled up with ſand, but the pavement of the ancient city ſtood 7½ feet lower than the ground on which the preſent city ſtands. Volney deſcribes it as an ill-built dirty city. Its length along the ſea-ſhore is about 600 paces, and its breadth 150. At the north-weſt ſide of the town is the caſtle, which is built in the ſea itſelf, 80 paces from the main land, to which it is joined by arches. To the weſt of this caſtle is a ſhoal 15 feet high above the ſea, and about 200 paces long. The ſpace between this ſhoal and the caſtle forms the road, but veſſels are not ſafe there in bad weather. The ſhoal, which extends along the town, has a baſon incloſed by a decayed pier. This was the ancient port; but it is ſo choked up by ſand, that boats alone can enter its mouth near the caſtle. Fakr-el-din, emir of the Druſes, deſtroyed all theſe little ports from Bairout to Acre, by ſinking boats and ſtones to prevent the Turkiſh ſhips from entering them. The baſon of Saide, if it were emptied, might contain 20 or 25 ſmall veſſels. On the ſide of the ſea, the town is abſolutely without any wall; and that which encloſes it on the land ſide is no better than a priſon-wall. The whole artillery does not exceed ſix cannons, and theſe are without carriages and gunners. The gariſon ſcarcely amounts to 100 men. The water comes from the river Aoula, through open canals, from which it is fetched by the women. Theſe canals ſerve alſo to water the orchards of mulberry and lemon trees.

Saide is a conſiderable trading town, and is the chief emporium of Damaſcus and the interior country. The French, who are the only Europeans to be found there, have a conſul, and five or ſix commercial houſes. Their exports conſiſt in ſilks, and particularly in raw and ſpun cottons. The manufacture of this cotton is the principal art of the inhabitants, the number of whom may be eſtimated at about 5000. It is 45 miles weſt from Damaſcus. E. Long. 36. 5. N. Lat. 37.

SIDUS GEORGIUM, in *Aſtronomy*, a new primary planet, diſcovered by Dr Herſchel in the year 1781. By moſt foreign, and even by ſome Britiſh philoſophers, it is known by the name of *Herſchel*, in honour of the diſcoverer. As the other planets are diſtinguiſhed by marks or characters, the planet Herſchel is diſtinguiſhed by an H, the initial letter of the diſcoverer's name, and a croſs to ſhow that it is a Chriſtian planet. See ASTRONOMY *Index*.

SIEGE, in the art of war, is to ſurround a fortified place with an army, and approach it by paſſages made in the ground, ſo as to be covered againſt the fire of the place.

SIEGEN, a town of Germany in Wetteravia, with a caſtle and the title of a principality, which it gives to a branch of the houſe of Naſſau. It is ſeated on a river of the ſame name, in E. Long. 8. 5. N. Lat. 50. 53.

SIENNA, a large, ancient, and celebrated city of Tuſcany in Italy; capital of the Sienneſe, with an archbiſhop's ſee, a famous univerſity, and a citadel. It is about four miles in circumference, and ſurrounded with an old wall. The metropolitan church is much eſteemed by travellers; and though it is a Gothic ſtructure, the architecture is admirable. It is built with black and white marble, and the pavement is of moſaic work. The town is adorned with a great number of palaces, fountains, and ſuperb churches, as alſo a magnificent hoſpital. The great area is round, and the houſes about it are of the ſame height, ſupported by piazzas, under which people may walk in hot or rainy weather; in the middle is a baſon, which can be filled with water at any time, to repreſent a ſea-fight with ſmall veſſels. The Italian language is taught here with ſuch purity, that a great many foreigners frequent it on that account. It is ſeated on three eminences, in a fertile ſoil, in E. Long. 11. 11. N. Lat. 43. 10.

SIENNESE, a duchy in Italy; bounded on the north by the Florentino, on the ſouth by the Mediterranean ſea and the duchy of Caſtro, on the eaſt by the Perugino and Orvietano, and on the weſt by the Florentino and the Tuſcan ſea; being about 55 miles in length, and as much in breadth. The ſoil is pretty fertile, eſpecially in mulberry trees, which feed a great number of ſilk-worms; and there are ſeveral mineral ſprings. Sienna is the capital town.

SIERRA LEONA, a large country on the weſt coaſt of Africa, which ſome extend from the Grain Coaſt on the ſouth-eaſt to Cape Verga or Vega on the north-weſt, i. e. between 7° and 10° N. Lat. Others, however, confine the country between Cape Verga and Cape Tagrin. There runs through it a great river of the ſame name, of which the ſource is unknown, but the mouth is in longitude 12. 30. weſt, lat. 8. 5. north, and is nine miles wide. The climate and ſoil of this tract of country appear to be, on both ſides of the river, among the beſt in Africa, or at leaſt the moſt favourable to European conſtitutions. The heat is much the ſame as that of the Weſt Indies; but on the higher grounds there is a cool ſea breeze, and in the mountainous parts the air is very temperate. According to Lieutenant Matthew, "Sierra Leona, if properly cleared and cultivated, would be equal in ſalubrity and ſuperior in produce to any of the iſlands in the Weſt Indies;" and others have affirmed, that "the air is better for a man's health than in many places of Europe." Theſe advantages of climate induced the Engliſh to eſtabliſh a factory at Sierra Leona; but they choſe not the moſt healthful ſituation. For the benefit of a ſpring of good water they fixed their reſidence in a low valley, which is often overſpread with miſts and noiſome vapours, while the air is clear and ſerene on the ſummits of the hills, to which water from the well might eaſily be carried.

Within the diſtrict occupied by this colony are the Foulahs, who are in general of a tawney complexion, though many of them are entirely black. They lead a wandering life, and roam about the country with large droves of cows, ſheep, goats, and horſes. They are much praiſed by travellers for their hoſpitality; nor is their humanity in other reſpects, leſs commendable; for, if one of their countrymen have the misfortune to fall into ſlavery, the reſt join ſtock to redeem him. Elephants are ſo numerous in the country of the Foulahs, that they are frequently ſeen in droves of 200 together. The people are very dexterous at hunting them, and other wild beaſts; from which they derive their principal articles of trade.

The animal productions of Sierra Leona are lions, from which it has its name; leopards, hyænas, muſk cats, and many kinds of weaſels; the japanzee or chimpanzee, a ſpecies of ſimia, which has a ſtill more ſtriking reſemblance to the human figure than even the ouran outang; porcupines, wild hogs, ſquirrels, and antelopes. Beſides theſe, which are natives of the country, oxen thrive in it, and even grow fat; aſſes too are employed in labour, and do not ſuffer by the climate; but ſheep ſuffer much from the heat, change their wool into hair, grow lean and increaſe very little: while the hardy goat is here as prolific and large as in any other country. Of the birds which frequent the woods of Sierra Leona we can give no perfect account. A ſpecies of crane is mentioned as eaſily tamed; common poultry multiply faſt; ducks thrive well, but geeſe and turkeys ſeem not to agree with the climate. Turtles of all kinds are very common, and ſometimes of a large ſize. Crocodiles or alligators of a non-deſcript ſpecies have been found ten or twelve feet in length, and lizards of ſix different ſpecies. Snakes, which are almoſt innumerable, haunt the houſes in the night in ſearch of poultry; and one was obſerved which meaſured 18 feet, but was happily found not to be venomous. Fiſhes are in great variety both in the ſea and in the rivers. Beſides the whale, the ſhark, ſtinging ray, and porpoiſe, there are eels, horſe-mackarel, tarpoons, cavillos, mullets, ſnappers, yellow-tails, old-maids, ten-pounders, and ſome other fiſhes; all of which, except the eels and ten-pounders, are eſteemed fine eating. Oyſters are found in great abundance, and another ſhell-fiſh, which the natives eat. Among the zoophytes, none is more worthy of notice than the common ſponge, which covers all the ſandy beaches of the river, particularly on the Bullom ſhore, and would fetch a high price in Great Britain.

Of the numerous vegetable productions of Sierra Leona, our limits will permit us only to mention the following. Rice, which is the plant chiefly cultivated, as the natives ſubſiſt almoſt entirely upon it, grows both in the high and low grounds. It proſpers indeed beſt in ſwamps, though the grain is better in a drier ſoil. Next to rice the caſſada conſtitutes the chief food of the inhabitants, and is cultivated with great care. The country likewiſe produces yams, various kinds of potatoes, eddoes, or the *arum eſculentum*. Oil-palm, plantains, and bananas; papaw, guava, oranges and limes; pompions, melons, and cucumbers; pine-apples, pigeon-peas, which dreſſed like Engliſh peas are a good pulſe; maize or Indian corn; millet, cocoa-nut trees; ockra; the tallow-tree; a great variety of tamarinds; different kinds of fig-trees and plums; a kind of fruit reſembling grapes, but more acid and acrid; cherries reſembling a fine nectarine in taſte; a ſpecies of the bread fruit-tree; the cream fruit, ſo called becauſe when wounded it yields a fine white juice reſembling ſugar or the beſt milk, of which the natives are very fond; the malaguetta pepper, or grains of paradiſe; a new ſpecies of nutmeg, but whether ſo good as the common ſort has not yet been aſcertained; a new ſpecies of the Peruvian bark, which it is hoped will prove as uſeful as the other; and cola, a fruit highly eſteemed by the natives for the ſame virtues with that bark; the ricinus, caſſia, dye-ſtuffs, and gums, of great value; cotton, tobacco, and ſugar-canes, which, it is thought, would thrive exceedingly well under proper cultivation.

Conſidering the ardour of the maritime nations of Europe for ſettling colonies in diſtant regions of the globe, it is ſomewhat ſurpriſing that a climate ſo temperate and a ſoil ſo productive as that of Sierra Leona did not long ago attract their notice. But it was left to be colonized for a better purpoſe than that which firſt drew the natives of Europe to the Weſt Indies and the American continent. Being thinly inhabited, Sierra Leona appeared to ſome benevolent gentlemen in England a place where, without incommoding the natives, a ſufficient quantity of ground might be bought on which to ſettle a great number of free negroes, who in 1786 ſwarmed in London in idleneſs and want. About 400 of theſe wretches, together with 60 whites, moſtly women of bad character and in ill health, were accordingly ſent out, at the charge of government, to Sierra Leona. Neceſſity, it was hoped, would make them induſtrious and orderly; and Captain Thomſon of the navy, who conducted them, obtained, for their uſe, a grant of land to his majeſty from King Tom, the neighbouring chief, and afterwards from Naimbanna, the king of the country. The colony, however, ſoon went to ruin; but the land which they occupied, being about 20 miles ſquare, his majeſty was enabled to grant by act of parliament to another colony founded on better principles and for a ſtill nobler purpoſe.

The moſt intelligent members of that ſociety, which laboured ſo ſtrenuouſly to procure an abolition of the ſlave-trade, juſtly concluding that the natives of Guinea would reap very little benefit from the attainment of their object, unleſs they ſhould be taught the principles of religion and the arts of civil life, which alone can render them really free, conceived the plan of a colony at Sierra Leona to be ſettled for the truly generous purpoſe of civilizing the Africans by maintaining with them a friendly intercourſe, and a commerce in every thing but men. This plan could not be carried into effect but at a very great expence. Subſcriptions were therefore opened upon rational and equitable terms, and a ſum deemed ſufficient was ſpeedily raiſed. An act of parliament was paſſed in favour of the ſubſcribers, by which they were incorporated by the denomination of the *Sierra Leona Company*; and in purſuance of that act they held their firſt meeting at London in October 1791.

The directors having ſtated the natural advantages of Sierra Leona, and its preſent miſerable condition, obſerved, that they had not merely to eſtabliſh a commercial

mercial factory, but that, to introduce civilization, cultivation, and a ſafe trade, the company muſt provide for the ſecurity of the perſons and property of the coloniſts. The directors therefore reſolved, that three or four veſſels ſhould ſail at once, with ſuch a number of people as would be able to protect and aſſiſt each other; with goods both for trade and for the ſupply of the colony. Accordingly ſeveral veſſels ſailed, having on board a council for the government of the colony and the management of the company's affairs; a number of artificers and other ſervants of the company; ſome ſoldiers, and a very few Engliſh ſettlers. The directors were laudably cautious in the choice of coloniſts. They admitted into the ſociety no white man of bad character, or who was not a declared enemy to the ſlave-trade; and as the chief object of their enterpriſe was the civilization of the natives, it was with great propriety that they choſe more than three-fourths of their ſettlers from the free negroes in Nova Scotia, who had borne arms for the Britiſh government during the American war. The ſuperintendant and council were particularly inſtructed to ſecure to all blacks and people of colour, at Sierra Leona, equal rights and equal treatment, in all reſpects, with whites. They were to be tried by jury, as well as others; and the council was deſired to allot to the blacks employments ſuited to their preſent abilities, and to afford them every opportunity of cultivating their talents. All practicable means of maintaining ſubordination were directed to be uſed; and the council was eſpecially inſtructed to promote religion and morals, by ſupporting public worſhip and the due obſervance of the Sabbath, and by the inſtruction of the people, and the education of children. But no perſon was to be prevented from performing or attending religious worſhip in whatever place, time, or manner, he might think fit, or from peaceably inculcating his own religious opinions. Orders were given in chooſing the ſeite of a town, to conſider health as the firſt object; and the firſt town was directed to be called *Free-Town*. Articles for building and cultivation were ſent out, beſides the cargoes for proſecuting the company's commerce; and ſchools for reading, writing, and accounts, were ordered to be ſet up for the purpoſe of inſtructing the children of ſuch natives as ſhould be willing to put them under the company's care.

The leading object of the company was to ſubſtitute, for that diſgraceful traffic which has too long ſubſiſted, a fair commerce with Africa, and all the bleſſings which might be expected to attend it. Conſiderable advantages appeared hereby likely to reſult to Great Britain, not only from our obtaining ſeveral commodities cheaper, but alſo for opening a market for Britiſh manufactures, to the increaſing demands of which it is difficult to aſſign a limit. From this connection, Africa was likely to derive the ſtill more important benefits of religion, morality, and civilization. To accompliſh theſe purpoſes, it was neceſſary for the company to poſſeſs a tract of land, as a repoſitory for their goods, and which the Africans might cultivate in peace, ſecure from the ravages of the ſlave-trade. It had been aſcertained, beyond a doubt, that the climate and ſoil of Africa were admirably ſuited to the growth of ſugar, ſpices, coffee, cotton, indigo, rice, and every other ſpecies of tropical produce. The company propoſed to inſtruct the natives to raiſe theſe articles, and to ſet them the example, by a ſpirited cultivation, on its own account. Directions were given to the company's commercial agent to puſh forward a trade, in a mode preſcribed, in the preſent produce of Africa. Meaſures were taken for cultivating, on the company's account, the moſt profitable tropical produce; and in particular, a perſon of long experience in the Weſt Indies was ordered to begin a ſugar plantation. A mineralogiſt and botaniſt were likewiſe engaged to go out and explore the country for new articles of commerce.

Every thing being thus ſettled upon the moſt equitable and benevolent principles, the ſhips ſailed with the Britiſh coloniſts, to whom, in March 1792, were added 1131 blacks from Nova Scotia. The native chiefs being reconciled to the plan, and made to underſtand its beneficent tendency towards their people, the colony proceeded to build *Free-Town*, on a dry and rather elevated ſpot on the ſouth ſide of the river. It occupied between 70 and 80 acres, its length being about one-third of a mile, and its breadth nearly the ſame; and it contained near 400 houſes, each having one-twelfth of an acre annexed, on which a few vegetables were raiſed. There were nine ſtreets running from north-weſt to ſouth-eaſt, and three croſs ſtreets, all 80 feet wide, except one of 160 feet, in the middle of which were all the public buildings. Theſe conſiſted of a governor's houſe and offices; a large ſtore-houſe; a large hoſpital; ſix or eight other houſes, offices, and ſhops, occupied by the company's ſervants; and a church capable of containing 800 people. The coloniſts at firſt ſuffered much from the rainy ſeaſon, againſt which it was not in their power to provide ſufficient protection; but at the end of it they recovered in a great meaſure their health and ſpirits, and proceeded with alacrity to execute the various purpoſes of their ſettlement. To excite emulation in culture, the government gave premiums to thoſe coloniſts who raiſed the greateſt quantities of rice, yams, eddoes, cabbages, Indian corn, and cotton, reſpectively. To limit the exceſſes of the ſlave-trade, and gain the favour of the neighbouring chiefs, the directors inſtructed the governor and council to redeem any native from the neighbourhood, who ſhould be unjuſtly ſold either to or by a Britiſh ſubject. The ſervants of the company conducted themſelves with the utmoſt propriety, being ſober, moral, and exemplary; and from the labours of the clergymen were derived ſervices highly important in every point of view. Before the end of two years from the inſtitution of the colony, order and induſtry had begun to ſhow their effects in an increaſing proſperity. The woods had been cut down to the diſtance of about three Engliſh miles all round the town. By theſe means the climate had become healthier, and ſickneſs had diminiſhed. The fame of the colony ſpread not only along the whole weſtern coaſt of Africa, but alſo to parts far diſtant from the coaſt; embaſſies had been received of the moſt friendly nature from kings and princes ſeveral hundred miles diſtant; and the native chiefs had begun to ſend their children to the colony, with full confidence, to be taught reading, writing, and accounts, and to be brought up in the Chriſtian religion. In a word, it was not without grounds that the directors looked forward to that joyful period when, by the influence of the company's meaſures, the continent of Africa ſhould be reſcued from her preſent ſtate of darkneſs and miſery, and exhibit a delightful ſcene of light and

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and knowledge of civilization and order, of peaceful induſtry and domeſtic comfort. On their beneficent exertions they hoped with confidence for the bleſſing of Providence; they were countenanced and ſupported by the Britiſh government; and upon the breaking out of the preſent war, the French Convention authoriſed one of their agents to write to the directors, requeſting a full account of the deſign of the inſtitution, and the names of the ſhips employed in their ſervice, and aſſuring them of the good wiſhes of the French government to ſo noble an undertaking. How completely that government fulfilled its promiſe is very generally known. Having vindicated the rights of man in Europe by the violation of every principle of truth and juſtice, they determined by the ſame means to give light and liberty to the Africans; and that they have fully carried their determination into effect will be ſeen by the following extract of a letter from Mr Afzelius, the company's botaniſt, dated Sierra Leona, 15th November 1794. "The French have been here and have ruined us. They arrived on the 28th of September laſt, early in the morning, with a fleet conſiſting of one large ſhip, two frigates, two armed brigs, and one cutter, together with two large armed merchant ſhips, taken by them at the Iſles de Loſs, an Engliſh ſlave factory to the north of our colony, and which they have alſo deſtroyed and burnt. So well had they concealed their nation, that we took them at firſt for Engliſh. They had Engliſh-built veſſels, which were rigged in the Engliſh way. They ſhowed the Engliſh flag, and had their ſailors, at leaſt thoſe we ſaw on deck, dreſſed like Engliſh. In ſhort, we did not perceive our miſtake till we obſerved them pointing their guns. We had not ſtrength ſufficient to reſiſt, and therefore our governor gave orders, that as ſoon as they ſhould begin to fire, the Britiſh flag ſhould be ſtruck, and a flag of truce hoiſted. Accordingly this was done, but ſtill they continued firing, and did much damage, both within and without the town. They killed two people and wounded three or four. But as we did not underſtand the meaning of this proceeding, we aſked them for an explanation; and they anſwered us, that we ſhould diſplay the flag of liberty, as a proof of our ſubmiſſion. We aſſured them that it ſhould already have been done, if we had had any, which terminated the hoſtilities from the ſhips. In the mean time, moſt of the inhabitants had fled from the town, having taken with them as much of their property as they conveniently could in ſuch a hurry. I was with the governor, together with a number of others; but as ſoon as I was certain they were enemies, I went towards my own houſe with a view to ſave as much as poſſible of my property and natural collections; but was received in ſuch a manner, that I could not venture to proceed. My houſe was ſituated near the ſhore, and unfortunately juſt oppoſite the frigate which fired. I ſaw the balls paſſing through the houſe, and heard them whizzing about my ears. I ſaw that I ſhould loſe all my property; but life was dearer to me, and I haſtened to the woods.

"In the afternoon the enemy landed, finding the town almoſt deſtitute of people, but rich in proviſions, clothing and other ſtores. They began immediately to break open the houſes and to plunder. What they did not want, they deſtroyed, burnt, or threw into the river. They killed all the cattle and animals they found in the fields or ſtreets, yards or elſewhere, not ſparing even aſſes, dogs, and cats. Theſe proceedings they continued the whole ſucceeding week, till they had entirely ruined our beautiful and proſpering colony; and when they found nothing more worth plundering, they ſet fire to the public buildings and all the houſes belonging to the Europeans; and burnt, as they ſaid, by miſtake nine or ten houſes of the coloniſts. In the mean time, they were not leſs active on the water. They ſent three of their veſſels to Bance iſland, an Engliſh ſlave factory higher up the river, which they plundered and burnt, together with ſome ſlave ſhips lying there. They took beſides about 10 or 12 prizes, including the company's veſſels. Moſt of theſe they unloaded and burnt. They took along with them alſo two of our armed veſſels, one of which was a large ſhip, laden with proviſions, and which had been long expected; but ſhe unfortunately arrived a few days too ſoon, and was taken with her whole cargo. We expected at leaſt to receive our private letters, but even this was refuſed, and they were thrown overboard. At laſt, after inflicting on us every hardſhip we could ſuffer, only ſparing our lives and the houſes of the coloniſts, they ſailed on the 13th of October laſt, at noon, proceeding downwards to the Gold Coaſt, and left us in the moſt dreadful ſituation, without proviſions, medicines, clothes, houſes, or furniture, &c. &c. and I fear much, that moſt of us ſhould have periſhed, had not our friends in the neighbourhood, both natives and Europeans, who were ſo happy as to eſcape the enemy, been ſo kind as to ſend us what they could ſpare. In the mean time, moſt of us have either been, or ſtill are, very ſick, and many have died for want of proper food and medicine. The worſt, however, is now paſt. At leaſt we are not in any want of proviſion, although of the coarſeſt kind, but are deſtitute of the moſt neceſſary articles and utenſils for the houſe, the table, and the kitchen.

It was thus that the Convention executed their purpoſe of *ſpreading light and liberty through the world.* The Sierra Leona colony was eſtabliſhed for no other end than to aboliſh the ſlave-trade, to enlighten the Africans, and to render them virtuous, rational, free, and happy; and thoſe powerful patrons of the rights of man deſtroyed that colony with many circumſtances of the moſt wanton cruelty. Though Mr Afzelius is a Swede, and ought therefore to have been protected by the laws of neutrality, they burnt his houſe with the reſt; deprived him of his trunks, his clothes, and his bed; deſtroyed the natural curioſities which he had collected at the hazard of his life; and carried away the inſtruments by means of which only he could collect more.

In 1798, Free-Town conſiſted of about 300 houſes, and a number of public buildings, together with three wharfs. The government houſe, ſo ſituated as to command the town and harbour, was protected by a paliſade, and ſix pieces of cannon. The inhabitants of this colony were then computed at 1200, of whom 15 were ſhopkeepers, 25 fiſhermen, 10 trading ſhipmaſters, owners of ſmall veſſels, 15 ſeamen, 20 labourers employed by the company, 4 ſchoolmaſters; about one half of the whole population petty farmers, and the reſt mechanics. The number of Europeans reſident at that time in the colony was about 30, and nearly 400 free natives wrought as labourers for wages, on the farms in the colony.

A charter of juſtice was obtained in 1800, to controul the turbulence of the blacks from Nova Scotia, and a ſmall military force from Goree was ſtationed at Sierra Leona. Parliament allowed the company 7000l. for the purpoſe of erecting a fort, with a promiſe of 8000l. more for the ſame undertaking. The company alſo received 10,000l. for their expence in ſettling the blacks from Nova Scotia, and a vote of parliament agreed to pay 4000l. for ſupporting the civil government of the colony.

The Maroons arrived in Sierra Leona in the month of October 1800, and greatly aſſiſted in ſuppreſſing an inſurrection of the Nova Scotia blacks, who had attempted to ſeize on the government of the colony. A body of natives of the Timmaney, headed by two of the fugitive blacks, made an attack on the unfiniſhed fort on the 18th of November, about day-break, but they were repulſed with loſs. A truce was concluded; but it was ſuppoſed that the Timmanee chiefs would make uſe of this interval to form alliances with the natives againſt the Britiſh, in order to exterminate them from this part of Africa. Soldiers to the amount of 65 were brought from Goree, and a ſhip of war was ſtationed in the river, to defend the ſettlement.

In 1802, parliament again voted 10,000l. to the company, for the annual expence of the ſettlement; and in February 1803, the directors were informed by Lord Hobart, that it would be for the intereſt of the colony to transfer the civil and military power from the company to the Britiſh government.

When Captain Hallowell arrived at Sierra Leona on the 12th of January 1803, he found the colony in a wretched condition, reporting to government on his return, that the Maroons were not ſatisfied with their condition, regarding it as one in which they could not find ſubſiſtence; that proviſions of every deſcription were both ſcarce and dear; that its inhabitants lived in hourly danger from the natives; and that the whole coloniſts lived in a ſtate of deſpondency. Government, however, was afterwards ſatisfied, from the explanations of the directors and their ſervants, that the account of Captain Hallowell was by much too unfavourable. Expectations are indulged that, ſince the entire abolition of the ſlave-trade, the colony will ſoon obtain a flouriſhing trade with the natives, in the exchange of Britiſh manufactures for the raw produce of the interior parts of Africa.

A committee of the houſe of commons has had a moſt ſatisfactory proof of the progreſſive improvement of the internal adminiſtration of the colony, ariſing from the additional powers conferred on the company by the charter of juſtice, and the increaſed vigilance and exertion of the Company's ſervants. The Maroons have, in a great meaſure, abandoned ſome pernicious habits they had long indulged, and by their attachment to the colony, and peaceable demeanour, have merited the approbation of government. The progreſs made in the erection of works has been conſiderable, and the colony may be regarded in a ſtate of ſufficient ſecurity againſt the attack of any native power. A body of volunteers has been raiſed within the colony, whoſe fidelity and attachment have been tried by experience. The ſickneſs and mortality which for ſome time exiſted, have in a great degree ſubſided; and there is reaſon to believe, that it rather originated with the troops when they entered the colony, and their habits of intemperance, than from any diſorder connected with their reſidence in that ſituation. The number of births, which has for ſome time exceeded that of the deaths in the colony, is a ſatisfactory proof that it is not unfriendly to population.

Sierra Leona is already rendered ſecure againſt the only enemies whoſe hoſtilities it has immediately to apprehend; its reſources are increaſed; its cultivation reviving; and it is in the poſſeſſion of every advantage that can ariſe from the enjoyment of internal tranquillity and order. It is ſufficiently manifeſt, from the inconveniences already experienced in the colony, that during its continuance, it will be eſſentially neceſſary to ſupport a local government capable of maintaining order among its inhabitants, and affording them protection. The expence of the civil eſtabliſhment for ſome years to come cannot be eſtimated at leſs than 10,000l. per annum *; that of completing the propoſed works has been eſtimated at 8000l. It alſo appears that the defence of the colony will require the preſent volunteer force to be permanently kept up, the expence of which has been eſtimated at 4000l. per annum; or if that eſtabliſhment ſhould be diſcontinued, a regular garriſon muſt be maintained at the conſtant eſtabliſhment of 100 effective men, excluſive of about 20 artillery men, which, conſidering the numerous caſualties in that climate, and great expence of ſupporting them, would exceed the ſum already mentioned.

* *The expence of the civil eſtabliſhment for 1809 exceeded 17,000l.*

SIERRA MORENA, a conſiderable ridge of mountains of Andaluſia in Spain. See SPAIN.

SIEUR, a title of reſpect among the French, like that of *maſter* among us. It is much uſed by lawyers, as alſo by ſuperiors in their letters to inferiors.

SIFANTO, or SIPHANTO, an iſland of the Archipelago, to the weſt of Paros, to the north-eaſt of Milo, and to the ſouth-weſt of Serphanto. The air is ſo good here, that many of the inhabitants live to the age of 120; and their water, fruits, wild fowl, and poultry, are excellent, but more eſpecially the grapes. It abounds with marble and granite, and is one of the moſt fertile and beſt cultivated of theſe iſlands. The inhabitants employ themſelves in cultivating olive-trees and capers; and they have very good ſilk. They trade in figs, onions, wax, honey, and ſtraw-hats; and may be about 8000 in all. E. Long. 25. 15. N. Lat. 37. 9.

SI-FANS, or TOU-FANS, a people inhabiting the country on the weſt of China. Their country is only a continued ridge of mountains, incloſed by the rivers Hoang-ho on the north, Ya-long on the weſt, and Yang-tſe-kiang on the eaſt, between the 30th and 35th degrees of north latitude.

Groſier's General Deſcription of China, vol. i. p. 203.

The Si-fans are divided into two kinds of people; the one are called by the Chineſe *Black Si-fans*, the other *Yellow*; names which are given them from the different colours of their tents. The black are the moſt clowniſh and wretched; they live in ſmall bodies, and are governed by petty chiefs, who all depend upon a greater.

The yellow Si-fans are ſubject to families, the oldeſt of which becomes a lama, and aſſumes the yellow dreſs. Theſe lama princes, who command in their reſpective diſtricts, have the power of trying cauſes, and puniſhing

ing criminals; but their government is by no means burdenſome; provided certain honours are paid them, and they receive punctually the dues of the god Fo, which amount to very little, they moleſt none of their ſubjects. The greater part of the Si-fans live in tents; but ſome of them have houſes built of earth, and even brick. Their habitations are not contiguous; they form at moſt but ſome ſmall hamlets, conſiſting of five or ſix families. They feed a great number of flocks, and are in no want of any of the neceſſaries of life. The principal article of their trade is rhubarb, which their country produces in great abundance. Their horſes are ſmall; but they are well ſhaped, lively and robuſt.

Theſe people are of a proud and independent ſpirit, and acknowledge with reluctance the ſuperiority of the Chineſe government, to which they have been ſubjected: when they are ſummoned by the mandarins, they rarely appear; but the government, for political reaſons, winks at this contempt, and endeavours to keep theſe intractable ſubjects under by mildneſs and moderation: it would, beſides, be difficult to employ rigorous means in order to reduce them to perfect obedience; their wild and frightful mountains (the tops of which are always covered with ſnow, even in the month of July) would afford them places of ſhelter, from which they could never be driven by force.

The cuſtoms of theſe mountaineers are totally different from thoſe of the Chineſe. It is, for example, an act of great politeneſs among them to preſent a white handkerchief of taffety or linen, when they accoſt any perſon whom they are deſirous of honouring. All their religion conſiſts in their adoration of the god Fo, to whom they have a ſingular attachment; their ſuperſtitious veneration extends even to his miniſters, on whom they have conſidered it as their duty to confer ſupreme power and the government of the nation.

SIGAULTIAN OPERATION, a method of delivery in caſes of difficult labour, firſt practiſed by M. Sigault. It conſiſts in enlarging the dimenſions of the pelvis, in order to procure a ſafe paſſage to the child without injuring the mother.

SIGESBECKIA, a genus of plants belonging to the claſs of ſyngeneſia, and to the order of polygamia ſuperflua; and in the natural ſyſtem ranging under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SIGETH, a town of Lower Hungary, and capital of a county of the ſame name. It is ſeated in a moraſs, and has a triple wall, with ditches full of water; and is defended by a citadel, being one of the ſtrongeſt places in Hungary. It now belongs to the houſe of Auſtria, and was retaken from the Turks in 1669, after it had been blocked up two years. In ſome maps it is called *Zigat*. E. Long. 18. 58. N. Lat. 46. 17.

SIGHING, an effort of nature, by which the lungs are put into greater motion, and more dilated, ſo that the blood paſſes more freely, and in greater quantity, to the left auricle, and thence to the ventricle. Hence we learn, ſays Dr Hales, how ſighing increaſes the force of the blood, and conſequently proportionably cheers and relieves nature, when oppreſſed by its too ſlow motion, which is the caſe of thoſe who are dejected and ſad.

SIGHT, or VISION. See ANATOMY, N° 142. and *Index* ſubjoined to OPTICS.

Imperfection of SIGHT *with regard to Colours.* Under the article COLOURS, is given an inſtance of a ſtrange deficiency of ſight in ſome people, who could not diſtinguiſh between the different colours. In the Phil. Tranſ. vol. lxviii. p. 611. we have an account of a gentleman who could not diſtinguiſh a claret colour from black. Theſe imperfections are totally unaccountable from any thing we yet know concerning the nature of this ſenſe.

Second SIGHT. See SECOND *Sight*.

SIGN, in general, the mark or character of ſomething abſent or inviſible. See CHARACTER.

Among phyſicians, the term *ſign* denotes ſome appearance in the human body which ſerves to indicate or point out the condition of the patient with regard to health or diſeaſe.

SIGN, in *Algebra*. See ALGEBRA.

SIGN, in *Aſtronomy*, a conſtellation containing a 12th part of the zodiac. See ASTRONOMY *Index*.

NAVAL SIGNALS. When we read at our fireſide the account of an engagement, or other intereſting operation of an army, our attention is generally ſo much engaged by the reſults, that we give but little to the movements which led to them, and produced them; and we ſeldom form to ourſelves any diſtinct notion of the conduct of the day. But a profeſſional man, or one accuſtomed to reflection, and who is not ſatisfied with the mere indulgence of eager curioſity, follows every regiment in its movements, endeavours to ſee their connection, and the influence which they have had on the fate of the day, and even to form to himſelf a general notion of the whole ſcene of action, at its different intereſting periods. He looks with the eye of the general, and ſees his orders ſucceed or fail.

But few trouble themſelves farther about the narration. The movement is ordered; it is performed; and the fortune of the day is determined. Few think how all this is brought about; and when they are told that during the whole of the battle of Cuſtrin, Frederic the Great was in the upper room of a country inn, from whence he could view the whole field, while his aids de camp, on horſeback, waited his orders in the yard below, they are ſtruck with wonder, and can hardly conceive how it can be done: but, on reflection, they ſee the poſſibility of the thing. Their imagination accompanies the meſſenger from the inn yard to the ſcene of action; they hear the general's orders delivered, and they expect its execution.

But when we think for a moment on the ſituation of the commander of a fleet, confined on board one ſhip, and this ſhip as much, or more cloſely, engaged, than any other of the fleet; and when we reflect that here are no meſſengers ready to carry his orders to ſhips of the ſquadron at the diſtance of miles from him, and to deliver them with preciſion and diſtinctneſs, and that even if this were poſſible by ſending ſmall ſhips or boats, the viciſſitudes of wind and weather may render the communication ſo tedious that the favourable moment may be irretrievably loſt before the order can be conveyed.—When we think of all theſe circumſtances, our thoughts are bewildered, and we are ready to imagine that a ſea battle is nothing but the unconnected ſtruggle of individual ſhips; and that when the admiral has once "cried havoc, and let ſlip the dogs of war," he has done all that his ſituation empowers him to do, and he muſt leave the fate of the day to the bravery and ſkill of his captains and ſailors.

1 Signals a language to the eye.

Yet it is in this ſituation, apparently the moſt unfavourable, that the orders of the commander can be conveyed, with a diſpatch that is not attainable in the operations of a land army. The ſcene of action is unincumbered, ſo that the eye of the general can behold the whole without interruption. The movements which it is poſſible to execute are few, and they are preciſe. A few words are ſufficient to order them, and then the mere fighting the ſhips muſt always be left to their reſpective commanders. This ſimplicity in the duty to be performed has enabled us to frame a language fully adequate to the buſineſs in hand, by which a correſpondence can be kept up as far as the eye can ſee. This is the language of SIGNALS, a language by writing, addreſſed to the eye, and which he that runneth may read. As in common writing certain arbitrary marks are agreed on to expreſs certain ſounds uſed in ſpeech, or rather, as in hieroglyphics certain arbitrary marks are agreed on to expreſs certain thoughts, or the ſubjects of theſe thoughts; ſo here certain exhibitions are made, which are agreed on to expreſs certain movements to be executed by the commander to whom they are addreſſed, and all are enjoined to keep their eyes fixed on the ſhip of the conductor of the fleet, that they may learn his will.

2 Uſed in ancient times,

It is ſcarcely poſſible for any number of ſhips to act in concert, without ſome ſuch mode of communication between the general and the commanders of private ſhips. We have no direct information of this circumſtance in the naval tactics of the ancient nations, the Greeks and Romans; yet the neceſſity of the thing is ſo apparent, that we cannot ſuppoſe it to have been omitted by the moſt ingenious and the moſt cultivated people who have appeared on the great theatre of the world: and we are perſuaded that Themiſtocles, Conon, and other renowned ſea commanders of Athens, had ſignals by which they directed the movements of their fleets. We read, that when Ægeus ſent his ſon Theſeus to Crete, it was agreed on, that if the ſhip ſhould bring the young prince back in ſafety, a white flag ſhould be diſplayed. But thoſe on board, in their joy for reviſiting their country after their perilous voyage, forgot to hoiſt the concerted ſignal. The anxious father was every day expecting the ſhip which ſhould bring back his darling ſon, and had gone to the ſhore to look out for her. He ſaw her, but without the ſignal agreed on. On which the old man threw himſelf into the ſea. We find, too, in the hiſtory of the Punic wars by Polybius, frequent alluſions to ſuch a mode of communication; and Ammianus Marcellinus ſpeaks of the *ſpeculatores* and *vexillarii*, who were on board the ſhips in the Adriatic. The coins both of Greece and Rome exhibit both flags and ſtreamers. In ſhort, we cannot doubt of the ancients having practiſed this hieroglyphical language. It is ſomewhat ſurpriſing that Lord Dudley, in his *Arcano del Mare*, in which he makes an oſtentatious diſplay of his knowledge of every thing connected with the ſea ſervice, makes no expreſs mention of this very eſſential piece of knowledge, although he muſt, by his long reſidence in Italy, have known the marine diſcipline of the Venetians and Genoeſe, the greateſt maritime powers then in Europe.

3 as well as in modern

In the naval occurrences of modern Europe, mention is frequently made of ſignals. Indeed, as we have already obſerved, it ſeems impoſſible for a number of ſhips to act in any kind of concert, without ſome method of communication. Numberleſs ſituations muſt occur, when it would be impoſſible to convey orders or information by meſſengers from one ſhip to another, and coaſt and alarm ſignals had long been practiſed by every nation. The idea, therefore, was familiar. We find, in particular, that Queen Elizabeth, on occaſion of the expedition to Cadiz, ordered her ſecretaries to draw up inſtructions, which were to be communicated to the admiral, the general, and the five counſellors of war, and by them to be copied and tranſmitted to the ſeveral ſhips of the navy, not to be opened till they ſhould arrive in a certain latitude. It was on this occaſion (ſays our hiſtorian Guthrie), "that we meet with the firſt regular ſets of ſignals and orders to the commanders of the Engliſh fleet." But, till the movements of a fleet have attained ſome ſort of uniformity, regulated and connected by ſome principles of propriety, and agreed on by perſons in the habit of directing a number of ſhips, we may with confidence affirm that ſignals would be nothing but a parcel of arbitrary marks, appropriated to particular pieces of naval ſervice, ſuch as attacking the enemy, landing the ſoldiers, &c.; and that they would be conſidered merely as referring to the final reſult, but by no means pointing out the mode of execution, or directing the movements which were neceſſary for performing it.

4 but firſt formed into a ſyſtem by James II. when duke of York.

It was James II. when duke of York, who firſt conſidered this practice as capable of being reduced into a ſyſtem, and who ſaw the importance of ſuch a compoſition. He, as well as the king his brother, had always ſhowed a great predilection for the ſea ſervice; and, when appointed admiral of England, he turned his whole attention to its improvement. He had ſtudied the art of war under Turenne, not as a paſtime, but as a ſcience, and was a favourite pupil of that moſt accompliſhed general. Turenne one day pointed him out, ſaying, "Behold one who will be one of the firſt princes and greateſt generals of Europe." When admiral of England, he endeavoured to introduce into the maritime ſervice all thoſe principles of concert and arrangement which made a number of individual regiments and ſquadrons compoſe a great army. When he commanded in the Dutch war, he found a fleet to be little better than a collection of ſhips, on board of each of which the commander and his ſhip's company did their beſt to annoy the enemy, but with very little dependence on each other, or on the orders of the general: and in the different actions which the Engliſh fleet had with the Dutch, every thing was confuſion as ſoon as the battle began. It is remarkable that the famous penſionary De Witt, who from a ſtateſman became a navigator and a great ſea commander in a few weeks, made the ſame repreſentation to the States General on his return from his firſt campaign.

In the memoirs of James II. written by himſelf, we have the following paſſage: "1665. On the 15th of March, the duke of York went to Gunfleet, the general rendezvous of the fleet, and haſtened their equipment. He ordered all the flag officers on board with him every morning, to agree on the order of battle and rank. In former battles, no order was kept, and this

under

under the duke of York, was the firſt in which fighting in a line and regular form of battle was obſerved."

This muſt be conſidered as full authority for giving the duke of York the honour of the invention. For whatever faults may be laid to the charge of this unfortunate prince, his word and honour ſtand unimpeached. And we are anxious to vindicate his claim to it, becauſe our neighbours the French, as uſual, would take the merit of this invention, and of the whole of naval tactics, to themſelves. True it is, that Colbert, the great and juſtly celebrated miniſter of Louis XIV. created a navy for his ambitious and vain-glorious maſter, and gave it a conſtitution which may be a model for other nations to copy. By his encouragement, men of the greateſt ſcientific eminence were engaged to contribute to its improvement: and they gave us the firſt treatiſes of naval evolutions. But it muſt ever be remembered, that our accompliſhed, though miſguided ſovereign, was then reſiding at the court of Louis; that he had formerly acted in concert with the French as a commander and flag officer, and was at this very time aiding them with his knowledge of ſea affairs. In the memorable day at La Hogue, the gallant Ruſſel, obſerving one of Tourville's movements, exclaimed, "There! they have got Pepys * among them." This anecdote we give on the authority of a friend, who heard an old and reſpectable officer (Admiral Clinton) ſay, that he had it from a gentleman who was in the action, and heard the words ſpoken; and we truſt that our readers will not be diſpleaſed at having this matter of general opinion eſtabliſhed on ſome good grounds.

Pepys as ſecreary to the uke of ork.

5 Vonderful mplicity his ſyem;

It was on this occaſion, then, that the duke of York made the movements and evolutions of a fleet the object of his particular ſtudy, reduced them to a ſyſtem, and compoſed that "Syſtem of Sailing and Fighting Inſtructions," which has ever ſince been conſidered as the code of diſcipline for the Britiſh navy, and which has been adopted by our rivals and neighbours as the foundation of their naval tactics. It does great honour to its author, although its merit will not appear very eminent to a careleſs ſurveyor, on account of that very ſimplicity which conſtitutes its chief excellence. It is unqueſtionably the reſult of much ſagacious reflection and painful combination of innumerable circumſtances, all of which have their influence; and it is remarkable, that although ſucceeding commanders have improved the ſubject by ſeveral ſubordinate additions, no change has to this day been made in its general principles or maxims of evolution.

Till ſome ſuch code be eſtabliſhed, it is evident that ſignals can be nothing but arbitrary and unconnected hieroglyphics, to be learned by rote, and retained by memory, without any exerciſe of the judgment; and the acquiſition of this branch of nautical ſkill muſt be a more irkſome taſk than that of learning the Chineſe writing. But ſuch a code being once ſettled, the character in which it may be expreſſed becomes a matter of rational diſcuſſion.

Accordingly, the ſailing and fighting inſtructions of the duke of York were accompanied by a ſet of ſignals for directing the chief or moſt frequent movements of the fleet. Theſe alſo were contrived with ſo much judgment, and ſuch attention to diſtinctneſs, ſimplicity, and propriety, that there has hardly been any change found neceſſary; and they are ſtill retained in the Britiſh navy as the uſual ſignals in all caſes when we are not anxious to conceal our movements from an enemy.

6 yet as an art has ſince his time received conſiderable improvements.

Notwithſtanding this acknowledged merit of the duke of York's ſignals, it muſt be admitted that great improvements have been made on this ſubject, conſidered as an art. The art military has, in the courſe of a century paſt, become almoſt an appropriate calling, and has therefore been made the peculiar ſtudy of its profeſſors. Our rivals the French were ſooner and more formally placed in this ſituation; and the miniſters of Louis XIV. took infinite and moſt judicious pains to make their military men ſuperior to all others by their academical education. A more ſcientific turn was given to their education, and the aſſiſtance of ſcientific men was liberally given them; and all the nations of Europe muſt acknowledge ſome obligations to them for information on every thing connected with the art of war. They have attended very much to this ſubject, have greatly improved it, and have even introduced a new principle into the art; and by this means have reduced it to the moſt ſimple form of reference to the code of ſailing and fighting inſtructions, by making the ſignals immediately expreſſive, not of orders, but of ſimple numbers. Theſe numbers being prefixed to the various articles of the code of inſtructions, the officer who ſees a ſignal thrown out by the admiral reads the number, and reports it to his captain, perhaps without knowing to what it relates. Thus ſimplicity and ſecrecy, with an unlimited power of variation, are combined. We believe that M. de la Bourdonnais, a brave and intelligent officer, during the war 1758, was the author of this ingenious thought.

We do not propoſe to give a ſyſtem of Britiſh ſignals. This would evidently be improper. But we ſhall ſhow our readers the practicability of this curious language, the extent to which it may be carried, and the methods which may be practiſed in accompliſhing this purpoſe. This may make it an object of attention to ſcientific men, who can improve it; and the young officer will not only be able to read the orders of the commander in chief, but will not be at a loſs, ſhould circumſtances place him in a ſituation where he muſt iſſue orders to others.

Signals may be divided into,

I. Day Signals.

II. Night Signals; and,

III. Signals in a Fog.

They muſt alſo be diſtinguiſhed into, 1. Signals of Evolution, addreſſed to the whole Fleet, or to Squadrons of the fleet, or to Divisions of theſe ſquadrons. 2. Signals of Movements to be made by particular ſhips; and, 3. Signals of Service, which may be either general or particular.

7 During an engagement the ſignals of the admiral are repeated by frigates ſtationed out of the line.

The great extent of a large fleet, the ſmoke in time of battle, and the ſituation of the commander in chief, who is commonly in the midſt of the greateſt confuſion and hotteſt fire, frequently makes it very difficult for the officers of diſtant ſhips to perceive his ſignals with diſtinctneſs. Frigates, therefore, are ſtationed out of the line, to windward or to leeward, whoſe ſole office it is to obſerve the admiral's ſignals, and inſtantly to repeat them. The eyes of all the ſignal officers in the private ſhips of war are directed to the repeating frigates, as well as to the admiral; and the officers of the repeating frigate, having no other duty, obſerve the admiral inceſſantly,

ſantly, and, being unembarraſſed by the action, can diſplay the ſignal with deliberation, ſo that it may be very diſtinctly ſeen. Being minutely acquainted with the ſubſtitutions which muſt be made on board the admiral when his maſts and rigging are in diſorder, his (perhaps imperfect) ſignal is exhibited by the repeating frigate in its proper form, ſo as to be eaſily underſtood. And to facilitate this communication, the commanders of the different ſquadrons repeat the ſignals of the commander in chief, and the commanders of diviſion repeat the ſignals of the commanders of their ſquadron.

8 Evolution ſignals are preceded by a ſignal of advertiſement, and accompanied with a directive ſignal.

Every evolution ſignal is preceded by a ſignal of ADVERTISEMENT and PREPARATION, which is general, and frequently by a gun, to call attention; and when all the ſignals have been made which direct the different parts of that evolution, another ſignal is made, which marks the cloſe of the complex ſignal, and divides it from others which may immediately follow it: and as the orders of the commander in chief may relate either to the movements of the whole fleet, thoſe of a ſingle diviſion, or thoſe of certain private ſhips, the EXECUTIVE SIGNAL, which dictates the particular movement, is accompanied by a DIRECTIVE SIGNAL, by which theſe ſhips are pointed out, to which the order is addreſſed.

9 Anſwered by the commander to whom they are addreſſed.

The commander of the ſhip to which any ſignal is addreſſed, is generally required to ſignify by a ſignal (which is general) that he has obſerved it. And if he does not thoroughly underſtand its meaning, he intimates this by another general ſignal. And here it is to be obſerved, that as ſoon as the ſignal is anſwered by the ſhips to which it is addreſſed, it is uſual to haul it down, to avoid the confuſion which might ariſe from others being hoiſted in the ſame place. The order remains till executed, notwithſtanding that the ſignal is hauled down.

10 Annulling ſignal.

It may happen that the commander who throws out the ſignal for any piece of ſervice, ſees reaſons for altering his plan. He intimates this by a general ANNULLING ſignal, accompanying the ſignal already given. This will frequently be more ſimple than to make the ſignals for the movements which would be required for re-eſtabliſhing the ſhips in their former ſituation.

All theſe things are of very eaſy comprehenſion, and require little thought for their contrivance. But when we come to the particular evolutions and movements, and to combine theſe with the circumſtances of ſituation in which the fleet may be at the time, it is evident, that much reflection is neceſſary for framing a body of ſignals which may be eaſily exhibited, diſtinctly perceived, and well underſtood, with little riſk of being miſtaken one for another. We ſhall take notice of the circumſtances which chiefly contribute to give them theſe qualities as we proceed in deſcribing their different claſſes.

I. *Of* DAY SIGNALS.

THESE are made by means of the ſhip's ſails, or by colours of various kinds.

Thoſe made with ſails are but few in number, and are almoſt neceſſarily limited to the ſituation of a fleet at anchor. Thus,

The following Signals	*uſually ſignify*
Main topgallant ſtayſail hoiſted	Officers and men belonging to the ſhip to come on board.
Fore topſail looſe	To prepare for ſailing.
Main topſail looſe	To unmoor.
Main topſail ſheets hauled home	To weigh.
Main topſail ſheets clewed up, and the yard hoiſted	Annul the former ſignal, and the ſhip to come to an anchor.
Topgallant ſails looſe, and the ſheets flying	Diſcovering ſtrange ſails.
Main-topgallant ſail looſe and hoiſted. Topſail-yard down	Recal ſhips in chaſe.
Mizen topſail hoiſted, and the ſheets clewed up	Moor.

Before we proceed to the deſcription of the ſignals by means of colours, ſuch as FLAGS, BANNERS (or triangular flags), PENDANTS or VANES, we muſt take notice of the oſtenſible diſtinctions of the various diviſions and ſubdiviſions of a fleet, ſo that we may underſtand how the ſame ſignal may be addreſſed to a ſquadron, diviſion, or ſingle ſhip or ſhips. We ſuppoſe it known that a fleet of ſhips of war is diſtributed into three grand diviſions (which we ſhall term *ſquadrons*), called the *van*, *centre*, and *rear*. Theſe denominations have not always a relation to the one being more advanced than the other, either towards the enemy, or in the direction of their courſe.

11 Meaning of the terms van, centre, and rear, in the line of battle at ſea.

In a land army, the poſition of every part is conceived from its reference to the enemy; and the reader, conceiving himſelf as facing the enemy, eaſily underſtands the terms *van*, *centre*, and *rear*, the *right* and *left wing*, &c. But the movements of a ſea army having a neceſſary dependence on the wind, they cannot be comprehended unleſs expreſſed in a language which keeps this circumſtance continually in view. The ſimpleſt and moſt eaſily conceived diſpoſition of a fleet, is that in which it is almoſt indiſpenſably obliged to form in order to engage an enemy. This is a ſtraight line, each ſhip directly ahead of its neighbour, and cloſe hauled. This is therefore called the *line of battle*. In this poſition, the two extremities of the fleet correſpond to the right and left wings of an army. Suppoſe this line to be in the direction eaſt and weſt, the wind blowing from the north-north-weſt, and therefore the fleet on the ſtarboard tack; the ſhips heads are to the weſt, and the weſtermoſt diviſion is undoubtedly the van of the fleet, and the eaſtermoſt diviſion is the rear. And it is in conformity to this arrangement and ſituation that the LIST OF THE FLEET is drawn up. But the ſhips may be on the ſame eaſt and weſt line, cloſe hauled, with their heads to the weſt, but the wind blowing from the ſouth-ſouth-weſt. They muſt therefore be on the larboard tack. The ſame ſhips, and the ſame diviſion, are ſtill, in fact, the van of the fleet. But ſuppoſe the ſhips heads to be to the eaſtward, and that they are cloſe hauled,

hauled, having the wind from the ſouth-ſouth-eaſt or the north-north-eaſt, the ſhips which were the real van on both tacks in the former ſituation are now, in fact, the rear on both tacks; yet they retain the denomination of the *van ſquadron* of this fleet, and are under the immediate direction of the officer of the ſecond rank, while the other extremity is under the direction of the third officer. This ſubordination therefore is rather an arrangement of rank and precedence than of evolution. It is, however, conſidered as the NATURAL ORDER to which the general ſignals muſt be accommodated. For this reaſon, the diviſion which is denominated *van* in the liſt of this fleet, is *generally* made to lead the fleet when in the line of battle on the ſtarboard tack, and to form the *weathermoſt* column in *the order of ſailing in columns;* and, in general, it occupies that ſtation from which it can moſt eaſily paſs into the place of the leading diviſion on the ſtarboard line of battle ahead. Although this is a technical nicety of language, and may frequently puzzle a landſman in reading an account of naval operations, the reflecting and intelligent reader will ſee the propriety of retaining this mode of conceiving the ſubordinate arrangement of a fleet, and will comprehend the employment of the ſignals which are neceſſary for re-eſtabliſhing this arrangement, or directing the movements while another arrangement is retained.

12
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s are ad-
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ch of
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ns.

This being underſtood, it is eaſy to contrive various methods of diſtinguiſhing every ſhip by the place which ſhe occupies in the fleet, both with reſpect to the whole line, with reſpect to the particular ſquadron, the particular diviſion of that ſquadron, and the particular place in that diviſion. This may be done by a combination of the poſition and colour of the pendants and vanes of each ſhip. Thus the colour of the pendants may indicate the ſquadron, their poſition or maſt on which they are hoiſted may mark the diviſion of that ſquadron, and a diſtinguiſhing vane may mark the place of the private ſhip in her own diviſion. The advantages attending this method are many. In a large fleet it would hardly be poſſible for the commander in chief to find a ſufficient variety of ſingle ſignals to mark the ſhip to which an order is addreſſed, by hoiſting it along with the ſignal appropriated to the intended movement. But by this contrivance one-third part of theſe ſignals of addreſs is ſufficient. It alſo enables the commander in chief to order a general change of poſition by a ſingle ſignal, which otherwiſe would require ſeveral. Thus, ſuppoſe that the fore, main, and mizen maſts, are appropriated (with the proper modifications) for exhibiting the ſignals addreſſed to the van, the centre, and the rear ſquadrons of the fleet, and that a red, a white, and a blue flag, are choſen for the diſtinguiſhing flags of the officers commanding theſe ſquadrons; then, if the commander in chief ſhall hoiſt a red flag at his mizen topgallant maſt head, it muſt direct the van ſquadron to take the poſition then occupied by the rear ſquadron, the evolution neceſſary for accompliſhing this end being ſuppoſed known by the commander of the ſquadron, who will immediately make the neceſſary ſignals to the ſquadron under his particular direction. In the ſame manner, the diſtinguiſhing ſignal for the leading ſhip of a ſquadron being hoiſted along with the ſignal of addreſs to the whole fleet, and the ſignal for any particular ſervice, will cauſe the three or the nine leading ſhips to execute that order, &c. &c.

All that has been ſaid hitherto may be conſidered as ſo many preparations for the real iſſuing of orders by the commander in chief. The moſt difficult part of the language remains, viz. to invent a number of ſignals which ſhall correſpond to that almoſt infinite variety of movements and ſervices which muſt be performed.

13
Eſſential qualities of ſignals are diſtinctneſs,

Diſtinctneſs, ſimplicity, and propriety, are the three eſſential qualities of all ſignals. A ſignal muſt be ſome object eaſily ſeen, ſtrongly marked, ſo that it may be readily underſtood, with little riſk of its being miſtaken for another. When made by flags, banners, or pendants, they muſt be of the fulleſt colours, and ſtrongeſt contraſts. The ſhips are frequently at a very great diſtance, ſo that the intervening air occaſions a great degradation of colour. They are ſeen between the eye and a very variable ſky; and in this ſituation, eſpecially in the morning or evening, or a dark day, it is not eaſy to diſtinguiſh one full colour from another, all of them approaching to the appearance of a black. At the diſtance of a very few miles hardly any full colours can be diſtinguiſhed but a ſcarlet and a blue. Red, blue, yellow, and white, are the colours which can be diſtinguiſhed at greater diſtances than any others, and are therefore the only colours admitted as ſignals. Even theſe are ſometimes diſtinguiſhed with difficulty. A yellow is often confounded with a dirty white, and a blue with a red. All other dark colours are found totally unfit. But as theſe afford but a ſmall variety, we muſt combine them in one flag, by making it ſtriped, ſpotted, or chequered, taking care that the oppoſition of colour may be as great as poſſible, and that the pieces of which the flags are made up may not be too minute. Red muſt never be ſtriped nor ſpotted with blue; and the ſtripes, ſpots, or chequers, ſhould never be leſs than one third of the breadth of the flag. Pl. CCCCXCVI. is a ſelection by an officer of experience, as a ſet very eaſily recogniſed, and little liable to be confounded. Their colours are repreſented by hatching, in the ſame manner as in heraldry (ſee HERALDRY).

Difference of ſhape, as flags, banners, or pendants, is another diſtinction by which the expreſſion may be varied. And in doing this, we muſt recollect, that in light winds it may be difficult to diſtinguiſh a flag from a banner, as neither are fully diſplayed for want of wind to detach the fly from the ſtaff.

And, laſtly, ſignals may be varied by their poſition, which may be on any lofty and well detached part of the maſts, yards, or rigging.

14
ſimplicity,

Simplicity is an eminent property in all ſignals. They are addreſſed to perſons not much accuſtomed to combinations, and who are probably much occupied by other preſſing duties. It were to be wiſhed that every piece of ſervice could be indicated by a ſingle flag. This is peculiarly deſirable with reſpect to the ſignals uſed in time of battle. The rapid ſucceſſion of events on this occaſion call for a multitude of orders from the commander in chief, and his ſhip is frequently clad over with flags and pendants, ſo that it is exceedingly difficult for the ſignal officer of a private ſhip to diſtinguiſh the different groups, each of which make a particular ſignal.

Theſe

15
and propriety.

Theſe conſiderations are the foundation of a certain *propriety* in ſignals, which directs us to a choice among marks which appear altogether arbitrary. Signals which run any riſk of being confounded, on account of ſome reſemblance, or becauſe their poſition hinders us from immediately perceiving their difference, ſhould be appropriated to pieces of ſervice which are hardly poſſible to be executed, or can hardly be wanted, in the ſame ſituation. No bad conſequence could eaſily reſult though the ſignal for *coming to cloſer action* ſhould reſemble that for *unmooring*, becauſe the preſent ſituation of the ſhips makes the laſt operation impoſſible or abſurd. Such conſiderations direct us to ſelect for battle ſignals, thoſe which are of eaſieſt exhibition, are the moſt ſimple, and have the leaſt dependence on the circumſtance of poſition; ſo that their ſignification may not be affected by the damages ſuſtained in the maſts or rigging of the flag ſhip. Such ſignals as are leſs eaſily ſeen at a diſtance, ſhould be appropriated to orders which can occur only in the middle of the fleet, &c. &c. Signals which are made to the admiral by private ſhips may be the ſame with ſignals of command from the flag ſhip, which will conſiderably diminiſh the number of ſignals perfectly different from each other.

16
By what means ſignals are diſtinctly conveyed,

With all theſe attentions and precautions a ſyſtem of ſignals is at laſt made up, fitted to the code of ſailing and fighting inſtructions. It is accompanied by another ſmall ſet for the duty of convoys. It muſt be engroſſed in two books; one for the officer of the flag ſhip, who is to make the ſignals, and the other is delivered to every private ſhip. In the firſt, the evolutions, movements, and other operations of ſervice, are ſet down in one column, and their correſponding ſignals in another. The firſt column is arranged, either alphabetically, by the diſtinguiſhing phraſe, or ſyſtematically, according to the arrangement of the ſailing and fighting inſtructions. The officer whoſe duty it is to make the ſignals, turn to this column for the order which he is to communicate, and in the other column he finds the appropriated ſignal.

17
and underſtood.

In the other book, which is conſulted for the interpretation of the ſignals, they are arranged in the leading column, either by the flags, or by the places of their exhibition. The firſt is the beſt method, becauſe the derangement of the flag ſhip's maſts and rigging in time of action may occaſion a change in the place of the ſignal.

18
The art of ſignals much improved ſince the publication of the *Tactique Navale*.

The *Tactique Navale* of the Chevalier de Morogues contains a very full and elaborate treatiſe on ſignals. We recommend this work to every ſea-officer, as full of inſtruction. The art of ſignals has been greatly ſimplified ſince the publication of this work, but we cannot but aſcribe much of the improvements to it. We believe that the author is the inventor of that ſyſtematic manner of addreſſing the order or *effective ſignal* to the different ſquadrons and diviſions of the fleet, by which the art of ſignals is made more conciſe, the execution of orders is rendered more ſyſtematic, and the commanders of private ſhips are accuſtomed to conſider themſelves as parts of an army, with a mutual dependence and connection. We are ready enough to acknowledge the ſuperiority of the French in manœuvring, but we affect to conſider this as an imputation on their courage. Nothing can be more unjuſt: and dear-bought experience ſhould long ere now have taught us the value of this ſuperiority. What avails that courage which we would willingly arrogate to ourſelves, if we cannot come to action with our enemy, or muſt do it in a ſituation in which it is almoſt impoſſible to ſucceed, and which needleſsly throws away the lives of our gallant crews? Yet this muſt happen, if our admirals do not make evolutions their careful ſtudy, and our captains do not habituate themſelves, from their firſt hoiſting a pendant, to conſider their own ſhip as connected with the moſt remote ſhip in the line. We cannot think that this view of their ſituation would in the leaſt leſſen the character which they have ſo juſtly acquired, of fighting their ſhip with a courage and firmneſs unequalled by thoſe of any other nation. And we may add, that it is only by ſuch a rational ſtudy of their profeſſion, that the gentleman can be diſtinguiſhed from the mercenary commander of a privateer.

II. Night Signals.

It is evident, that the communication of orders by night muſt be more difficult and more imperfect than by day. We muſt, in general, content ourſelves with ſuch orders as are neceſſary for keeping the fleet together, by directing the more general movements and evolutions which any change of circumſtances may render neceſſary. And here the diviſion and ſubordinate arrangement of the fleet is of indiſpenſible neceſſity, it being hardly poſſible to particulariſe every ſhip by a ſignal of addreſs, or to ſee her ſituation, The orders are therefore addreſſed to the commanders of the different diviſions, each of whom is diſtinguiſhed by his poop and top-lights, and is in the midſt of, and not very remote from, the ſhips under his more particular charge. Yet even in this unfavourable ſituation, it is frequently neceſſary to order the movements of particular ſhips. Actions during the night are not uncommon. Purſuits and rallyings are ſtill oftener carried on at this time. The common dangers of the ſea are as frequent and more diſaſtrous. The ſyſtem of ſignals therefore is very incomplete till this part be accompliſhed.

Night ſignals muſt be made by guns, or by lights, or by both combined.

19
How gun-ſignals may be varied.

Gun-ſignals are ſuſceptible of variety both in number and in diſpoſition. The only diſtinct variation which can be made in this diſpoſition, is by means of the time elapſed between the diſcharges. This will eaſily admit of three varieties, ſlow, moderate, and quick.—Half-minute guns are as ſlow as can eaſily be liſtened to as appertaining to one ſignal. Quarter-minute guns are much better, and admit of two very diſtinct ſubdiviſions. When the gunners, therefore, are well trained to this ſervice (eſpecially ſince the employment of firelocks for cannon), intervals of 15 or 12 ſeconds may be taken for ſlow firing, 8 or 10 ſeconds for moderate, and 4 or 5 ſeconds for quick firing. If theſe could be reduced one half, and made with certainty and preciſion, the expreſſion would be incomparably more diſtinct. A very ſmall number of firings varied in this way will give a conſiderable number of ſignals. Thus five guns, with the variety of only quick and moderate, will give 20 very diſtinguiſhable ſignals. The ſame principle muſt be attended to here as in the flag ſignals. The moſt ſimple muſt be appropriated to the moſt important orders, ſuch as occur in the worſt weather, or ſuch as are moſt

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moſt liable to be miſtaken. Quick firing ſhould not make part of a ſignal to a very diſtant ſhip, becauſe the noiſe of a gun at a great diſtance is a lengthened ſound, and two of them, with a very ſhort interval, are apt to coaleſce into one long-continued ſound. This mode of varying gun ſignals by the time muſt therefore be employed with great caution, and we muſt be very certain of the ſteady performance of the gunners.

Note, that a preparatory ſignal or advertiſement that an effective ſignal is to be made, is a very neceſſary circumſtance. It is uſual (at leaſt in hard weather) to make this by a double diſcharge, with an interval of half a ſecond, or at moſt a ſecond.

Gun-ſignals are ſeldom made alone, except in ordinary ſituations and moderate weather; becauſe accident may derange them, and inattention may cauſe them to eſcape notice, and, once made, they are over, and their repetition would change their meaning. They are alſo improper on an enemy's coaſt, or where an enemy's cruiſers or fleets may be expected.

20 nals by ts.

Signals by lights are either made with LIGHTS ſimply ſo called, i. e. lanthorns ſhown in different parts of the ſhip, or by rockets. Lights may differ by number, and by poſition, and alſo by figure. For the flag ſhip always carrying poop or top-lights, or both, preſents an object in the darkeſt night, ſo that we can tell whether the additional lights are exhibited about the mainmaſt, the foremaſt, the mizenmaſt, &c. And if the lights ſhown from any of theſe ſituations are arranged in certain diſtinguiſhable ſituations in reſpect to each other, the number of ſignals may be greatly increaſed. Thus three lights may be in a vertical line, or in a horizontal line, or in a triangle; and the point of this triangle may be up, or down, or forward, or aft, and thus may have many ſignifications.

Lights are alſo exhibited by falſe fires or rockets: Theſe can be varied by number, and by ſuch differences of appearance as to make them very diſtinguiſhable. Rockets may be with ſtars, with rain fire, or ſimple ſquibs.

21 ſe two ies of als may om- d.

By varying and combining theſe, a very great number of ſignals may be produced, fully ſufficient to direct every general movement or evolution, or any ordinary and important ſervice. The Chevalier de Morogues has given a ſpecimen of ſuch a ſyſtem of night ſignals, into which he has even introduced ſignals of addreſs or direction to every ſhip of a large fleet; and has alſo given ſignals of number, by which depths of ſoundings, points of the compaſs, and other things of this kind, may be expreſſed both eaſily and diſtinctly. He has made the ſignals by rockets perfectly ſimilar in point of number to thoſe by lanthorns, ſo that the commander can take either; a choice which may have its uſe, becauſe the ſignals by rockets may cauſe the preſence of a fleet to be more extenſively known than may be convenient.

22 eral ob- ations erning t fig-

The commander in chief will inform the fleet by ſignal, that guns, or perhaps rockets, are not to be uſed that night. This ſignal, at the ſame time, directs the fleet to cloſe the line or columns, that the light ſignals may be better obſerved.

It is indeed a general rule to ſhow as few lights as poſſible; and the commander frequently puts out his own poop and top-lights, only ſhowing them from time to time, that his ſhips may keep around him.

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The ſignal lanthorns on board the flag ſhip, and a lanthorn kept in readineſs on board of every private ſhip, to anſwer or acknowledge ſignals from the commander in chief, are all kept in bags, to conceal their lights till the moment they are fixed in their places, and the preparatory or advertiſing ſignal has been made.

The commander in chief ſometimes orders by ſignal every ſhip to ſhow a light for a minute or two, that he may judge of the poſition of the fleet; and the admiral's ſignal muſt always be acknowledged by thoſe to whom it is addreſſed.

It is of particular importance that the fleet be kept together. Therefore the leading ſhips of the fleet, on either tack, are enjoined to acknowledge the ſignals of the commander in chief by a ſignal peculiar to their ſtation. Thus the commander in chief learns the poſition of the extremities of his fleet.

In framing a ſet of night ſignals, great attention muſt be given to their poſition, that they be not obſcured by the ſails. The nature of the order to be given will frequently determine this. Thus, an order for the rear ſhips to make more ſail, will naturally direct us to exhibit the ſignal at the mizen peek; and ſo of other pieces of ſervice. Lanthorns expoſed in groups, ſuch as triangles, lozenges, &c. are commonly ſuſpended at the corners of large frames of laths, at the diſtance of a fathom at leaſt from each other. Attempts have been made to ſhow lights of different colours; but the riſk of miſtake or failure in the compoſition at the laboratory, makes this rather hazardous. Coloured lanthorns are more certain; but when the glaſſes are made of a colour ſufficiently intenſe, the vivacity of the light (which at no time is very great) is too much diminiſhed. Beſides, the very diſtance changes the colour exceedingly and unaccountably.

III. *Of* SIGNALS *in a* FOG.

THESE can be made only by noiſes, ſuch as the firing of cannon and muſkets, the beating of drums and ringing of bells, &c. Fog ſignals are the moſt difficult to contrive of any, and are ſuſceptible of the leaſt variety. The commander in chief is principally concerned to keep his fleet together; and unleſs ſomething very urgent requires it, he will make no change in his courſe or rate of ſailing. But a ſhift of wind or other cauſes may make this neceſſary. The changes which he will order, it will be prudent to regulate by ſome fixed rule, which is in general convenient. Thus, when a fleet is in the order of ſailing upon a wind, and a fog comes on, the fleet will hold on the ſame courſe. If the wind ſhould come a little more on the beam, the fleet will ſtill keep cloſe to the wind. Certain general rules of this kind being agreed on, no ſignals are neceſſary for keeping the fleet together; and the ſhips can ſeparate or run foul of each other only by difference in their rate of ſailing, or by inaccurate ſteerage. To prevent this, the commander in chief fires a gun from time to time, and the ſhips of the fleet judge of his ſituation and diſtance by the ſound. The commanders of diviſions fire guns, with ſome diſtinction from thoſe of the commander in chief. This both informs the commander in chief of the poſition of his ſquadrons, and enables the private ſhips of each diviſion to keep in the neighbourhood of their own flag ſhip. On board of every private ſhip the drum is beaten, or the bell is chimed, very quarter

23 By obſerving certain general rules ſignals during a fog are in many caſes unneceſſary.

quarter of an hour, according as the ſhip is on the ſtarboard or larboard tack. By ſuch contrivances, it is never difficult to keep a fleet in very good order when ſailing on a wind. The wind is almoſt always moderate, and the ſhips keep under a very eaſy ſail. It is much more difficult when going large, and ſeparation can be prevented only by the moſt unwearied attention. The greateſt riſk is the falling in with ſtrange ſhips ſteering another courſe.

But evolutions and other movements are frequently indiſpenſible. The courſe muſt be changed by tacking or wearing, and other ſervices muſt be performed. None, however, are admitted but the moſt probable, the moſt ſimple, and the moſt neceſſary.

24
How they are given when neceſſary.

The commander in chief firſt informs the fleet by the *preparatory fog ſignal*, that he is about to order an evolution, and that he is to direct it by *fog ſignals*. This precaution is indiſpenſible to prevent miſtakes. Along with this advertiſing ſignal he makes the ſignal of the movement intended. This not only calls the attention of the fleet, but makes the ſhips prepare for the preciſe execution of that movement. The commanders of diviſions repeat the advertiſing ſignal, which informs their ſhips of their ſituation, and the private ſhips beat their drums or chime their bells. Thus the whole ſhips of the fleet cloſe a little, and become a little better acquainted with their mutual poſition. It is now underſtood that a movement is to be made preciſely a quarter of an hour after the advertiſement. At the expiration of this time, the effective ſignal for this movement is made by the commander in chief, and muſt be inſtantly repeated by the commanders of diviſions, and then the movement muſt be made by each ſhip, according to the ſailing and fighting inſtructions. This muſt be done with the utmoſt attention and preciſion, becauſe it produces a prodigious change in the relative poſition of the ſhips; and even although the good ſenſe of the commander in chief will ſelect ſuch movements for accompliſhing his purpoſe as produce the ſmalleſt alterations, and the leaſt riſk of ſeparation or running foul of each other; it is ſtill extremely difficult to avoid theſe misfortunes. To prevent this as much as poſſible, each ſhip which has executed the movement, or which has come on a courſe thwarting that of the fleet, intimates this by a ſignal properly adapted, often adding the ſignal of the tack on which it is now ſtanding, and even its particular ſignal of recognizance. This is particularly incumbent on the flag ſhips and the leading ſhips of each diviſion.

After a reaſonable interval, the commander in chief will make proper ſignals for bringing the fleet to a knowledge of their reunion in this new poſition.

25
Improper to publiſh a particular account of ſignals.

This muſt ſerve for a general account of the circumſtances which muſt be attended to in framing a code of ſignals. The arbitrary characters in which the language is written muſt be left to the ſagacity of the gentlemen of the profeſſion. It muſt be obſerved, that the ſtratagems of war make ſecrecy very neceſſary. It may be of immenſe hazard if the enemy ſhould underſtand our ſignals. In time of battle it might frequently fruſtrate our attempts to deſtroy them, and at all times would enable them to eſcape, or to throw us into diſorder. Every commander of a ſquadron, therefore, iſſues private ſignals, ſuited to his particular deſtination; and therefore it is neceſſary that our code of ſignals be ſuſceptible of endleſs variations. This is exceedingly eaſy, without any increaſe of their number. The commander needs only intimate that ſuch and ſuch a ſignal is ſo and ſo changed in its meaning during his command.

26
Signals m be made the imme diate ex- preſſions o numbers.

We cannot leave this article without returning to an obſervation which we made almoſt in the beginning, viz. that the ſyſtem of ſignals, or, to ſpeak more properly, the manner of framing this ſyſtem, has received much improvement from the gentlemen of the French navy, and particularly from the moſt ingenious thought of M. de la Bourdonnais, of making the ſignals the immediate expreſſions of *numbers* only, which numbers may be afterwards uſed to indicate any order whatever. We ſhall preſent our readers with a ſcheme or two of the manner in which this may be done for all ſignals, both day, night, and fog. This alone may be conſidered as a ſyſtem of ſignals, and is equally applicable to every kind of information at a diſtance. Without detracting in the ſmalleſt degree from the praiſe due to M. de la Bourdonnais, we muſt obſerve, that this principle of *notation* is of much older date. Biſhop Wilkins, in his Secret and Swift Meſſenger, expreſsly recommends it, and gives ſpecimens of the manner of execution; ſo does Dr Hooke in ſome of his propoſals to the Royal Society. Gaſpar Schottus alſo mentions it in his *Technica Curioſa*; and Kircher, among others of his Curious Projects.

27
M. de la Bourdon- nais's me- thod for- doing this

M. de la Bourdonnais's method is as follows:

He chooſes pendants for his effective ſignals, becauſe they are the moſt eaſily diſplayed in the proper order. Several pendants, making part of one ſignal, may be hoiſted by one hallyard, being ſtopped on it at the diſtance of four or ſix feet from each other. If it be found proper to throw out another ſignal at the ſame time and place, they are ſeparated by a red pendant without a point. His colours are choſen with judgement, being very diſtinctly recogniſed, and not liable to be confounded with the addreſſing ſignals appropriated to the different ſhips of the fleet. They are,

For N° 1.	Red.	For N° 6.	Red, with blue tail.
2.	White.	7.	White, with blue tail.
3.	Blue.	8.	White, with red tail.
4.	Yellow.	9.	Blue, with yellow tail.
5.	Red, with white tail.	10.	Yellow, with blue tail.

Three ſets of ſuch pendants will expreſs every number under a thouſand, by hoiſting one above the other, and reckoning the uppermoſt hundreds, the next below it tens, and the loweſt units. Thus the number 643 will be expreſſed by a pendant red with blue tail, a yellow pendant below it, and a blue one below the laſt.

This method has great advantages. The ſignals may be hoiſted in any place where beſt ſeen, and therefore the ſignification is not affected by the derangement of the flag-ſhip's maſts and rigging. And by appropriating the ſmaller numbers to the battle ſignals, they are more ſimple, requiring fewer pendants.

28
might be rendered much ſim pler by uſing few colours.

As this method requires a particular ſet of colours, it has its inconveniences. An admiral is often obliged to ſhift his flag, even in time of action. He cannot eaſily take the colours along with him. It is therefore better to make uſe of ſuch colours as every private ſhip is provided with. One ſet of 11 will do, with the addition

dition of three, at moſt of four pendants, of ſingular make, to mark 100, 200, 300, 400. Two of theſe flags, one above the other, will expreſs any number under 100, by uſing the 11th as a ſubſtitute for any flag that ſhould be repeated. Thus the 11th flag, along with the flag for eight or for ſix, will expreſs the number 88 or 66, &c. Thus we are able to expreſs every number below 500, and this is ſufficient for a very large code of ſignals.

And in order to diminiſh as much as poſſible the number of theſe compound ſignals, it will be proper that a number of ſingle flag ſignals be preſerved, and even varied by circumſtances of poſition, for orders which are of very frequent occurrence, and which can hardly occur in ſituations where any obſtructions are occaſioned by loſs of maſts, &c. And farther, to avoid all chance of miſtake, a particular ſignal can be added, intimating that the ſignals now exhibited are numerary ſignals; or, which is ſtill better, all ſignals may be conſidered as numerary ſignals; and thoſe which we have juſt now called *ſingle flag ſignals* may be ſet down oppoſite to, or as expreſſing, the largeſt numbers of the code.

This method requires the ſignal of advertiſement, the annulling ſignal, the ſignal of addreſs to the particular ſhip or diviſion, the ſignal of acknowledgment, the ſignal of indiſtinctneſs, of diſtreſs, of danger, and one or two more which, in every method, muſt be employed.

Another method of expreſſing numbers with fewer colours is as follows: Let the flags be A, B, C, D, E, F, and arrange them as follows:

29 other thod of preſſing nbers by er co- s,

	A	B	C	D	E	F
	1	2	3	4	5	6
A	7	8	9	10	11	12
B	13	14	15	16	17	18
C	19	20	21	22	23	24
D	25	26	27	28	29	30
E	31	32	33	34	35	36
F	37	38	39	40	41	42

The number expreſſed by any pair of flags is found in the interſection of the horizontal and perpendicular columns. Thus the flag D, hoiſted along with and above the flag F, expreſſes the number 40, &c. In order to expreſs a greater number (but not exceeding 84) ſuppoſe 75, hoiſt the flag $\overset{C}{E}$, which expreſſes 33, or 75 wanting 42, and above them a flag or ſignal G, which alone expreſſes 42.

30 ch may lſo im- ed.

This method may be ſtill farther improved by arranging the flags thus:

	A	B	C	D	E	F
	1	2	3	4	5	6
A	7	8	9	10	11	12
B	—	13	14	15	16	17
C	—	—	18	19	20	21
D	—	—	—	22	23	24
E	—	—	—	—	25	26
F	—	—	—	—	—	27

In this laſt method the ſignification of the ſignal is totally independent of the poſition of the flags. In whatever parts of the ſhip the flags D and E are ſeen, they expreſs the number 23. This would ſuit battle ſignals.

31 A third method.

Another method ſtill may be taken. Flags hoiſted anywhere on the foremaſt may be accounted units, thoſe on the mainmaſt tens, and thoſe on the mizenmaſt hundreds. Thus numeral ſignals may be made by a ſhip diſmaſted, or having only poles in their place.

Many other ways may be contrived for expreſſing numbers by colours, and there is great room for exercising the judgment of the contriver. For it muſt always be remembered, that theſe ſignals muſt be accompanied with a ſignal by which it is addreſſed to ſome particular ſhip or diviſion of the fleet, and it may be difficult to connect the one with the other, which is perhaps ſhown in another place, and along with other executive ſignals.

32 Advantages of numeral ſignals.

One great advantage of theſe numeral ſignals is, that they may be changed in their ſignification at pleaſure. Thus, in the firſt method, it can be ſettled, that on Sundays the colours A, B, C, D, &c. expreſs the cyphers 1, 2, 3, 4, &c. but that on Mondays they expreſs the cyphers 0, 1, 2, 3, &c. and on Tueſdays the cyphers 9, 0, 1, 2, &c.; and ſo on through all the days of the week. This mean of ſecrecy is mentioned by Dr Hooke for the coaſt and alarm ſignals, where, by the by, he ſhews a method for conveying intelligence over land very ſimilar to what is now practiſed by the French with their telegraph.

33 Numbers may be alſo expreſſed by night ſignals.

It is equally eaſy to expreſs numbers by night ſignals. Thus M. de la Bourdonnais propoſes that one diſcharge of a great gun ſhall expreſs 7, and that 1, 2, 3, 4, 5, 6, ſhall be expreſſed by lights. Therefore to expreſs 24, we muſt fire three guns, and ſhow three lights. This is the moſt perfect of all forms of night and fog ſignals. For both the manner of firing guns and of exhibiting lights may be varied to a ſufficient extent with very few guns or lights, and with great diſtinctneſs.

Thus, for guns. Let F mark the firing of a ſingle gun at moderate intervals, and *ff* a double gun, that is, two diſcharged at the interval of a ſecond. We may expreſs numbers thus:

1	F.
2	F, F.
3	F, F, F.
4	F, F, F, F.
5	F, *ff*.
6	F, F, *ff*.
7	F, *ff*, F.
8	F, *ff*, F, F.
9	F, *ff*, F, *ff*.
10	*ff*.
100, &c.	*ff*, *ff*, or *fff*.

It might be done with fewer guns if the *ff* were admitted as the firſt firing. But it ſeems better to begin always with the ſingle gun, and thus the double gun beginning a ſignal diſtinguiſhes the tens, &c.

In like manner, a ſmall number of lights will admit of a great variety of very diſtinct poſitions, which may ſerve for all ſignals to ſhips not very remote from the commander in chief. For orders to be underſtood at a very great diſtance, it will be proper to appropriate the numbers which are indicated by ſignals made with

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Signature.

rockets. Theſe can be varied in number and kind to a ſufficient extent, ſo as to be very eaſily diſtinguiſhed and underſtood. It is ſufficient to have ſhown how the whole, or nearly the whole, notation of ſignals may be limited to the expreſſion of numbers.

34 Concluding remarks.

We have taken little notice of the ſignals made by private ſhips to the commander in chief. This is a very eaſy buſineſs, becauſe there is little riſk of confounding them with other ſignals. Nor have we ſpoken of ſignals from the flag ſhips whoſe ultimate interpretation is number, as when ſhips are directed to change their courſe ſo many points. Thoſe alſo are eaſily contrived in any of the methods already deſcribed: alſo when a private ſhip wiſhes to inform the commander in chief that ſoundings are found at ſo many fathoms. In like manner, by numbering the points of the compaſs, the admiral can direct to chace to any one of them, or may be informed of ſtrange ſhips being ſeen in any quarter, and what is their number.

SIGNALS by the Drum, made uſe of, in the exerciſe of the army, inſtead of the word of command, viz.

SIGNALS.	*Operations.*
A ſhort roll. -	To caution.
A flam, -	To perform any diſtinct thing.
To arms, - -	To form the line or battalion.
The march,	To advance, except when intended for a ſalute.
The quick march, -	To advance quick.
The point of war, -	To march and charge.
The retreat, -	To retreat.
Drum ceaſing, -	To halt.
Two ſhort rolls, -	To perform the flank firing.
The dragoon march,	To open the battalion.
The grenadier march,	To form the column.
The troop, -	To double diviſions.
The long roll, -	To form the ſquare.
The grenadier march, -	To reduce the ſquare to the column.
The preparative,	To make ready and fire.
The general, -	To ceaſe firing.
Two long rolls, -	To bring or lodge the colours.

SIGNATURE, a ſign or mark impreſſed upon any thing, whether by nature or art. Such is the general ſignification of the word; but in the plural number it has been uſed, in a particular ſenſe, to denote thoſe external marks by which phyſiognomiſts and other dabblers in the occult ſciences pretend to diſcover the nature and internal qualities of every thing on which they are found. According to Lavater, every corporeal object is characterized by ſignatures peculiar to itſelf.

The doctrine of ſignatures, like alchemy and aſtrology, was very prevalent during the 15th and 16th centuries; and was conſidered as one of the occult ſciences which conferred no ſmall degree of honour on their reſpective profeſſors. Some of theſe philoſophers, as they thought fit to ſtyle themſelves, maintained that plants, minerals, and animals, but particularly plants, had ſignatures impreſſed on them by the hand of nature, indicating to the adept the *therapeutic* uſes to which they might be applied. Others, ſuch as the myſtic theoſophiſts and chemiſts of that day, proceeded much farther in abſurdity, maintaining that every ſubſtance in nature had either *external* ſignatures immediately diſcernible, or *internal* ſignatures, which, when brought into view by fire or menſtrua, denoted its connection with ſome ſidereal or celeſtial archetype. Of the doctrine of ſignatures, as it relates merely to the therapeutic uſes of plants and minerals, traces are to be found in the works of ſome of the greateſt authors of antiquity; but the celeſtial ſignatures, we believe, were diſcovered only by the moonlight of the monkiſh ages. Pliny informs us *, that the marble called *ophites*, from its being ſpotted like a ſerpent, was diſcovered by thoſe ſpots to be a ſovereign remedy for the bite of that animal; and that the colour of the *hæmatites* or blood-ſtone intimated that it was fit to be employed to ſtop an hemorrhagy; but we do not recollect his attributing the virtues of theſe minerals to a ſidereal or celeſtial influence.

Signature || Silesia.

SIGNATURE, a ſigning of a perſon's name at the bottom of an act or deed written by his own hand.

SIGNATURE, in *Printing*, is a letter put at the bottom of the firſt page at leaſt, in each ſheet, as a direction to the binder in folding, gathering, and collating them. The ſignatures conſiſt of the capital letters of the alphabet, which change in every ſheet; if there be more ſheets than letters in the alphabet, to the capital letter is added a ſmall one of the ſame ſort, as Aa, Bb; which are repeated as often as neceſſary. In large volumes it is eaſy to diſtinguiſh the number of alphabets, after the firſt three or four, by placing a figure before the ſignature, as 5 B, 6 B, &c.

SIGNET, one of the king's ſeals, made uſe of in ſealing his private letters, and all grants that paſs by bill ſigned under his majeſty's hand: it is always in the cuſtody of the ſecretaries of ſtate.

SIGNET, in *Scots Law*. See LAW, Part III. § 17.

SILENE, CATCHFLY, or *Viſcous Campion*, a genus of plants belonging to the claſs *decandria*, and order *trigynia*; and in the natural ſyſtem arranged under the 22d order, *Caryophylleæ*. See BOTANY *Index*.

SILESIA, a duchy of Germany, bounded on the eaſt by Poland; on the weſt, by Bohemia and Lower Luſatia; on the ſouth, by a chain of mountains, and a thicket of conſiderable extent which ſeparates it from Hungary; and to the north, by the marquiſate of Brandenburg and Poland. From north-weſt to ſouth-eaſt it is about 274 miles, and about 100 where broadeſt: but it is much contracted at both ends. Upon the frontiers of this country, to the weſt and ſouth, are very high mountains, and ſome likewiſe in other parts of it. One of the ridges upon the frontiers is ſtyled the *Riphæan Mountains*, another the *Moravian*, another the *Bohemian*, and another the *Hungarian*, *Crapack*, or *Carpathian*. A branch of the Bohemian is called the *Giant Mountains*. The winter on theſe hilly tracts is more ſevere, ſets in ſooner, and laſts longer, than in the low lands. The inhabitants uſe a kind of ſkates when the ſnow is deep, as they do in Carniola. Little or no grain is raiſed in the mountains and ſome ſandy tracts; but the reſt of the country is abundantly fruitful, not only in grain, but fruits, roots, paſture, flax, hops, madder, tobacco, and hemp, yielding alſo ſome wine, with conſiderable quantities of ſilk and honey. In many places are great woods of pines, fir, beech, larch, and other trees, affording tar, pitch, roſin, turpentine, lampblack, and timber for all uſes. In this country alſo is found marble of ſeveral ſorts, ſome precious ſtones, limeſtone, millſtone, pitcoal, turf, vitriol, ſome ſilver ore, copper, lead, iron, and mineral ſprings. Great num-

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* *Hiſt. Nat.* lib. 34.

bers of black cattle and horſes are brought hither from Poland and Hungary for ſale, thoſe bred in the country not being ſufficient; but of ſheep, goats, game, and veniſon, they have great plenty. As for wild beaſts, here are lynxes, foxes, weaſels, otters, and beavers. The rivers, lakes, and ponds, yield fiſh of ſeveral ſorts, particularly ſturgeons ſeveral ells in length, and ſalmon. Beſides a number of ſmaller ſtreams to water this country, there is the Oder, which traverſes it almoſt from one end to the other; and the Viſtula, which after a pretty long courſe through it enters Poland. The number of the cities and market-towns is ſaid to be about 200, the county of Glatz included, and that of the villages 5000. The inhabitants who are computed to be about 1,821,065 are a mixture of Germans, Poles, and Moravians. The language generally ſpoken is German; but in ſome places the vulgar tongue is a dialect of the Sclavonic. The ſtates conſiſt of the princes and dukes, and thoſe called *ſtate-lords*, with the nobility, who are immediately ſubject to the ſovereign, and the repreſentatives of the chief cities; but ſince the country fell under the dominion of the king of Pruſſia, no diets have been held. The king, however, when he took poſſeſſion of the country, confirmed all the other privileges of the inhabitants. With reſpect to religion, not only Proteſtants, but Papiſts, Jews, and Greeks, enjoy full liberty of conſcience. The greateſt part of Sileſia lies in the dioceſe of Breſlaw, but ſome part of it in the Poliſh dioceſes of Poſen and Cracow. The biſhop of Breſlaw ſtands immediately under the pope with regard to ſpirituals; but all eccleſiaſtical benefices, not excepting the ſee of Breſlaw, is in the king's gift. Beſides Latin ſchools, colleges, and ſeminaries, at Breſlaw is an univerſity, and at Lignitz an academy for martial exerciſes. The principal manufactures here are woollens, linens, and cottons of ſeveral ſorts, with hats, glaſs-ware, gunpowder, and iron manufactures. Of theſe there is a conſiderable exportation. Accounts are generally kept in rix-dollars, ſilver groſchens, and ducats. With reſpect to its revolutions and preſent government, it was long a part of the kingdom of Poland; afterwards it had ſeveral dukes and petty princes for its ſovereigns, who by degrees became ſubject to the kings of Bohemia, until at laſt King Charles IV. incorporated the whole duchy with Bohemia; and thus it continued in the poſſeſſion of the houſe of Auſtria, until the king of Pruſſia in 1742, taking advantage of the troubles that enſued upon the death of the emperor Charles VI. and pretending a kind of claim, wreſted a great part of it, together with the county of Glatz, from his daughter and heireſs Maria Thereſa, the late empreſs dowager; ſo that now only a ſmall part of it is poſſeſſed by the houſe of Auſtria, and connected with the empire, the reſt being governed by the king of Pruſſia, without acknowledging any ſort of dependence on the crown of Bohemia or the empire. For the adminiſtration of juſtice in all civil, criminal, and feudal caſes, and ſuch as relate to the revenue, the king of Pruſſia has eſtabliſhed three ſupreme judicatories, to which an appeal lies from all the inferior ones, and from which, when the ſum exceeds 500 rix-dollars, cauſes may be moved to Berlin. The Lutheran churches and ſchools are under the inſpection of the upper conſiſtories, and thoſe of the Papiſts under that of the biſhop's court at Breſlaw; but from both an appeal lies to the tribunal at Berlin. As to the revenue, the exciſe here is levied only in the walled towns, being on the ſame footing as in the marquiſate of Brandenburg; but in the reſt of the country the contributions are fixed, and the ſame both in peace and war. The ſeveral branches of the revenue are under the management of the war and domain offices of Breſlaw and Glogau. The whole revenue ariſing to the king of Pruſſia from Sileſia and the county of Glatz amounts to about four millions of rix-dollars per annum.

Sileſia is divided into Upper and Lower, and each of theſe again into principalities and lordſhips; of ſome of which both the property and juriſdiction belong immediately to the ſovereign, but of others to his ſubjects and vaſſals. In regard to the character of the people, the boors are accounted very dull and ſtupid; but of thoſe of a higher rank, many have diſtinguiſhed themſelves by their wit and learning, as well as by their military and political talents.

SILESIAN EARTH, in the *Materia Medica*, a fine aſtringent bole. It is very heavy, of a firm compact texture, and in colour of a browniſh yellow. It breaks eaſily between the fingers, and does not ſtain the hands; is naturally of a ſmooth ſurface, is readily diffuſible in water, and melts freely into a butter-like ſubſtance in the mouth. It leaves no grittineſs between the teeth, and does not ferment with acids. It is found in the perpendicular fiſſures of rocks near the gold mines in Hungary.

SILICERNIUM, among the Romans, was a feaſt of a private nature, provided for the dead ſome time after the funeral. It conſiſted of beans, lettuces, bread, eggs, &c. Theſe were laid upon the tomb, and they fooliſhly believed that the dead would come out for the repaſt. What was left was generally burnt on the ſtone. The word *ſilicernium* is derived from *ſilex* and *cœna*, i. e. "a ſupper upon a ſtone." Eating what had thus been provided for the dead, was eſteemed a mark of the moſt miſerable poverty. A ſimilar entertainment was made by the Greeks at the tombs of the deceaſed; but it was uſual among them to treat the ghoſts with the fragments from the feaſt of the living. See FUNERAL and INFERIÆ.

SILEX. See FLINT.

SILICEOUS EARTHS. See SILICA, CHEMISTRY *Index*.

SILIUS ITALICUS, CAIUS, an ancient Roman poet, and author of an epic poem in 17 books, which contains an hiſtory of the ſecond Punic war, ſo famous for having decided the empire of the world in favour of the Romans. He was born in the reign of Tiberius, and is ſuppoſed to have derived the name of *Italicus* from the place of his birth; but whether he was born at Italica in Spain, or at Corfinium in Italy, which, according to Strabo, had the name of *Italica* given it during the Social war, is a point which cannot be known: though, if his birth had happened at either of theſe places, the grammarians would tell us, that he ſhould have been called *Italicenſis*, and not *Italicus*. When he came to Rome, he applied himſelf to the bar; and, by a cloſe imitation of Cicero, ſucceeded ſo well, that he became a celebrated advocate and moſt accompliſhed orator. His merit and character recommended him to the higheſt offices in the republic, even to the conſulſhip, of which he was poſſeſſed when Nero died. He is ſaid to have been aiding and aſſiſting in accuſing perſons of high rank and fortune, whom that wicked emperor had devoted to deſtruction: but he retrieved his character afterwards by a long and uniform courſe of virtuous behaviour. Veſpaſian ſent him as proconſul into Aſia, where he behaved with clean hands and unblemiſhed reputation. After having thus ſpent the beſt part of his life in the ſervice of his country, he bade adieu to public affairs, reſolving to conſecrate the remainder to polite retirement and the muſes. He had ſeveral fine villas in the country: one at Tuſculum, celebrated for having been Cicero's; and a farm near Naples, ſaid to have been Virgil's, at which was his tomb, which Silius often viſited. Thus Martial compliments him on both theſe accounts:

> *Silius hæc magni celebrat monumenta Maronis,*
> *Jugera facundi qui Ciceronis habet.*
> *Hæredem Dominumque ſui tumulique lariſque*
> *Non alium mallet nec Maro nec Cicero.*
> Epigr. 49. lib. xi.

> Of Tully's ſeat my Silius is poſſeſs'd,
> And his the tomb where Virgil's aſhes reſt.
> Could thoſe great ſhades return to chooſe their heir,
> The preſent owner they would both prefer.

In theſe retirements he applied himſelf to poetry: led not ſo much by any great force of genius, which would certainly not have ſuffered him to ſtay till life was in the wane and his imagination growing cold, as by his exceeding great love of Virgil, to whoſe memory he paid the higheſt veneration. He has imitated him in his poem; and though he falls infinitely ſhort of him, yet he has diſcovered a great and univerſal genius, which would have enabled him to ſucceed in ſome degree in whatever he undertook.

Having been for ſome time afflicted with an impoſthume, which was deemed incurable, he grew weary of life, to which, in the language of Pliny, he put an end with determined courage.

There have been many editions of Silius Italicus. A neat and correct one was publiſhed at Leipſic in 1696, in 8vo, with ſhort and uſeful notes by Cellarius: but the beſt is that *cum notis integris variorum et Arnoldi Drakenborch.* Traject. ad Rhen. 1717, in 4to.

SILK, a very ſoft, fine, bright thread, the work of an inſect called *bombyx*, or the ſilk worm.

1
Opinions of the ancients concerning the nature of ſilk.

As the ſilk worm is a native of China, the culture of ſilk in ancient times was entirely confined to that country. We are told that the empreſſes, ſurrounded by their women, ſpent their leiſure hours in hatching and rearing ſilk worms, and in weaving tiſſues and ſilk veils. That this example was ſoon imitated by perſons of all ranks, we have reaſon to conclude; for we are informed that the Chineſe, who were formerly clothed in ſkins, in a ſhort time after were dreſſed in veſtments of ſilk. Till the reign of Juſtinian, the ſilk worm was unknown beyond the territories of China, but ſilk was introduced into Perſia long before that period. After the conqueſt of the Perſian empire by Alexander the Great, this valuable commodity was brought into Greece, and thence conveyed to Rome. The firſt of the Roman writers extant by whom ſilk is mentioned, are Virgil and Horace; but it is probable that neither of them knew from what country it was obtained, nor how it was produced. By ſome of the ancients it was ſuppoſed to be a fine down adhering to the leaves of certain trees or flowers. Others imagined it to be a delicate ſpecies of wool or cotton; and even thoſe who had learned that it was the work of an inſect, ſhow by their deſcriptions that they had no diſtinct idea of the manner in which it was formed. Among the Romans, ſilk was deemed a dreſs too expenſive and too delicate for men, and was appropriated wholly to women of eminent rank and opulence. Elagabulus is ſaid to have been the firſt man among the Romans who wore a garment of fine ſilk: Aurelian complained that a pound of ſilk was ſold at Rome for 12 ounces of gold; and it is ſaid he refuſed to give his wife permiſſion to wear it on account of its exorbitant price.

2
Brought
from Chin
by the Per
ſians till t
time of Ju
tinian.

For ſeveral centuries the Perſians ſupplied the Roman empire with the ſilks of China. Caravans traverſed the whole latitude of Aſia, in 243 days, from the Chineſe ocean to the ſea-coaſt of Syria, carrying this commodity. Sometimes it was conveyed to the ports of Guzerat and Malabar, and thence tranſported by ſea to the Perſian gulf. The Perſians, with the uſual rapacity of monopoliſts, raiſed the price of ſilk to ſuch an exorbitant height, that Juſtinian, eager not only to obtain a full and certain ſupply of a commodity which was become of indiſpenſible uſe, but ſolicitous to deliver the commerce of his ſubjects from the exactions of his enemies, endeavoured, by means of his ally, the Chriſtian monarch of Abyſſinia, to wreſt ſome portion of the ſilk trade from the Perſians. In this attempt he failed; but when he leaſt expected it, he, by an unforeſeen event, attained, in ſome meaſure, the object which he had in view. Two Perſian monks having been employed as miſſionaries in ſome of the Chriſtian churches, which were eſtabliſhed (as we are informed by Coſmas) in different parts of India, had penetrated into the country of the Seres, or China. There they obſerved the labours of the ſilk worm, and became acquainted with all the arts of man in working up its productions into ſuch a variety of elegant fabrics. The proſpect of gain, or perhaps an indignant zeal, excited by ſeeing this lucrative branch of commerce engroſſed by unbelieving nations, prompted them to repair to Conſtantinople. There they explained to the emperor the origin of ſilk, as well as the various modes of preparing and manufacturing it, myſteries hitherto unknown, or very imperfectly underſtood in Europe; and encouraged by his liberal promiſes, they undertook to bring to the capital a ſufficient number of thoſe wonderful inſects, to whoſe labours man is ſo much indebted. This they accompliſhed, by conveying the eggs of the ſilk worm in a hollow cane. They were hatched by the heat of a dunghill, fed with the leaves of a wild mulberry tree, and they multiplied and worked in the ſame manner as in thoſe climates where they firſt became objects of human attention and care. Vaſt numbers of theſe inſects were ſoon reared in different parts of Greece, particularly in the Peloponneſus. Sicily afterwards undertook to breed ſilk worms with equal ſucceſs, and was imitated, from time to time, in ſeveral towns of Italy. In all theſe places extenſive manufactures were eſtabliſhed and carried on with ſilk of domeſtic production. The demand for ſilk from the eaſt diminiſhed of courſe, the ſubjects of the Greek emperors were no longer obliged to have recourſe to the Perſians for a ſupply of it, and a conſiderable change took place

Robertſon Diſquiſition concerning India, p. 8

3
Silk worm
introduced
into Europ
by two
monks.

in

in the nature of the commercial intercourſe between Europe and India.

As ſilk is the production of a worm, it will be firſt neceſſary to give a deſcription of its nature and mode of manufacturing. But before we give any account of the moſt approved methods of managing ſilk worms in Europe, it will be proper to preſent a ſhort deſcription of the methods practiſed in China, the original country of the ſilk worm. Theſe are two: they either permit them to remain at liberty on mulberry trees, or keep them in rooms. As the fineſt ſilk is produced by worms confined in rooms, and as the firſt method is very ſimple, it will ſuffice to deſcribe the ſecond.

4
Method of earing ſilk vorms in hina.

To begin with the eggs, which are laid on large ſheets of paper, to which they firmly adhere. The ſheets are hung up on a beam of the room, with the eggs inward, and the windows are opened in the front to admit the wind; but no hempen ropes muſt ever come near the worms or their eggs. After ſome days the ſheets are taken down, rolled up looſely with the eggs inward, and then hung up again, during the ſummer and autumn. At the end of December, or the beginning of January, the eggs are put into cold water, with a little ſalt diſſolved in it. Two days after they take them out, hang them up again, and when dry roll them a little tighter, and encloſe each ſeparately, ſtanding on one end in an earthen veſſel. Some put them into a lye made of mulberry tree aſhes, and then lay them ſome moments in ſnow-water, or elſe hang them up three nights on a mulberry tree to receive the ſnow or rain, if not too violent. The time of hatching them is when the leaves of the mulberry trees begin to open, for they are haſtened or impeded according to the different degrees of heat or cold to which they are expoſed. When they are ready to come forth, the eggs ſwell, and become a little pointed.

The third day before they are hatched, the rolls of paper are taken out of the veſſel, ſtretched out, and hung up with their backs toward the ſun, till they receive a kindly warmth; and then being rolled up cloſe, they are ſet upright in a veſſel in a warm place. This is repeated the next day, and the eggs change to an aſh-gray. They then put two ſheets together, and rolling them cloſe tie the ends.

The third day, towards night, the ſheets are unrolled and ſtretched on a fine mat, when the eggs appear blackiſh. They then roll three ſheets together, and carry them into a pretty warm place, ſheltered from the ſouth wind. The next day the people taking out the rolls, and opening them, find them full of worms like ſmall black ants.

The apartment choſen for ſilk worms is on a dry ground, in a pure air, and free from noiſe. The rooms are ſquare, and very cloſe, for the ſake of warmth; the door faces the ſouth, and is covered with a double mat, to keep out the cold; yet there ſhould be a window on every ſide, that when it is thought neceſſary the air may have a free paſſage. In opening a window to let in a refreſhing breeze, care muſt be taken to keep out the gnats and flies. The room muſt be furniſhed with nine or ten rows of frames, about nine inches one above the other. On theſe they place ruſh hurdles, upon which the worms are fed till they are ready to ſpin; and, to preſerve a regular heat, ſtove fires are placed at the corners of the room, or elſe a warming pan is carried up and down it; but it muſt not have the leaſt flame or ſmoke. Cow-dung dried in the ſun is eſteemed the moſt proper fuel.

The worms eat equally day and night. The Chineſe give them on the firſt day forty-eight meals, that is, one every half hour; the next thirty; the third day they have ſtill leſs. As cloudy and rainy weather takes away their ſtomach, juſt before their repaſt a wiſp of very dry ſtraw, the flame of which muſt be all alike, is held over the worms to free them from the cold and moiſture that benumbs them, or elſe the blinds are taken from the windows to let in the full day-light.

Eating ſo often haſtens their growth, on which the chief profit of the ſilk worm depends. If they come to maturity in 23 or 25 days, a large ſheet of paper covered with worms, which at their firſt coming from the eggs weigh little more than a drachm, will produce 25 ounces of ſilk; but if not till 28 days, they then yield only 20 ounces; and if they are a month or 40 days in growing, they then produce but ten.

They are kept extremely clean, and are often removed; and when they are pretty well grown, the worms belonging to one hurdle are divided into three, afterwards they are placed on ſix, and ſo on to the number of 20 or more; for being full of humours, they muſt be kept at a due diſtance from each other. The critical moment for removing them is when they are of a bright yellow and ready to ſpin; they muſt be ſurrounded with mats at a ſmall diſtance, which muſt cover the top of the place to keep off the outward air; and becauſe they love to work in the dark. However, after the third day's labour, the mats are taken away from one o'clock till three, but the rays of the ſun muſt not ſhine upon them. They are at this time covered with the ſheets of paper that were uſed on the hurdles.

The cocoons are completed in ſeven days, after which the worm is metamorphoſed into a chryſalis; the cocoons are then gathered, and laid in heaps, having firſt ſet apart thoſe deſigned for propagation upon a hurdle, in a cool airy place. The next care is to kill the moths in thoſe cones which are not to be bored. The beſt way of doing it is to fill large earthen veſſels with cones in layers of ten pounds each, throwing in four ounces of ſalt with every layer, and covering it with large dry leaves like thoſe of the water-lily, and cloſely ſtopping the mouth of the veſſels. But in laying the cones into the veſſels, they ſeparate the long, white, and glittering ones, which yield a very fine ſilk, from thoſe that are thick, dark, and of the colour of the ſkin of an onion, which produce a coarſer ſilk.

5
Deſcription and hiſtory of the ſilk worm.

The ſilk worm is a ſpecies of caterpillar, which, like all others of the ſame claſs, undergoes a variety of changes, that, to perſons who are not acquainted with objects of this kind, will appear to be not a little ſurpriſing.

The Bee, N° 72.

It is produced from a yellowiſh-coloured egg, about the ſize of a ſmall pin-head, which has been laid by a kind of grayiſh-coloured moth, which the vulgar confound with the butterfly.

Theſe eggs, in the temperature of this climate, if kept beyond the reach of the fire and ſunſhine, may be preſerved during the whole of the winter and ſpring months without danger of hatching: and even in ſummer they may eaſily be prevented from hatching if they be kept in a cool place; but in warmer climates it is ſcarcely

ſcarcely poſſible to preſerve them from hatching, even for a few days, or from drying ſo much as to deſtroy them. Hence it is eaſy for a native of Britain to keep the eggs till the food on which the worm is to feed be ready for that purpoſe. When this food is in perfection, the eggs need only be expoſed to the ſun for a day or two, when they will be hatched with great facility.

When the animal is firſt protruded from the egg, it is a ſmall black worm, which is active, and naturally aſcends to the top of the heap in ſearch of food. At this ſtage of his growth the ſilk worm requires to be fed with the youngeſt and moſt tender leaves. On theſe leaves, if good, he will feed very freely for about eight days, during which period he increaſes in ſize to about a quarter of an inch in length. He is then attacked with his firſt ſickneſs, which conſiſts in a kind of lethargic ſleep for about three days continuance; during which time he refuſes to eat, and changes his ſkin, preſerving the ſame bulk. This ſleep being over, he begins to eat again, during five days, at which term he is grown to the ſize of full half an inch in length; after which follows a ſecond ſickneſs, in every reſpect like the former.

He then feeds for other five days; during which time he will have increaſed to about three quarters of an inch in length, when he is attacked with his third ſickneſs. This being over, he begins to eat again, and continues to do ſo for five days more, when he is attacked by his fourth ſickneſs, at which time he is arrived at his full growth. When he recovers this ſickneſs, he feeds once more during five days with a moſt voracious appetite; after which he diſdains his food, becomes tranſparent, a little on the yellowiſh caſt, and leaves his ſilky traces on the leaves where he paſſes. Theſe ſigns denote that he is ready to begin his cocoon, and will eat no more.

Thus it appears that the whole duration of the life of the worm, in this ſtate of its exiſtence, in our climate, is uſually about 46 days; 28 of which days he takes food, and remains in his ſick or torpid ſtate 18; but it is to be obſerved, that during warm weather the periods of ſickneſs are ſhortened, and in cold weather lengthened, above the terms here ſpecified. In very hot climates it may be ſaid to live faſter, and ſooner to attain maturity, than in thoſe that are colder. Dr Anderſon informs us, that at Madras the worm undergoes its whole evolutions in the ſpace of 22 days. It appears, however, that it feeds fully as many days in India as in Europe, the difference being entirely occaſioned by ſhortening the period of ſickneſs. The longeſt ſickneſs he had ſeen them experience there did not exceed two days; and during ſummer it only laſts a few hours.

When the worm has attained its full growth, it ſearches about for a convenient place for forming its cocoon, and mounts upon any branches or twigs that are put in its way for that purpoſe. After about two days ſpent in this manner, it ſettles in its place, and forms the cocoon, by winding the ſilk which it draws from its bowels round itſelf into an oblong roundiſh ball.

During this operation it gradually loſes the appearance of a worm; its length is much contracted, and its thickneſs augmented. By the time the web is finiſhed, it is found to be transformed into an oblong roundiſh ball, covered with a ſmooth ſhelly ſkin, and appears to be perfectly dead. In this ſtate of exiſtence it is called an *aurelia*. Many animals in this ſtate may be often ſeen ſticking on the walls of out-houſes, ſomewhat reſembling a ſmall bean.

In this ſtate it remains for ſeveral days entirely motionleſs in the heart of the cocoon, after which it burſts like an egg hatching, and from that comes forth a heavy dull-looking moth with wings; but theſe wings it never uſes for flying; it only crawls ſlowly about in the place it has been hatched. This creature forces its way through the ſilk covering which the worm had woven, goes immediately in queſt of its mate, after which the female lays her eggs; and both male and female, without taſting food in this ſtage of their exiſtence, die in a very ſhort time.

The ſilk worm, when at its full ſize, is from an inch and a quarter to an inch and a half in length, and about half an inch in circumference. He is either of a milk or pearl colour, or blackiſh; theſe laſt are eſteemed the beſt. His body is divided into ſeven rings, to each of which are joined two very ſhort feet. He has a ſmall point like a thorn exactly above the anus. The ſubſtance which forms the ſilk is in his ſtomach, which is very long, wound up, as it were, upon two ſpindles, as ſome ſay, and ſurrounded with a gum, commonly yellowiſh, ſometimes white, but ſeldom greeniſh. When the worm ſpins his cocoon, he winds off a thread from each of his ſpindles, and joins them afterwards by means of two hooks which are placed in his mouth, ſo that the cocoon is formed of a double thread. Having opened a ſilk worm, you may take out the ſpindles, which are folded up in three plaits, and, on ſtretching them out, and drawing each extremity, you may extend them to near two ells in length. If you then ſcrape the thread ſo ſtretched out with your nail, you ſcrape off the gum, which is very like bees wax, and performs the ſame office to the ſilk it covers as gold leaf does to the ingot of ſilver it ſurrounds, when drawn out by the wire drawer. This thread which is extremely ſtrong and even, is about the thickneſs of a middling pin.

6
Particular attention ought to be paid to the breed of ſilk worms.

Of ſilk worms, as of moſt other animals, there is a conſiderable variety of breeds, ſome of which are much more hardy, and poſſeſs qualities conſiderably different from others. This is a particular of much importance to be adverted to at the time of beginning to breed theſe creatures in any place; for it will make a great difference in the profit on the whole to the undertaker if he rears a good or a bad ſort (A). This is a department in reſpect to the economy of animals that has been in every

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(A) As the ſucceſs of the ſilk manufacture muſt depend on the breed of worms, it is of great conſequence to bring them from thoſe countries where they are reckoned beſt.

Mr Andrew Wright, an ingenious ſilk manufacturer of Paiſley, has given the following directions for conveying the eggs of the ſilk worm from diſtant countries by ſea: As ſoon as the moth has laid her eggs, dry them immediately, and put them into glaſs phials; ſeal them ſo cloſe that damp air or water will not penetrate into them. Put theſe phials that contain the eggs into earthen pots filled with cold water; and as often as the water becomes warm

Silk.

every caſe much leſs adverted to than it deſerves; and in particular with regard to the ſilk worm it has been almoſt entirely overlooked. A few eggs of the ſilk worm can be eaſily tranſported by poſt in a letter from any part of Europe to another, eſpecially during the winter ſeaſon. It would therefore be an eaſy matter for any patriotic ſociety, ſuch as the Society of Arts in London, to obtain a ſpecimen of the eggs from every country in which ſilk is now reared, to put theſe under the care of a perſon who could be depended upon, and who underſtood the management of them, with orders to keep each kind diſtinct from another, and advert to every particular that occurred in their management, ſo as to make a fair eſtimate of their reſpective merits. By theſe means the beſt might be ſelected, and thoſe of inferior value rejected. Forty or fifty of each ſort might be enough for the experiment; but it ought to be repeated ſeveral times before concluſions could be drawn from it that might be altogether relied upon; for it is well known that a variation of circumſtances will make a change in the reſult; and it is by no means certain that the ſame particular would affect thoſe of one breed exactly in the ſame manner as it would do thoſe of a different breed. One may be more hardy with regard to cold, another more delicate in reſpect to food, and ſo on. It is experience alone that can aſcertain the circumſtances here inquired for.

7 Th ma- na ment of k wo s m be dif ent in erent cli tes;

From the above-mentioned particulars, it is evident, that the management of ſilk worms muſt be very different in hot climates from what is required in thoſe that are colder. At Madras, it appears from Dr Anderſon's experiments that it is very difficult to prevent the eggs from hatching for a very few days, ſo that many generations of them muſt be propagated in one year. "In this hotteſt ſeaſon," ſays he, in a letter to Sir Joſeph Banks, dated July 6. 1791, "the ſhorteſt time I have been able to remark for the whole evolutions of the ſilk worm is 40 days; that is to ſay, ſix days an egg, 22 a worm, 11 a grub in the cocoon, and one a moth or butterfly." Fortunately, where the climate forces forward their production ſo rapidly, nature hath been equally provident of food for their ſubſiſtence; for in theſe regions the mulberry continues to grow and puſh out leaves throughout the whole year.

8 but ay be eaſ rear- ed tem- per cli ,

Though the ſilk worm be a native of China, there is no doubt but it might eaſily be propagated perhaps in moſt parts of the temperate zones. The eggs of this inſect, indeed, require a conſiderable degree of warmth to hatch them, but they can alſo endure a ſevere froſt. No leſs than 5400lbs of ſilk were raiſed in 1789 in the cold, ſandy territories of Pruſſia. In the province of Pekin, in China, where great quantities of ſilk are fabricated, the winter is much colder than even in Scotland. From the information of ſome Ruſſians who were ſent thither to learn the Chineſe language, we find that Reaumur's thermometer was obſerved from 10 to 15, and even 20 degrees below the freezing point. Nor is it difficult to rear the food of the ſilk worm in a temperate clime. The mulberry-tree is a hardy vegetable, which bears, without injury, the winters of Sweden, and even of Siberia. Of the ſeven ſpecies of the mulberry (ſee Morus) enumerated by Linnæus, four of theſe (viz. the white, red, black, and Tartarian), there is every reaſon to believe could be reared both in Britain and Ireland. The *white* grows in Sweden; the *red* is abundant round Quebec; the *black* delights in bleak ſituations, expoſed to wind on the ſea ſhore; and the *Tartarian* mulberry is repreſented as growing in the chilly regions of Siberia.

Be No 15

9 Whether any ſpecies of mulberry tree be ſuperior to others.

As to the ſuperior qualities of the different ſpecies, probably there is very little to be pointed out amongſt the four juſt mentioned with regard to nouriſhment, except what may be drawn from the following fact: that if the firſt three are laid down together, the ſilk worm will firſt eat the white, then the red, and next the black, in the order of the tenderneſs of the leaves. The Tartarian ſeems to hold as high a place in its eſteem as either the red or black; but all muſt yield to the white, which ſeems to be its natural food.

In Calabria the red mulberry is uſed; in Valencia the white; and in Granada, where excellent ſilk is produced, the mulberries are all black. The white ſeems to proſper very well in a moiſt ſtiff ſoil: the black agrees well with a dry, ſandy, or gravelly ſoil; and the white is moſt luxuriant in a moiſt rich loam.

10 Britain poſſeſſes ſome advantages over warmer countries for raiſing ſilk.

It may juſtly be aſſerted, that Britain poſſeſſes ſome advantages in the raiſing of raw ſilk which are not enjoyed by warmer countries. Even in the ſouth of France, Mr Arthur Young informs us, the mulberry leaves are often nipped by froſt in the bud; but this is ſcarcely ever the caſe with us. It is well known that thunder and lightning are hurtful to the ſilk worm. Now our climate can boaſt that it is almoſt wholly exempted from thoſe dreadful ſtorms of thunder and lightning which prevail ſo much in hot climates. Nature has then furniſhed us with every thing requiſite for the ſilk manufacture; it remains only for us to improve the advantages which we poſſeſs. Let mulberry trees be planted by proprietors of lands, and let a few perſons of ſkill and attention devote their time to the raiſing of ſilk worms. This is an employment that will not interfere with any manufacture already eſtabliſhed; on the contrary, it would afford a reſpectable, a lucrative, and agreeable employment to ladies, or to females in general, who have at preſent too few profeſſions to which they can apply. The ſociety inſtituted at London for the encouragement of arts, manufactures, and commerce, much to their honour, have offered premiums to thoſe who ſhall plant a certain number of mulberry trees.

11 Method of raiſing mulberry trees in the ſouth of France.

The following method of raiſing mulberry trees from ſeed is practiſed in the ſouth of France, and has been repeated with ſucceſs in the Eaſt Indies by Dr Anderſon of Madras. "Take the ripe berries of the mulberry when it is full of juice and of ſeeds. Next take a rough horſe-hair line or rope, ſuch as we dry linen on, and with a good handful of ripe mulberries run your hand along the line, bruiſing the berries and maſhing them

Letters on the Culture of Raw Silk on the Coaſt of Coromandel.

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warm renew it. Place the earthen veſſels in the coldeſt place of the ſhip, and let them remain until the end of the voyage. It muſt be obſerved, that the ſhip choſen for this purpoſe ought to be one that would arrive in Britain in the months of June or July.

them as much as poſſible as your hand runs along, ſo that the pulp and ſeeds of the berries may adhere in great abundance to the rope or hair line. Next dig a trench in the ground where you wiſh to plant them, much like what is practiſed in kitchen gardens in England for crops of various kinds. Next cut the rope or hair line into lengths according to the length of the trench you think fit to make, and plunge the line full of maſhed berries into the trench, and then cover it over well with earth, always remembering afterwards to water it well, which is eſſential to the ſucceſs. The ſeeds of the berries thus ſown will grow, and ſoon ſhoot out young ſuckers, which will bear young leaves, which are the beſt food for the ſilk worm.

"The facility and rapidity with which young leaves may by this means be produced is evident, for as many rows of trenches may thus be filled as can be wiſhed; and it can never be neceſſary to have mulberry trees higher than our raſpberries, currants, or gooſeberry buſhes. Whenever they get beyond that, they loſe their value; and if theſe trenches ſucceed, you may have a ſupply coming freſh up day after day, or any quantity you pleaſe." Thus abundance of theſe trees might be reared. But as mulberry trees are not yet found in abundance in this country, it were to be wiſhed that ſome other food could be ſubſtituted in their place: attempts have accordingly been made by thoſe who have reared ſilk worms, and it has been found poſſible to ſupport the ſilk worm upon lettuce (B). *Bee*, N°70.

12 Miſs Rhodes fed ſilk worms on lettuce for ſome time.

Miſs Henrietta Rhodes, a lady who has made ſome ſucceſsful experiments on raiſing ſilk worms in England, had found that the ſilk worm could with ſafety be kept on lettuce for ſome time. This is pretty generally known by ladies who have turned their attention to this ſubject; but ſhe found that in general they could not with ſafety be kept upon that food above three weeks. If longer fed upon that plant, the worms for the moſt part die without ſpinning a web at all. She found, however, that they did not always die, but that in ſome caſes they produced very good cocoons, even when fed entirely on lettuce. She therefore with reaſon ſuſpected that the death of the animal muſt be occaſioned by ſome extraneous circumſtance, and not from the poiſonous quality of the food itſelf; the circumſtance ſhe ſuſpected, from ſome incidental obſervations, was the coldneſs of that food; and therefore ſhe thought it was not impoſſible, but if they were kept in a very warm place, while fed on lettuce, they might attain, in all caſes, a due perfection.

13 General Mordaunt ſtill more ſucceſsful.

General Mordaunt having been informed of this conjecture, reſolved to try the experiment. He got ſome ſilk worm eggs, had them hatched in his hot-houſe, and cauſed them to be all fed upon lettuce and nothing elſe. They proſpered as well as any worms could do, few or none of them died; and they afforded as fine cocoons as if they had been fed upon mulberry leaves. As far as one experiment can go, this affords a very exhilarating proſpect in many points of view. If one kind of food has been noxious, merely on account of an improper temperature, others may be found which have been hurtful only from a ſimilar cauſe; ſo that it is not impoſſible but we may at laſt find that this delicate creature may be ſupported by a variety of kinds of food. Few, however, could be more eaſily obtained than lettuce; and this plant, when cabbaged (the coſs, or ice lettuce eſpecially), would poſſeſs one quality that the mulberry leaf never can poſſeſs, from the want of which many millions of worms die in thoſe countries where ſilk is now reared; for it is obſerved, that when the leaves are gathered wet, it is ſcarcely poſſible to preſerve the worms alive for any length of time; ſo that during a continuance of rainy weather many of them are unavoidably cut off; but a lettuce, when cabbaged, reſiſts moiſture. If gathered, even during rain, the heart of it is dry; ſo that if the outer leaves be thrown aſide at that time, the worms would be continued in perfect health. The expence, too, of cultivating and gathering lettuce, would be ſo much leſs than that of gathering mulberry leaves, as to occaſion a ſaving that would be much more than ſufficient to counterbalance the expence of heating the conſervatory, as a little reflection will ſhow.

But the great point to be now aſcertained is, whether it is a fact that worms fed on lettuce, if kept in a due temperature, will continue in good health, in general, till they ſhall have perfected their cocoon? One experiment is too little to eſtabliſh this fact with perfect certainty. It would therefore be neceſſary that more experiments ſhould be made on this ſubject.

14 Silk worm ſaid to be fed on dri mulberry leaves.

It is ſaid that Dr Lodovico Bellardi, a learned and ingenious botaniſt of Turin, has, after a number of experiments, diſcovered a new method of feeding ſilk worms, when they are hatched before the mulberry trees have produced leaves, or when it happens that the froſt deſtroys the tender branches. This new method conſiſts in giving the worms dried leaves of the mulberry-tree. One would think that this dry nouriſhment would not be much reliſhed by theſe inſects; but repeated experiments made by our author, prove that they prefer it to any other, and eat it with the greateſt avidity. The mulberry leaves muſt be gathered about the end of autumn, before the froſts commence, in dry weather, and at times when the heat is greateſt. They muſt be dried afterwards in the ſun, by ſpreading them upon large cloths, and laid up in a dry place after they have been reduced to powder. When it is neceſſary to give this powder to the worms, it ſhould be gently moiſtened with a little water, and a thin coat of it muſt be placed around the young worms, which will immediately begin to feed upon it.

15 Proper experiments ought to b made on various vegetables.

We have mentioned all the different kinds of food, which, as far as we have heard, have been tried with any ſucceſs to nouriſh the ſilk worm; not, however, with great confidence, but as experiments which it might be worth while carefully to conſider and perform. We muſt not omit to mention that one perſon, who has had much

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(B) It is not improbable, ſays Dr Anderſon, to whoſe valuable work entitled the *Bee*, we have been much indebted in drawing up this article, that other kinds of food may be found which will anſwer the ſame purpoſe. The cichorium intybus and common endive might be tried, as they have the ſame lacteſcent quality with the lettuce.

much experience in the managing of ſilk worms, aſſures us, that the ſilk produced from any other food than mulberry leaves is of an inferior quality, and that the worms are ſickly. We think, however, that there is reaſon to ſuſpect that the experiment has not been ſkilfully performed; and therefore, before every other food except mulberry leaves is diſcarded, the experiment ought to be performed with more attention and care. We know that many animals in a domeſtic ſtate can live upon food very different from that which ſupported them when running wild in the fields. Certain it is, however, that every animal, in its ſtate of nature, partakes of a food peculiar to itſelf, which is rejected by other animals as if it were of a poiſonous quality; and it may be mentioned as a curious fact, as well as an admirable inſtance of the care of that Being who feeds the fowls of heaven, that notwithſtanding the numberleſs inſects that prey upon animals and vegetables, the mulberry tree is left untouched by them all, as the excluſive property of the ſilk worm, the chief of the inſect tribe, which toils and ſpins for the uſe of man.

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cts.

Having now conſidered the food proper for the ſilk worm, we ſhall next conſider what ſituation is moſt favourable to them. In the opinion of ſome perſons in this country who have been in the practice of rearing ſilk worms, they ought always to be kept in a dry place, well ſheltered, and poſſeſſing a conſiderable degree of warmth, and which is not expoſed to ſudden tranſitions from heat to cold. If the weather be too cold, a ſmall fire muſt be made: this is of moſt importance when the worms are ready for ſpinning. A ſouthern expoſure is therefore preferable. Some think light is of great utility to ſilk worms, others think that they thrive better in the dark. As to what apartments are beſt accommodated for promoting the health of ſilk worms, and moſt convenient for thoſe who have the care of them, they may be various according to the extent of the manufacture or the wealth of the proprietors. Silk worms may be kept in boxes or in ſhelves. When ſhelves are to be uſed, they may be conſtructed in the following manner: The ſhelves may be of wicker, ranged at the diſtance of a foot and a half, and fixed in the middle of the room: their breadth ought to be ſuch, that any perſon can eaſily reach to the middle from either ſide. This is perhaps the ſimpleſt and cheapeſt apparatus for rearing ſilk worms; but there is another apparatus which may be recommended to thoſe who are anxious to unite ſome degree of elegance with convenience. This apparatus is the invention of the Rev. George Swayne of Puckle-church, a gentleman who has ſtudied this ſubject much, in order to find out the way for promoting the culture of ſilk among the poor. This apparatus, with the deſcription of it, may be found in the Tranſactions of the Society for encouraging Arts, Manufactures, and Commerce, vol. vii. p. 148. The apparatus conſiſts of a wooden frame four feet two inches high, each ſide 16 inches and a half wide, divided into eight partitions by ſmall pieces of wood which form grooves, into which the ſlides run, and are thus eaſily thruſt into or drawn out of the frame. The upper ſlide in the model ſent to the ſociety by Mr Swayne is of paper only, and deſigned to receive the worms as ſoon as hatched; the two next are of catgut, the threads about one-tenth of an inch diſtant from each other: theſe are for the inſects when a little advanced in ſize: the five lower ones are of wicker work; but, as Mr Swayne afterwards found, netting may be ſubſtituted with advantage inſtead of wicker bottoms. Under each of theſe, as well as under thoſe of catgut, are ſliders made of paper, to prevent the dung of the worms from falling on thoſe feeding below them.

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13
Proper time for hatching ſilk worms.

The management of ſilk worms is next to be attended to. The proper time for hatching them is when the leaves of the mulberry are full grown, or nearly ſo; that as ſoon as theſe inſects are capable of receiving food they may obtain it in abundance. To attempt to hatch them ſooner would be hurtful, as the weather would not be ſufficiently warm. Beſides, as leaves are neceſſary to the life of a vegetable, if the young leaves of the mulberry tree are cropped as ſoon as they are unfolded, the tree will be ſo much weakened as to be incapable of producing ſo many leaves as it would otherwiſe have done; and if this practice be frequently repeated, will inevitably be deſtroyed.

19
How they ought to be hatched and fed.

When the proper ſeaſon is arrived, the eggs may be hatched either by the heat of the ſun, when it happens to be ſtrong enough, or by placing them in a ſmall room moderately heated by a ſtove or fire; and after being expoſed for ſix or ſeven days to a gentle heat, the ſilk worm iſſues from the egg in the form of a ſmall black hairy caterpillar. When Mr Swayne's apparatus is uſed, the worms are to be kept on the drawers with paper bottoms till they are grown ſo large as not readily to creep through the gauze-bottomed drawers: they are then to be placed on thoſe drawers, where they are to remain till their excrements are ſo large as not readily to fall through; when this is the caſe, they muſt be removed to the drawers with the wicker or netting bottoms, and fed thereon, till they ſhow ſymptoms of being about to ſpin. It is ſcarcely neceſſary to mention, that the paper ſlides beneath the gauze and wicker drawers are intended to receive the dung, which ſhould be emptied as often as the worms are fed, at leaſt once a-day; or to direct, that when the worms are fed, the ſlides are to be firſt drawn out a conſiderable way, and the drawers to reſt upon them.

20
Wet or damp food produces contagious diſeaſes.

It has been already mentioned, that wet or damp food is exceedingly prejudicial to thoſe inſects. It produces contagious and fatal diſeaſes. To prevent the neceſſity of giving them wet or damp food, attention ought to be paid to the weather, ſo that when there is an immediate proſpect of rain, a ſufficient quantity of leaves may be gathered to ſerve the worms two or three days. In this country, the leaves of the black or red mulberry tree may be preſerved good for food, although kept four or five days, by the following method: When new gathered, lay them looſely in glazed earthen veſſels, place theſe in a cold place, well aired, not expoſed to drought.

21
Ought to be kept as clean as poſſible.

The utmoſt attention muſt be paid to preſerve the place where ſilk worms are kept as clean as poſſible: the houſe or room muſt be well ventilated, that no noxious vapours be accumulated. By ſome experiments of M. Faujas de St Fond, which are recorded in his hiſtory of Languedoc, it appears that the ſilk worm is much injured by foul air. All decayed leaves muſt be removed from them, as it is now well known that they emit bad air in great abundance.

One of the moſt difficult branches of the management of ſilk worms has hitherto been the cleaning without bruiſing

Bee, N°95.

22 How they may be cleaned without bruiſing them.

bruiſing them. To avoid this inconvenience, the peaſants in France and Italy frequently allow the whole litter to remain without ever cleaning them, which is the cauſe of that unwholeſome ſtench that has been ſo often remarked by thoſe who viſit the places for rearing ſilk worms in theſe countries. This difficulty may be effectually removed by providing a net, or, what would be ſtill better, a wire-bottomed frame, wrought into large meſhes like a riddle. Have that made of a ſize exactly ſufficient to cover the wooden box in which the worms are kept. When you mean to ſhift them, ſpread freſh leaves into the wire baſket; and let it down gently over the worms till it comes within their reach. They no ſooner perceive the freſh food than they abandon the rubbiſh below, and creep through the meſhes, ſo as to fix themſelves upon the leaves; then by gently raiſing the freſh baſket, and drawing out the board below (which ought to be made to ſlip out like the ſlip-bottom of a bird's cage), you get off all the excrements and decayed leaves, without incommoding the worms in the ſmalleſt degree; and along with the litter you will draw off an inch or two in depth of the fouleſt mephitic vapours. To get entirely rid of theſe, the board, when thus taken out, ſhould be carried without doors, and there cleaned; and the ſlip-board immediately replaced to receive all the excrements and offals. After it is replaced, the wire frame that had been elevated a little, may be allowed to deſcend to a convenient diſtance above the board without touching it. Thus will there be left a vacant ſpace for the mephitic air to fall below the worms, ſo as to allow them to inhabit a wholeſome region of the atmoſphere.

When a freſh ſupply of food is to be given before cleaning, the wire frame ought to be let down as cloſe to the board as can be ſafely done, and another wire-bottomed frame put over it, with freſh leaves, as before deſcribed. When the worms have abandoned that in their turn, let the ſlip-board, together with the lower wire frame, be drawn out and removed, and ſo on as often as neceſſary. To admit of this alternate change, every table, conſiſting of one ſlip-board, ought to have two ſets of wire-bottomed frames of the ſame ſize; the ſlip-board to be always put into its place immediately after it is cleaned, and the wire frames reſerved to be afterwards placed over the other. By this mode of management, it is probable that the worms would be ſaved from the diſeaſes engendered by the mephitic air, and the numerous deaths that are the conſequence of it avoided.

23 Quicklim would ab- ſorb all th bad air which ſur rounds them.

Dr Anderſon, to whom we have already acknowledged our obligations, and to whom this country has been much indebted for valuable works on agriculture, the fiſheries, &c. adviſes thoſe who have the management of ſilk worms to ſtrew a thin ſtratum of freſh ſlaked quicklime upon the ſlip-board each time it is cleaned immediately before it is put into its place. This would abſorb the mephitic gas, for as ſoon as it is generated it would deſcend upon the ſurface of the quicklime. Thus would the worms be kept continually in an atmoſphere of pure air (c). Were the walls of the apartments to be frequently waſhed with quicklime and water, it would tend much to promote cleanlineſs at a ſmall expence, and augment the healthineſs of the worms as well as that of the perſons who attend them.

24 Mr Swayne' receptac for the worms, when go- ing to ſpi *Tranſac- tions of t Society f. the Enco ragemen of Arts,* v vii. p. 1

When the ſilk worm refuſes its food, and leaves ſilky traces on the leaves over which it paſſes, it is a proof that it is ready to begin its cocoon. It is now neceſſary to form a new receptacle, which is commonly done by pinning together papers in the ſhape of inverted cones with broad baſes. "This method (ſays Mr Swayne), where there are many worms, is exceedingly tedious, waſtes much paper, and uſes a large number of pins; beſides, as the ſilk worm always weaves an outer covering or defenſive web before it begins the cocoon or oval ball, I apprehended that it cauſed a needleſs waſte of ſilk in forming the broad web at the top. The method I make uſe of is, to roll a ſmall piece of paper (an uncut octavo leaf, ſuch as that of an old magazine, is ſufficient for three), round my fore-finger, and to give it a twiſt at the bottom; which is done with the utmoſt expedition, and gives no occaſion for the uſe of pins. Theſe rolled paper-caſes being likewiſe of a form more nearly reſembling that of a cocoon, with a much narrower opening on the top than the others, takes away the neceſſity of waſting much ſilk in the outer web, and conſequently leaves more to be employed in forming the ball. The ſilk is readily taken out of theſe caſes by untwiſting the bottom; and if this be done with moderate care, and the papers are preſerved, they will ſerve ſeveral times for the like purpoſe."

25 Others r commend buſhes of heath.

Others adviſe, that when the ſilk worms are preparing to ſpin, little buſhes of heath, broom, or twigs, ſhould be

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(c) To put this queſtion beyond a doubt, Mr Blancard made the following comparative experiments, which were ſeveral times repeated. "I procured (ſays he) four glaſs jars nine inches high and five in diameter, cloſing the mouth with cork ſtoppers. After which I placed in each of them, in their ſecond life (ſo *mue* may be tranſlated, which means the ſtage between the different ſickneſſes), twelve ſilk worms, which were fed four times a-day; and in which I confined in this kind of priſon all their life, without taking away either their dead companions or their ordure or litter. I ſprinkled with chalk the worms of only two of theſe jars, and kept the two others to compare with them.

"In thoſe without lime, I never obtained either more or leſs than three ſmall and imperfect cocoons (*chiques ou bouffard*), and in the two that were ſprinkled with lime, I had very often twelve, and never leſs than nine fine full-ſized firm cocoons."

This experiment affords the moſt ſatisfactory proof of the utility of this proceſs. From a number of trials he found, that even when the worms were covered with a large proportion of lime, they never were in any way incommoded by it.

be ſtuck upright near the ſhelf or box in which they are incloſed: the worms mount theſe, and attach their web to them.

26
How ſilk worms may be revived when affected by thunder.

Tranſactions of the American Philoſophical Society, vol. ii.

When the worms are ready to mount, in order to ſpin, if the weather be hot, attended with thunder, you will ſee them in a languiſhing condition; your care muſt then be to revive them, which is effected thus: Take a few eggs and onions, and fry them in a pan with ſome ſtale hog's lard, the ranker the better, and make pancake; which done, carry it ſmoaking hot into the room where they are kept, and go round the chamber with it. You will be ſurpriſed to ſee how the ſmell revives them, excites thoſe to eat who have not done feeding, and makes the others that are ready to ſpin climb up the twigs.

27
Different kinds of cocoons.

In about ten or twelve days, according to the accounts which we have received from Mr Andrew Wright of Paiſley, it may be ſafely concluded, that if the worms have finiſhed their work, the cocoons may be collected.

We ſhall now diſtinguiſh the cocoons from one another according to their value or their uſe, and conſider the method of managing each. They may be diſtinguiſhed into the good and bad. The good cocoons may be known by theſe marks: they are little, ſtrong, and firm; have a fine grain, both ends are round, and they are free from ſpots. Among the good cocoons alſo may be arranged thoſe which are called *calcined* cocoons, in which the worm, in conſequence of ſickneſs, is petrified or reduced to a fine powder. Theſe cocoons produce more ſilk than others, and are ſold in Piedmont at half as much again. They may be diſtinguiſhed by the noiſe which the worm makes when the cocoon is ſhaken. Of the bad cocoons there are ſix ſpecies: 1. The *pointed cocoons*, one extremity of which ends in a point; the ſilk which covers the point is weak, and ſoon breaks or tears. 2. The *cocalons*, which are bigger, but the contexture is weak. 3. The *dupions*, or double cocoons, which have been formed by the joint labour of two and ſometimes of three worms. 4. The *ſoufflons*, which have a looſe contexture, ſometimes ſo looſe that they are tranſparent. 5. The *perforated cocoons*, which have a hole at one end. 6. The *bad choquette*, which is compoſed of defective cocoons, ſpotted or rotten. Beſides theſe there is the *good choquette*, which does not properly belong to either of theſe two claſſes: it is formed of thoſe cocoons in which the worm dies before the ſilk is brought to perfection. The worms adhere to one ſide of the cocoon, and therefore when the cocoon is ſhaken will not rattle: the ſilk is as fine, but is not of ſo bright a colour, nor is ſo ſtrong and nervous, as that which is obtained from good cocoons.

28
Mr Wright's inſtructions for ſelecting and preſerving the royal cocoons.

The cocoons which are kept for breeding are called *royal* cocoons. For ſelecting and preſerving theſe, we have been favoured with ſome valuable inſtructions by Mr Wright of Paiſley, which we ſhall preſent to our readers.—The largeſt and beſt cocoons ought to be kept for breed, about an equal number of males and females; the cocoons that contain the former are ſharper pointed at the ends than thoſe that contain the latter. Although it ſhould happen that there are more females than males, little inconvenience or ill conſequences can ariſe from it, as one male will ſerve two or three females, if the time of their coming out of the cocoons anſwer. About 12 or 15 days after they begin to ſpin, the cocoons for breed may be laid on ſheets of white paper; about this time the moth opens for itſelf a paſſage through the end of its cocoon, and iſſues out. When the female has laid her eggs, which on an average may amount to 250, they are ſpread upon ſheets of paper and hung up to dry in ſome place where they may not be expoſed to the heat of the ſun: after being dried they muſt be kept in a cool well-aired place, where neither vapours nor moiſture can reach them. That they may be preſerved from external accidents, as inſects of different kinds will deſtroy them, and mice is their enemy in all the ſtages of their exiſtence, they ſhould be kept in ſtone pots or glaſs bottles with their mouths ſtopped, and there remain until brought out next ſeaſon to be hatched.

29
How to prepare the cocoons for being wound.

The cocoons from which the ſilk is to be immediately wound muſt be expoſed to the heat of an oven, in order to kill the chryſalis or aurelia, which would otherwiſe eat its way through the cocoon, and render it uſeleſs. The following directions are given for managing this proceſs by one of the firſt ſilk manufacturers in Italy.

Tranſactions of the American Philoſophical Society, vol. ii.

Put your cocoons in long ſhallow baſkets, and fill them within an inch of the top. You then cover them up with paper, and put a wrapper over that. Theſe baſkets are to be diſpoſed in an oven, whoſe heat is as near as can be that of an oven from which the bread is juſt drawn after being baked. When your cocoons have remained therein near an hour, you muſt draw them out; and to ſee whether all the worms are dead, draw out a dupion from the middle of your baſket and open it: if the worm be dead, you may conclude all the reſt are ſo; becauſe the contexture of the dupion being ſtronger than that of the other cocoons, it is conſequently leſs eaſy to be penetrated by the heat. You muſt obſerve to take it from the middle of the baſket, becauſe in that part the heat is leaſt perceptible. After you have drawn your baſkets from the oven, you muſt firſt cover each of them with a woollen blanket or rug, leaving the wrapper beſides, and then you pile them above one another. If your baking has ſucceeded, your woollen cover will be all over wet with a kind of dew, the thickneſs of your little finger. If there be leſs, it is a ſign your cocoons have been too much or too little baked. If too much baked, the worm, being over-dried, cannot tranſpire a humour he no longer contains, and your cocoon is then burnt. If not enough baked, the worm has not been ſufficiently penetrated by the heat to diſtil the liquor he contains, and in that caſe is not dead.

You muſt let your baſkets ſtand thus covered five or ſix hours if poſſible, in order to keep in the heat, as this makes an end of ſtifling thoſe worms which might have avoided the firſt impreſſion of the fire. You are likewiſe to take great care to let your cocoons ſtand in the oven the time that is neceſſary; for if they do not ſtand long enough, your worms are only ſtunned for a time and will afterwards be revived. If, on the other hand, you leave them too long in the oven, you burn them: many inſtances of theſe two caſes are frequently to be met with. It is a good ſign when you ſee ſome of the butterflies ſpring out from the cocoons which have been baked, becauſe you may be certain they are not burnt. For if you would kill them all to the laſt worm, you would burn many cocoons which might be more expoſed to the heat than that particular worm.

The next operation is the winding of the ſilk. Before you begin to wind, you muſt prepare your cocoons as follows :

30 How the ſilk is to be wound from the cocoons.

1. In ſtripping them of that waſte ſilk that ſurrounds them, and which ſerved to faſten them to the twigs. This burr is proper to ſtuff quilts, or other ſuch uſes ; you may likewiſe ſpin it to make ſtockings, but they will be coarſe and ordinary.

2. You muſt ſort your cocoons, ſeparating them into different claſſes in order to wind them apart. Theſe claſſes are, the good white cocoons ; the good cocoons of all the other colours ; the dupions ; the cocalons, among which are included the weak cocoons ; the good choquette ; and, laſtly, the bad choquette. In ſorting the cocoons, you will always find ſome perforated cocoons amongſt them, whoſe worm is already born ; thoſe you muſt ſet apart for fleuret. You will likewiſe find ſome ſoufflons, but very few ; for which reaſon you may put them among the bad choquette, and they run up into waſte.

The good cocoons, as well white as yellow, are the eaſieſt to wind ; thoſe which require the greateſt care and pains are the cocalons ; you muſt wind them in cooler water than the others, and if you take care to give them to a good windſter, you will have as good ſilk from them as the reſt. You muſt likewiſe have careful windſters for the dupions and choquettes. Theſe two ſpecies require hotter water than the common cocoons.

The good cocoons are to be wound in the following manner : Firſt, chooſe an open convenient place for your filature, the longer the better, if you intend to have many furnaces and coppers. The building ſhould be high and open on one ſide, and walled on the other, as well to ſcreen you from the cold winds and receive the ſun, as to give a free paſſage to the ſteam of your baſons or coppers.

Theſe coppers or baſons are to be diſpoſed (when the building will admit of it) in a row on each ſide of the filature, as being the moſt convenient method of placing them, for by that means in walking up and down you ſee what every one is about. And theſe baſons ſhould be two and two together, with a chimney between every couple.

Having prepared your reels (which are turned by hands, and require a quick eye), and your fire being a light one under every baſon, your windſter muſt ſtay till the water is as hot as it can be without boiling. When every thing is ready, you throw into your baſons two or three handfuls of cocoons, which you gently bruſh over with a wiſk about ſix inches long, cut ſtumpy like a broom worn out : by theſe means the threads of the cocoons ſtick to the wiſk. You muſt diſengage theſe threads from the wiſk, and purge them by drawing theſe ends with your fingers till they come off entirely clean. This operation is called *la Battue*.

When the threads are quite clear, you muſt paſs four of them (if you will wind fine ſilk) through each of the holes in a thin iron bar that is placed horizontally at the edge of your baſon ; afterwards you twiſt the two ends (which conſiſt of four cocoons each) twenty or twenty-five times, that the four ends in each thread may the better join together in croſſing each other, and that your ſilk may be plump, which otherwiſe would be flat.

Your windſter muſt always have a bowl of cold water by her, to dip her fingers in, and to ſprinkle very often the ſaid bar, that the heat may not burn the thread.

Your threads, when thus twiſted, go upon two iron hooks called rampins, which are placed higher, and from thence they go upon the reel. At one end of the axis of the reel is a cog-wheel, which catching in the teeth of the poſt-rampin, moves it from the right to the left, and conſequently the thread that is upon it ; ſo that your ſilk is wound on the reel croſsways, and your threads form two hanks of about four fingers broad.

As often as the cocoons you wind are done, or break or diminiſh only, you muſt join freſh ones to keep up the number requiſite, or the proportion ; becauſe, as the cocoons wind off, the thread being finer, you muſt join two cocoons half wound to replace a new one : Thus you may wind three new ones and two half wound, and your ſilk is from four to five cocoons.

When you would join a freſh thread, you muſt lay one end on your finger, which you throw lightly on the other threads that are winding, and it joins them immediately, and continues to go up with the reſt. You muſt not wind off your cocoons too bare or to the laſt, becauſe when they are near at an end, the *bairré*, that is, the huſk, joins in with the other threads, and makes the ſilk foul and gouty.

When you have finiſhed your firſt parcel, you muſt clean your baſons, taking out all the ſtriped worms, as well as the cocoons, on which there is a little ſilk, which you firſt open and take out the worm, and then throw them into a baſket by you, into which you likewiſe caſt the looſe ſilk that comes off in making the battue.

You then proceed as before with other two or three handfuls of cocoons ; you make a new battue ; you purge them, and continue to wind the ſame number of cocoons or their equivalent, and ſo to the end.

As was already mentioned, the windſter muſt always have a bowl of cold water by her, to ſprinkle the bar, to cool her fingers every time ſhe dips them in the hot water, and to pour into her baſon when neceſſary, that is, when her water begins to boil. You muſt be very careful to twiſt your threads a ſufficient number of times, about 25, otherwiſe your ſilk remains flat, inſtead of being round and full ; beſides, when the ſilk is not well croſſed, it never can be clean, becauſe a gout or nub that comes from a cocoon will paſs through a ſmall number of theſe twiſts, though a greater will ſtop it. Your thread then breaks, and you paſs what foulneſs there may be in the middle of your reel between the two hanks, which ſerves for a head-band to tie them.

You muſt obſerve that your water be juſt in a proper degree of heat. When it is too hot, the thread is dead, and has no body ; when it is too cold, the ends which form the thread do not join well, and form a harſh ill-qualified ſilk.

You muſt change the water in your baſon four times a day for your dupions and choquette, and twice only for good cocoons when you wind fine ſilk ; but if you wind coarſe ſilk, it is neceſſary to change it three or four times. For if you were not to change the water, the ſilk would not be ſo bright and gloſſy, becauſe the worm

contained

contained in the cocoons foul it very conſiderably. You muſt endeavour to wind as much as poſſible with clear water, for if there are too many worms in it, your ſilk is covered with a kind of duſt which attracts the moth, and deſtroys your ſilk.

You may wind your ſilk of what ſize you pleaſe, from one cocoon to 1000; but it is difficult to wind more than 30 in a thread. The nicety, and that in which conſiſts the greateſt difficulty, is to wind even; becauſe as the cocoon winds off the end is finer, and you muſt then join other cocoons to keep up the ſame ſize. This difficulty of keeping the ſilk always even is ſo great, that (excepting a thread of two cocoons, which we call ſuch) we do not ſay a ſilk of three, of four, or ſix cocoons; but a ſilk of three to four; of four to five, of ſix to ſeven cocoons. If you proceed to a coarſer ſilk, you cannot calculate ſo nicely as to one cocoon more or leſs. We ſay, for example, from 12 to 15, from 15 to 20, and ſo on.

31
What num-
er of
vorms pro-
uce a cer-
ain quan-
ity of ſilk.

What number of worms are neceſſary to produce a certain quantity of ſilk has not been aſcertained. And as different perſons who wiſhed to determine this point have had different reſults, the truth ſeems to be, that from various circumſtances the ſame number of worms may produce more ſilk at one time than at another. It is related in the ſecond volume of the Tranſactions of the Society for encouraging Arts, &c. that Mrs Williams obtained nearly an ounce and a half of ſilk from 244 cocoons. Mr Swayne from 50 cocoons procured 100 grains. Miſs Rhodes obtained from 250 of the largeſt cocoons, three quarters of an ounce and a dram. From a paper in the ſecond volume of the American Tranſactions, which we have before referred to in the courſe of this article, we are informed that 150 ounces of good cocoons yield about 11 ounces of ſilk from five to ſix cocoons: if you wind coarſer, ſomething more. But what appears aſtoniſhing, Mr Salvatore Bertezen, an Italian, to whom the Society for encouraging Arts, &c. adjudged their gold medal, raiſed five pounds of excellent ſilk from 12,000 worms.

32
ength of
e threads.

The cocoons produce a thread of very unequal length; you may meet with ſome that yield 1200 ells, whilſt others will ſcarcely afford 200 ells. In general, you may calculate the production of a cocoon from 500 to 600 ells in length.

SILK-Loom. See WEAVING.

SILK-Worm. See SILK.

SILLA, a large town on the Niger, by which the travels of Mr Park were bounded towards the eaſt. He gives no particular deſcription of the place, which his health and ſpirits permitted him not to ſurvey, but aſſigns the reaſons by which he was induced to proceed no farther. On his arrival, he was allowed to remain under a tree, till it was quite dark, ſurrounded by hundreds of people. But their language was extremely different from the other parts of Bambarra; and he was given to underſtand, that in his progreſs eaſtward, the Bambarra tongue was very little underſtood; and that, on his reaching Jenné, he would find the greater part of the inhabitants accuſtomed to ſpeak a different language. He had now become the prey of ſickneſs, exhauſted with hunger and fatigue, half naked, and without any article of value, to procure for himſelf proviſions, clothes, or lodging, on which account he reſolved to return, finding that to preſecute his journey further in that direction was wholly impracticable. Silla, according to the lateſt map of Africa, is in 14° 48′ N. Lat. and 1° 24′ W. Long.

SILPHA, CARRION-BEETLE, a genus of inſects belonging to the order *coleopteræ*. See ENTOMOLOGY *Index*.

SILPHIUM, a genus of plants belonging to the claſs of ſyngeneſia, and to the order of polygamia neceſſaria; and in the natural ſyſtem arranged under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SILVER, a well known metallic ſubſtance. For an account of its properties, ſee CHEMISTRY *Index*.

SILVER, Ores of. See MINERALOGY *Index*.

Shell-SILVER, is prepared of the ſhreds of ſilver leaf, or of the leaves themſelves, for the uſe of painters, after the ſame manner as ſhell-gold. See *Shell-GOLD*.

SILVERING, the covering of any thing with ſilver. It is uſual to ſilver metals, wood, paper, &c. which is performed either with fire, oil, or ſize. Metal-gilders ſilver by the fire; painter gilders all the other ways. See GILDING.

To ſilver copper or braſs. 1. Cleanſe the metal with aquafortis, by waſhing it lightly, and immediately throwing it into pure water; or by heating it red hot, and ſcouring it with ſalt and tartar, and pure water, with a ſmall wire bruſh. 2. Diſſolve ſome ſilver in aquafortis, in a broad-bottomed glaſs veſſel, or of glazed earth; then evaporate away the aquafortis over a chaffing diſh of coals. 3. Put five or ſix times its quantity of water, or as much as will be neceſſary to diſſolve it perfectly, on the remaining dry calx; evaporate this water with the like heat; then put more freſh water, and evaporate again; and, if need be, the third time, making the fire towards the latter end ſo ſtrong as to leave the calx perfectly dry, which, if your ſilver is good, will be of a pure white. 4. Take of this calx, common ſalt, cryſtals of tartar, of each a like quantity or bulk, and mixing well the whole compoſition, put the metal into pure water, and take of the ſaid powder with your wet fingers, and rub it well on, till you find every little cavity of the metal ſufficiently ſilvered over. 5. If you would have it richly done, you muſt rub on more of the powder; and, in the laſt place, waſh the ſilvered metal in pure water, and rub it hard with a dry cloth.

SILVERING of Glaſſes. See *FOLIATING of Looking-glaſſes.*

SILURIS, a genus of fiſhes belonging to the order abdominales. See ICHTHYOLOGY *Index*.

SIMANCAS, a village on the eaſtern boundary of the kingdom of Leon in Spain, ſix miles below Valladolid, on the river Giſnerga. Dr Robertſon, in the introduction to his Hiſtory of America, makes mention of it, and it is remarkable for the archives of the kingdoms of Leon and Caſtile, kept in the caſtle. This collection was begun when the kings often reſided at Valladolid, in which city is ſtill the civil and military tribunal for almoſt the whole of Spain to the north of the Tagus. It was thought proper to have thoſe papers kept in the vicinity of that court, for which purpoſe this caſtle was peculiarly fitted, being entirely erected of ſtone. At one period there were two large halls in this office filled with papers reſpecting the firſt ſettlement of the Spaniards in South America. There was likewiſe in the room called the *ancient royal patronage*, a box containing treaties with England, in which are many letters and treaties between the kings of England and Spain, from the year 1400 to 1600. There was alſo a ſtrong box in the ſame archives, with five locks, which, we are told, has not been opened ſince the time of Philip II. and it is ſuppoſed that it contains the proceſs againſt Philip's ſon Prince Charles. But it appears that ſome of the ſtate papers have been removed to Madrid.

SIMEON *of Durham*, the cotemporary of William of Malmſbury, took great pains in collecting the monuments of our hiſtory, eſpecially in the north of England, after they had been ſcattered by the Danes. From theſe he compoſed a hiſtory of the kings of England, from A. D. 616 to 1130; with ſome ſmaller hiſtorical pieces. Simeon both ſtudied and taught the ſciences, and particularly the mathematics at Oxford; and became precentor of the church at Durham, where he died, probably ſoon after the concluſion of his hiſtory, which was continued by John, prior of Hexham, to A. D. 1156.

SIMIA, the Monkey, a genus of quadrupeds belonging to the claſs of mammalia, and order of primates, in the Linnæan ſyſtem, but by Mr Pennant arranged under the digitated quadrupeds. See Mammalia *Index*.

SIMILE, or Similitude, in *Rhetoric*, a compariſon of two things, which though different in other reſpects, yet agree in ſome one. The difference between a ſimile and compariſon is ſaid to conſiſt in this, that the ſimile properly belongs to whatever we call the quality of a thing, and the compariſon to the quantity. See Comparison; and Oratory, N° 118.

SIMILOR, a name given to an alloy of red copper and zinc, made in the beſt proportions, to imitate ſilver and gold.

SIMON Maccabeus, a celebrated leader and high-prieſt of the Jews, who, after rendering the moſt important ſervices to his country, was at laſt treacherouſly ſlain by his ſon-in-law. See *the Hiſtory of the* Jews, N° 15.

Enfield's Hiſtory of Philoſophy, vol. ii. p. 161.

SIMON Magus, or the Sorcerer, was a native of Gitton, a village of Samaria. According to the uſual practice of the Aſiatics of that age, he viſited Egypt, and there probably became acquainted with the ſublime myſteries taught in the Alexandrian ſchool, and learned thoſe theurgic or magical operations, by means of which it was believed that men might be delivered from the power of evil demons. Upon his return into his own country, the author of the Clementine Recognitions relates, that he impoſed upon his countrymen by high pretenſions to ſupernatural powers. And St Luke atteſts, that this artful fanatic, uſing ſorcery, had bewitched the people of Samaria, giving out that he was *ſome great one*; and that he obtained ſuch general attention and reverence in Samaria, that the people all gave heed to him from the leaſt to the greateſt, ſaying "This man is the great power of God."

By the preaching of Philip the Deacon, he was with other Samaritans converted to the Chriſtian faith, and admitted into the infant church by the ordinance of baptiſm. His converſion, however, ſeems not to have been real; for, upon ſeeing the miraculous effects of the laying on of the apoſtle's hands, he offered them money, ſaying, "Give me alſo this power, that on whomſoever I lay hands he may receive the Holy Ghoſt." He probably thought Peter and John magicians like himſelf, but better ſkilled in the art of deceiving the multitude.

Being ſharply reproved for this impiety, he ſeems by his anſwer to have been made ſenſible of his ſin; but his repentance, if ſincere, was of ſhort duration. Returning to his former practices of impoſture, he travelled through various provinces of the empire, oppoſing the progreſs of the goſpel; and arriving at Rome, he led aſtray vaſt numbers of people by his pretended miracles. How long he lived in that metropolis of the world, or in what manner he died, we have no accounts that can be fully depended on. The Chriſtian writers tell us, that being raiſed in the air by two dæmons, he was deprived of their ſupport by the prayers of St Peter and St Paul, and falling, broke his legs. By ſome he is thought to have been the perſon mentioned by Suetonius, who, undertaking to fly in the preſence of Nero, fell to the ground with ſuch violence, that his blood ſpurted up to the gallery where the emperor was ſitting.

The ſum of this impoſtor's doctrine, diveſted of allegory, was, that from the Divine Being, as a fountain of light, flow various orders of æons, or eternal natures, ſubſiſting within the plenitude of the divine eſſence; that beyond theſe, in the order of emanation, are different claſſes of intelligences, among the loweſt of which are human ſouls; that matter is the moſt remote production of the emanative power, which, on account of its infinite diſtance from the Fountain of Light, poſſeſſes ſluggiſh and malignant qualities, which oppoſe the divine operations, and are the cauſe of evil; that it is the great deſign of philoſophy to deliver the ſoul from its impriſonment in matter, and reſtore it to that divine light from which it was derived: and that for this purpoſe God had ſent him one of the firſt æons among men. To his wife Helena he alſo aſcribed a ſimilar kind of divine nature, pretending that a female æon inhabited the body of this woman, to whom he gave the name of Εννοια, *Wiſdom*; whence ſome Chriſtian fathers have ſaid, that he called her the *Holy Spirit*. He alſo taught the tranſmigration of ſouls, and denied the reſurrection of the body.

Simon, *Richard*, was born at Dieppe the 15th May 1638. He began his ſtudies among the prieſts of the Oratory in that city, but quitted their ſociety in a ſhort time. From Dieppe he went to Paris, where he made great progreſs in the ſtudy of the oriental languages. Some time afterwards he joined the ſociety of the Oratory again, and became a prieſt of it in 1660. In 1670 he publiſhed ſome pieces of a ſmaller kind. In 1678 his Critical Hiſtory of the Old Teſtament appeared, but was immediately ſuppreſſed by the intrigues of Meſſieurs du Port Royal. It was reprinted the year after, and its excellence ſoon drew the attention of foreigners; an edition of it was accordingly publiſhed at Amſterdam in Latin, and at London in Engliſh.

He died at Dieppe in 1712, at the age of 74.

He certainly poſſeſſed a vaſt deal of learning: his criticiſm is exact, but not always moderate; and there reigns in his writings a ſpirit of novelty and ſingularity which raiſed him a great many adverſaries. The moſt celebrated of theſe were Le Clerc, Voſſius, Jurieu, Du Pin, and Boſſuet. Simon wrote an anſwer to moſt of the

the books that were publiſhed againſt him, and diſplays a pride and obſtinacy in his controverſial writings which do him little honour.

He was the author of a great many books. The following are the principal: 1. The Ceremonies of the Jews, tranſlated from the Italian of Leo of Modena, with a ſupplement concerning the ſects of the Carraites and Samaritans. 2. *L'Hiſtoire Critique du Vieux Teſtament*, "The Critical Hiſtory of the Old Teſtament." This is a very important work, and deſerves the attention of every clergyman. He ſometimes, however, deviates from the road of integrity, to ſerve the cauſe of the church of Rome, particularly in his endeavours to prove the uncertainty of the Hebrew language. Theſe paſſages have been very juſtly expoſed and confuted by Dr Campbell, in his ingenious Preliminary Diſſertations to his new Tranſlation of the Goſpels. 3. Critical Hiſtory of the Text of the New Teſtament. 4. Critical Hiſtory of the Verſions of the New Teſtament. 5. Critical Hiſtory of the principal Commentators on the New Teſtament. 6. Inſpiration of the Sacred Books. 7. A tranſlation of the New Teſtament. This book was cenſured by Cardinal Noailles and Boſſuet. 8. The Hiſtory of the riſe and progreſs of Eccleſiaſtical Revenues, which is commended by Voltaire, as is his Critical Hiſtory of the Old Teſtament. It reſulted from a quarrel with a community of Benedictines. 9. A new ſelect Library, which points out the good books in various kinds of literature, and the uſe to be made of them. 10. Critical Hiſtory of the Belief and Cuſtoms of the Nations on the Levant. 11. Critical Letters, &c.

SIMONICAL, is applied to any perſon guilty of ſimony. See SIMONY.

SIMONIDES, the name of ſeveral poets celebrated in antiquity; but by the Marbles it appears that the eldeſt and moſt illuſtrious of them was born in the 55th Olympiad, 538 years B. C. and that he died in his 90th year; which nearly agrees with the chronology of Euſebius. He was a native of Ceos, one of the Cyclades, in the neighbourhood of Attica, and the preceptor of Pindar. Both Plato and Cicero give him the character not only of a good poet and muſician, but ſpeak of him as a perſon of great virtue and wiſdom. Such longevity gave him an opportunity of knowing a great number of the firſt characters in antiquity with whom he was in ſome meaſure connected. It appears in Fabricius, from ancient authority, that Simonides was cotemporary and in friendſhip with Pittacus of Mitylene, Hipparchus tyrant of Athens, Pauſanias king of Sparta, Hiero tyrant of Syracuſe, with Themiſtocles, and with Alevades king of Theſſaly. He is mentioned by Herodotus; and Xenophon, in his Dialogue upon Tyranny, makes him one of the interlocutors with Hiero king of Syracuſe. Cicero alleges, what has often been quoted in proof of the modeſty and wiſdom of Simonides, that when Hiero aſked him for a definition of God, the poet required a whole day to meditate on ſo important a queſtion: at the end of which, upon the prince putting the ſame queſtion to him a ſecond time, he aſked two days reſpite; and in this manner always doubled the delay each time he was required to anſwer it; till at length, to avoid offending his patron by more diſappointments, he frankly confeſſed that he found the queſtion ſo difficult, that the more he meditated upon it, the leſs was his hope of being able to ſolve it.

In his old age, perhaps from ſeeing the reſpect which money procured to ſuch as had loſt the charms of youth and the power of attaching mankind by other means, he became ſomewhat mercenary and avaricious. He was frequently employed by the victors at the games to write panegyrics and odes in their praiſe, before his pupil Pindar had exerciſed his talents in their behalf: but Simonides would never gratify their vanity in this particular, till he had firſt tied them down to a ſtipulated ſum for his trouble; and upon being upbraided for his meanneſs, he ſaid, that he had two coffers, in one of which he had for many years put his pecuniary rewards; the other was for honours, verbal thanks, and promiſes; that the firſt was pretty well filled, but the laſt remained always empty. And he made no ſcruple to confeſs in his old age, that of all the enjoyments of life, the love of money was the only one of which time had not deprived him.

He was frequently reproached for his vice; however, he always defended himſelf with good humour. Upon being aſked by Hiero's queen, Whether it was moſt deſirable to be learned or rich? he anſwered, that it was far better to be rich; for the learned were always dependent on the rich, and waiting at their doors; whereas, he never ſaw rich men at the doors of the learned. When he was accuſed of being ſo ſordid as to ſell part of the proviſions with which his table was furniſhed by Hiero, he ſaid he had done it in order "to diſplay to the world the magnificence of that prince and his own frugality." To others he ſaid, that his reaſon for accumulating wealth was, that "he would rather leave money to his enemies after death, than be troubleſome to his friends while living."

He obtained the prize in poetry at the public games when he was fourſcore years of age. According to Suidas, he added four letters to the Greek alphabet; and Pliny aſſigns to him the eighth ſtring of the lyre; but theſe claims are diſputed by the learned.

His poetry was ſo tender and plaintive, that he acquired the cognomen of *Melicertes*, "ſweet as honey;" and the tearful eye of his muſe was proverbial. Dionyſius places him among thoſe poliſhed writers who excel in a ſmooth volubility, and flow on like plenteous and perennial rivers, in a courſe of even and uninterrupted harmony.

It is to Dionyſius that we are indebted for the preſervation of the following fragment of this poet. Danae being by her mercileſs father incloſed in a cheſt, and thrown into the ſea with her child, when night comes on, and a ſtorm ariſes which threatens to overſet the cheſt, ſhe, weeping and embracing the young Perſeus, cries out:

Sweet child! what anguiſh does thy mother know,
Ere cruel grief has taught thy tears to flow!
Amidſt the roaring wind's tremendous ſound,
Which threats deſtruction as it howls around;
In balmy ſleep thou lieſt, as at the breaſt,
Without one bitter thought to break thy reſt.——
The glimm'ring moon in pity hides her light,
And ſhrinks with horror at the ghaſtly ſight.
Didſt thou but know, ſweet innocent! our woes,
Not opiate's pow'r thy eyelids now could cloſe.

Simonides ‖ Simoom.

Sleep on, ſweet babe! ye waves in ſilence roll;
And lull, O lull, to reſt my tortur'd ſoul!

There is a ſecond great poet of the name of Simonides recorded on the Marbles, ſuppoſed to have been his grandſon, and who gained, in 478 B. C. the prize in the games at Athens.

SIMONY, is the corrupt preſentation of any one to an eccleſiaſtical benefice for money, gift, or reward. It is ſo called from the reſemblance it is ſaid to bear to the ſin of Simon Magus, though the purchaſing of holy orders ſeems to approach nearer to his offence. It was by the canon law a very grievous crime: and is ſo much the more odious, becauſe, as Sir Edward Coke obſerves, it is ever accompanied with perjury; for the preſentee is ſworn to have committed no ſimony. However, it was not an offence puniſhable in a criminal way at the common law: it being thought ſufficient to leave the clerk to eccleſiaſtical cenſures. But as theſe did not affect the ſimoniacal patron, nor were efficacious enough to repel the notorious practice of the thing, divers acts of parliament have been made to reſtrain it by means of civil forfeitures; which the modern prevailing uſage, with regard to ſpiritual preferments, calls aloud to be put in execution. The ſtatute 31 Eliz. c. 6. enacts, that if any patron, for money or any other corrupt conſideration or promiſe, directly or indirectly given, ſhall preſent, admit, inſtitute, induct, inſtall, or collate any perſon to an eccleſiaſtical benefice or dignity, both the giver and taker ſhall forfeit two years value of the benefice or dignity; one moiety to the king, and the other to any one who will ſue for the ſame. If perſons alſo corruptly reſign or exchange their benefices, both the giver and taker ſhall in like manner forfeit double the value of the money or other corrupt conſideration. And perſons who ſhall corruptly ordain or licenſe any miniſter, or procure him to be ordained or licenſed (which is the true idea of ſimony), ſhall incur a like forfeiture of forty pounds; and the miniſter himſelf of ten pounds, beſides an incapacity to hold any eccleſiaſtical preferment for ſeven years afterwards. Corrupt elections and reſignations in colleges, hoſpitals, and other eleemoſynary corporations, are alſo puniſhed, by the ſame ſtatute, with forfeiture of the double value, vacating the place or office, and a devolution of the right of election, for that turn, to the crown.

SIMOOM, a hot wind which blows occaſionally in the deſerts of Africa, and probably in other widely extended countries parched in the ſame manner by a vertical ſun. Its effects on the human body are dreadful. If inhaled in any quantity, it produces inſtant ſuffocation, or at leaſt leaves the unhappy ſufferer oppreſſed with aſthma and lowneſs of ſpirits. The approach of this awful ſcourge of God is indicated by a redneſs in the air, well underſtood by thoſe who are accuſtomed to journey through the deſert; and the only refuge which they have from it, is to fall down with their faces cloſe to the ground, and to continue as long as poſſible without drawing in their breath.

Bruce's Travels. vol. iv. p. 559.

Mr Bruce, who, in his journey through the deſert, ſuffered from the ſimoom. gives of it the following graphical deſcription: "At eleven o'clock, while we contemplated with great pleaſure the rugged top of Chiggre, to which we were faſt approaching, and where we were to ſolace ourſelves with plenty of good water,

Simoom ‖ Simplicity.

Idris our guide cried out, with a loud voice, Fall upon your faces, for here is the ſimoom. I ſaw from the ſouth-eaſt a haze come, in colour like the purple part of the rainbow, but not ſo compreſſed or thick. It did not occupy twenty yards in breadth, and was about twelve feet high from the ground. It was a kind of bluſh upon the air, and it moved very rapidly; for I ſcarce could turn to fall upon the ground with my head to the northward, when I felt the heat of its current plainly upon my face. We all lay flat on the ground as if dead, till Idris told us it was blown over. The meteor or purple haze which I ſaw was indeed paſſed, but the light air that ſtill blew was of heat to threaten ſuffocation. For my part, I found diſtinctly in my breaſt that I had imbibed a part of it, nor was I free of an aſthmatic ſenſation till I had been ſome months in Italy, at the baths of Poretta, near two years afterwards." Though the ſeverity of this blaſt ſeems to have paſſed over them almoſt inſtantaneouſly, it continued to blow ſo as to exhauſt them till twenty minutes before five in the afternoon, laſting through all its ſtages very near ſix hours, and leaving them in a ſtate of the utmoſt deſpondency.

SIMPLE, ſomething not mixed or compounded; in which ſenſe it ſtands oppoſed to *compound.*

Simple, in the *Materia Medica*, a general name for all herbs or plants, as having each its particular virtue, whereby it becomes a ſimple remedy.

SIMPLICITY in writing. If we examine the writers whoſe compoſitions have ſtood the teſt of ages, and obtained that higheſt honour, "the concurrent approbation of diſtant times and nations," we ſhall find that the character of ſimplicity is the unvarying circumſtance which alone hath been able to gain this univerſal homage from mankind. Among the Greeks, whoſe writers in general are of the ſimple kind, the divineſt poet, the moſt commanding orator, the fineſt hiſtorian, and deepeſt philoſopher, are, above the reſt, conſpicuouſly eminent in this great quality. The Roman writers riſe towards perfection according to that meaſure of ſimplicity which they mingle in their works; indeed they are all inferior to the Greek models. But who will deny that Lucretius, Horace, Virgil, Livy, Terence, Tully, are at once the ſimpleſt and beſt of Roman writers? unleſs we add the noble annaliſt who appeared in after-times; who, notwithſtanding the political turn of his genius, which ſometimes interferes, is admirable in this great quality, and by it far ſuperior to his contemporaries. It is this one circumſtance that hath raiſed the venerable Dante, the father of modern poetry, above the ſucceeding poets of his country, who could never long maintain the local and temporary honours beſtowed upon them; but have fallen under that juſt neglect which time will ever decree to thoſe who deſert a juſt ſimplicity for the florid colourings of ſtyle, contraſted phraſes, affected conceits, the mere trappings of compoſition and Gothic minutiæ. It is this which has given to Boileau the moſt laſting wreath in France, and to Shakeſpeare and Milton in England; eſpecially to the former, whoſe writings contain ſpecimens of perhaps the pureſt and ſimpleſt Engliſh that is anywhere to be found, except in the Bible or Book of Common Prayer. As it appears from theſe inſtances, that ſimplicity is the only univerſal characteriſtic of juſt writing, ſo the ſuperior eminence of the ſacred Scriptures in this quality hath been generally acknowledged. One of the greateſt critics in antiquity, himſelf conſpicuous in the ſublime and ſimple manner, hath borne this teſtimony to the writings of Moſes and St Paul; and by parity of reaſon we muſt conclude, that had he been converſant with the other ſacred writers, his taſte and candour would have allowed them the ſame encomium.

It hath been often obſerved, even by writers of no mean rank, that the "Scriptures ſuffer in their credit by the diſadvantage of a literal verſion, while other ancient writings enjoy the advantage of a free and embelliſhed tranſlation." But in reality theſe gentlemen's concern is ill placed and groundleſs: for the truth is, "that moſt other writings are impaired by a literal tranſlation; whereas giving only a due regard to the idiom of different languages, the ſacred writings, when literally tranſlated, are then in their full perfection."

Now this is an internal proof, that in all other writings there is a mixture of local, relative, exterior ornament, which is often loſt in the transfuſion from one language to another. But the internal beauties, which depend not on the particular conſtruction of tongues, no change of tongue can deſtroy. Hence the Bible preſerves its native beauty and ſtrength alike in every language, by the ſole energy of unadorned phraſe, natural images, weight of ſentiment, and great ſimplicity.

It is in this reſpect like a rich vein of gold, which, under the ſevereſt trials of heat, cold, and moiſture, retains its original weight and ſplendour, without either loſs or alloy; while baſer metals are corrupted by earth, air, water, fire, and aſſimilated to the various elements through which they paſs.

This circumſtance, then, may be juſtly regarded as ſufficient to vindicate the compoſition of the ſacred Scriptures, as it is at once their chief excellence and greateſt ſecurity. It is their excellence, as it renders them intelligible and uſeful to all; it is their ſecurity, as it prevents their being diſguſed by the falſe and capricious ornaments of vain or weak tranſlators. We may ſafely appeal to experience and fact for the confirmation of theſe remarks on the ſuperior ſimplicity, utility, and excellence, of the ſtyle of the Holy Scripture. Is there any book in the world ſo perfectly adapted to all capacities? that contains ſuch ſublime and exalted precepts, conveyed in ſuch an artleſs and intelligible ſtrain, that can be read with ſuch pleaſure and advantage by the lettered ſage and the unlettered peaſant?

SIMPLOCE. See ORATORY, N° 72.

SIMPSON, THOMAS, profeſſor of mathematics at the royal academy at Woolwich, fellow of the Royal Society, and member of the Royal Academy at Stockholm, was born at Market Boſworth in Leiceſterſhire in 1710. His father, a ſtuff-weaver, taught him only to read Engliſh, and brought him up to his own buſineſs; but meeting with a ſcientific pedlar, who likewiſe practiſed fortune-telling, young Simpſon by his aſſiſtance and advice left off weaving, and profeſſed aſtrology. As he improved in knowledge, however, he grew diſguſted with his pretended art; and renouncing it, was driven to ſuch difficulties for the ſubſiſtence of his family, that he came up to London, where he worked as a weaver, and taught mathematics at his ſpare hours. As his ſcholars increaſed, his abilities became better known, and he publiſhed his Treatiſe on Fluxions, by ſubſcription, in 1737: in 1740, he publiſhed his Treatiſe on the Nature and Laws of Chance; and Eſſays in Speculative and Mixed Mathematics. After theſe appeared his Doctrine of Annuities and Reverſions; Mathematical Diſſertations; Treatiſe on Algebra; Elements of Geometry; Trigonometry, Plane and Spherical; Select Exerciſes; and his Doctrine and Application of Fluxions, which he profeſſes to be rather a new work, than a ſecond edition of his former publication on fluxions. In 1743, he obtained the mathematical profeſſorſhip at Woolwich academy; and ſoon after was choſen a member of the Royal Society, when the preſident and council, in conſideration of his moderate circumſtances, were pleaſed to excuſe his admiſſion-fees, and his giving bonds for the ſettled future payments. At the academy he exerted all his abilities in inſtructing the pupils who were the immediate objects of his duty, as well as others whom the ſuperior officers of the ordnance permitted to be boarded and lodged in his houſe. In his manner of teaching he had a peculiar and happy addreſs, a certain dignity and perſpicuity, tempered with ſuch a degree of mildneſs, as engaged the attention, eſteem, and friendſhip of his ſcholars. He therefore acquired great applauſe from his ſuperiors in the diſcharge of his duty. His application and cloſe confinement, however, injured his health. Exerciſe and a proper regimen were preſcribed to him, but to little purpoſe: for his ſpirits ſunk gradually, till he became incapable of performing his duty, or even of reading the letters of his friends. The effects of this decay of nature were greatly increaſed by vexation of mind, owing to the haughty and inſulting behaviour of his ſuperior the firſt profeſſor of mathematics. This perſon, greatly his inferior in mathematical accompliſhments, did what he could to make his ſituation uneaſy, and even to depreciate him in the public opinion: but it was a vain endeavour, and only ſerved to depreſs himſelf. At length his phyſicians adviſed his native air for his recovery, and he ſet out in February 1761; but was ſo fatigued by his journey, that upon his arrival at Boſworth, he betook himſelf to his chamber, and grew continually worſe till the day of his death, which happened on the 14th of May, in the 51ſt year of his age.

SIMSON, DR ROBERT, profeſſor of mathematics in the univerſity of Glaſgow, was born in the year 1687 of a reſpectable family, which had held a ſmall eſtate in the county of Lanark for ſome generations. He was, we think, the ſecond ſon of the family. A younger brother was profeſſor of medicine in the univerſity of St Andrew's, and is known by ſome works of reputation, particularly a Diſſertation on the Nervous Syſtem, occaſioned by the Diſſection of a Brain completely Oſſified.

Dr Simſon was educated in the univerſity of Glaſgow under the eye of ſome of his relations who were profeſſors. Eager after knowledge, he made great progreſs in all his ſtudies; and, as his mind did not, at the very firſt openings of ſcience, ſtrike into that path which afterwards ſo ſtrongly attracted him, and in which he proceeded ſo far almoſt without a companion, he acquired in every walk of ſcience a ſtock of information, which, though it had never been much augmented afterwards, would have done credit to a profeſſional man in any of his ſtudies. He became, at a very early period, an adept in the philoſophy and theology of the ſchools, was able to ſupply the place of a ſick relation in the claſs of oriental languages, was noted for hiſtorical knowledge, and one of the moſt knowing botaniſts of his time.

It was during his theological ſtudies, as preparatory for his entering into orders, that mathematics took hold of his fancy. He uſed to tell in his convivial moments how he amuſed himſelf when preparing his exerciſes for the divinity hall. When tired with vague ſpeculation, in which he did not meet with certainty to reward his labours, he turned up a book of oriental philology, in which he found ſomething which he could diſcover to be true or to be falſe, without going out of the line of ſtudy which was to be of ultimate uſe to him. Sometimes even this could not relieve his fatigue. He then had recourſe to mathematics, which never failed to ſatisfy and refreſh him. For a long while he reſtricted himſelf to a very moderate uſe of the cordial, fearing that he would ſoon exhauſt the ſmall ſtock which ſo limited and abſtract a ſcience could yield; till at laſt he found, that the more he learned, a wider field opened to his view, and ſcenes that were inexhauſtible. Becoming acquainted with ſubjects far beyond the elements of the ſcience, and with numbers of names celebrated during that period of ardent reſearch all over Europe, he found it to be a manly and important ſtudy, by which he was as likely to acquire reputation as by any other. About this time, too, a proſpect began to open of making mathematics his profeſſion for life. He then gave himſelf up to it without reſerve.

His original incitement to this ſtudy as a treat, as ſomething to pleaſe and refreſh his mind in the midſt of ſeverer taſks, gave a particular turn to his mathematical ſtudies, from which he never could afterwards deviate. Perſpicuity and elegance are more attainable, and more diſcernible, in pure geometry, than in any other parts of the ſcience of meaſure. To this therefore he chiefly devoted himſelf. For the ſame reaſon he preferred the ancient method of ſtudying pure geometry, and even felt a diſlike to the Carteſian method of ſubſtituting ſymbols for operations of the mind, and ſtill more was he diſguſted with the ſubſtitution of ſymbols for the very objects of diſcuſſion, for lines, ſurfaces, ſolids, and their affections. He was rather diſpoſed in the ſolution of an algebraical problem, where quantity alone was conſidered, to ſubſtitute figure and its affections for the algebraical ſymbols, and to convert the algebraic formula into an analogous geometrical theorem. And he came at laſt to conſider algebraic analyſis as little better than a kind of mechanical knack, in which we proceed without ideas of any kind, and obtain a reſult without meaning, and without being conſcious of any proceſs of reaſoning, and therefore without any conviction of its truth. And there is no denying, that if genuine unſophiſticated taſte alone is to be conſulted, Dr Simſon was in the right: for though it muſt alſo be acknowledged, that the reaſoning in algebra is as ſtrict as in the pureſt geometry of Euclid or Apollonius, the *expert* analyſt has little perception of it as he goes on, and his final equation is not felt by himſelf as the reſult of ratiocination, any more than if he had obtained it by Paſcal's arithmetical mill. This does not in the leaſt diminiſh our admiration of the algebraic analyſis; for its almoſt boundleſs graſp, its rapid and certain procedure, and the delicate metaphyſics and great addreſs which may be diſplayed in conducting it. Such, however, was the ground of the ſtrong bias of Dr Simſon's mind to the analyſis of the ancient geometers. It increaſed as he went forward; and his veneration (we may call it his *love* or *affection*) for the ancient geometry was carried to a degree of idolatry. His chief labours were exerted in efforts to reſtore the works of the ancient geometers; and he has nowhere beſtowed much pains in advancing the modern diſcoveries in mathematics. The noble inventions, for example, of fluxions and of logarithms, by which our progreſs in mathematical knowledge, and in the uſeful application of this knowledge, is ſo much promoted, attracted the notice of Dr Simſon; but he has contented himſelf with demonſtrating their truth on the genuine principles of the ancient geometry. Yet was he very thoroughly acquainted with all the modern diſcoveries; and there are to be ſeen among his papers diſcuſſions and inveſtigations in the Carteſian method, which ſhow him thoroughly acquainted with all the principles, and even expert in the *tours de main*, of the moſt refined ſymbolical analyſis (A).

About the age of 25 Dr Simſon was choſen profeſſor of mathematics in the univerſity of Glaſgow. He went to London immediately after his appointment, and there formed an acquaintance with the moſt eminent men of that bright era of Britiſh ſcience. Among theſe he always mentioned Captain Halley (the celebrated Dr Edmund Halley) with particular reſpect; ſaying, that he had the moſt acute penetration, and the moſt juſt taſte in that ſcience, of any man he had ever known. And, indeed, Dr Halley has ſtrongly exemplified both of theſe in his divination of the work of *Apollonius de Sectione Spatii*, and the 8th book of his *Conics*, and in ſome of the moſt beautiful theorems in Sir Iſaac Newton's *Principia*. Dr Simſon alſo admired the wide and maſterly ſteps which Newton was accuſtomed to take in his inveſtigations, and his manner of ſubſtituting geometrical figures for the quantities which are obſerved in the phenomena of nature. It was from Dr Simſon that the writer of this article had the remark which has been oftener than once repeated in the courſe of this Work, "That the 39th propoſition of the firſt book of the *Principia* was the moſt important propoſition

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(A) In 1752 the writer of this article being then his ſcholar, requeſted him to examine an account which he gave him of what he thought a new curve (a conchoid having a circle for its baſe). Dr Simſon returned it next day with a regular liſt of its leading properties, and the inveſtigation of ſuch as he thought his ſcholar would not ſo eaſily trace. In this haſty ſcrawl the lines related to the circle were familiarly conſidered as arithmetical fractions of the radius conſidered as unity. This was before Euler publiſhed his Arithmetic of the Sines and Tangents, now in univerſal uſe.

poſition that had ever been exhibited to the phyſico-mathematical philoſopher;" and he uſed always to illuſtrate to his more advanced ſcholars the ſuperiority of the geometrical over the algebraic analyſis, by comparing the ſolution given by Newton of the inverſe problem of centripetal forces, in the 42d propoſition of that book, with the one given by John Bernoulli in the Memoirs of the Academy of Sciences at Paris for 1713. We have heard him ſay, that to his own knowledge Newton frequently inveſtigated his propoſitions in the ſymbolical way, and that it was owing chiefly to Dr Halley that they did not finally appear in that dreſs. But if Dr Simſon was well informed, we think it a great argument in favour of the ſymbolic analyſis, when this moſt ſucceſsful *practical artiſt* (for ſo we muſt call Newton when engaged in a taſk of diſcovery) found it conducive either to diſpatch or perhaps to his very progreſs.

Returning to his academical chair, Dr Simſon diſcharged the duties of a profeſſor for more than 50 years with great honour to the univerſity and to himſelf.

It is almoſt needleſs to ſay, that in his prelections he followed ſtrictly the Euclidian method in elementary geometry. He made uſe of Theodoſius as an introduction to ſpherical trigonometry. In the higher geometry he prelected from his own Conics; and he gave a ſmall ſpecimen of the *linear problems* of the ancients, by explaining the properties, ſometimes of the conchoid, ſometimes of the ciſſoid, with their application to the ſolution of ſuch problems. In the more advanced claſs he was accuſtomed to give Napier's mode of conceiving logarithms, i. e. quantities as generated by motion; and Mr Cotes's view of them, as the ſums of ratiunculæ; and to demonſtrate Newton's lemmas concerning the limits of ratios; and then to give the elements of the fluxionary calculus; and to finiſh his courſe with a ſelect ſet of propoſitions in optics, gnomonics, and central forces. His method of teaching was ſimple and perſpicuous, his elocution clear, and his manner eaſy and impreſſive. He had the reſpect, and ſtill more the affection, of his ſcholars.

With reſpect to his ſtudies, we have already informed the reader that they got an early bias to pure geometry, and to the elegant but ſcrupulous methods of the ancients.

We have heard Dr Simſon ſay, that it was in a great meaſure owing to Dr Halley that he ſo early directed his efforts to the reſtoration of the ancient geometers. He had recommended this to him, as the moſt certain way for him, then a very young man, both to acquire reputation, and to improve his own knowledge and taſte, and he preſented him with a copy of Pappus's Mathematical Collections, enriched with ſome of his own notes. The perſpicuity of the ancient geometrical analyſis, and a certain elegance in the nature of the ſolutions which it affords, eſpecially by means of the local theorems, ſoon took firm hold of his fancy, and made him, with the ſanguine expectation of a young man, direct his very firſt efforts to the recovery of this *in toto;* and the reſtoration of Euclid's Poriſms was the firſt taſk which he ſet himſelf. The accompliſhed geometer knows what a deſperate taſk this was, from the ſcanty and mutilated account which we have of this work in a ſingle paſſage of Pappus. It was an ambition which nothing but ſucceſs could juſtify in ſo young an adventurer. He ſucceeded; and ſo early as 1718 ſeemed to have been in complete poſſeſſion of this method of inveſtigation, which was conſidered by the eminent geometers of antiquity as their ſureſt guide through the labyrinths of the higher geometry. Dr Simſon gave a ſpecimen of his diſcovery in 1723 in the Philoſophical Tranſactions. And after this time he ceaſed not from his endeavours to recover that choice collection of Poriſms which Euclid had collected, as of the moſt general uſe in the ſolution of difficult queſtions. What ſome of theſe muſt have been was pointed out to Dr Simſon by the very nature of the general propoſition of Pappus, which he has reſtored. Others were pointed out by the lemmas which Pappus has given as helps to the young mathematician towards their demonſtration. And, being thus in poſſeſſion of a conſiderable number, their mutual relations pointed out a ſort of ſyſtem, of which theſe made a part, and of which the blanks now remained to be filled up.

Dr Simſon, having thus gained his favourite point, had leiſure to turn his attention to the other works of the ancient geometers; and the poriſms of Euclid now had only an occaſional ſhare. The *loci plani* of Apollonius was another taſk which he very early engaged in, and completed about the year 1738. But, after it was printed, he imagined that he had not given the *ipſiſſimæ propoſitiones* of Apollonius, and in the preciſe ſpirit and order of that author. The impreſſion lay by him for ſome years; and it was with great reluctance that he yielded to the intreaties of his mathematical friends, and publiſhed the work, in 1746, with ſome emendations, where he thought he had deviated fartheſt from his author. He quickly repented of this ſcanty conceſſion, and recalled what he could of the ſmall number of copies which he had given to the bookſellers, and the impreſſion again lay by him for years. He afterwards recorrected the work, and ſtill with ſome reluctance allowed it to come abroad as the Reſtitution of Apollonius. The public, however, had not been ſo faſtidious as Dr Simſon, and the work had acquired great celebrity, and he was now conſidered as one of the firſt and the moſt elegant geometers of the age: for, in the mean time, he had publiſhed his Conic Sections, a work of uncommon merit, whether we conſider it as equivalent to a complete reſtitution of the celebrated work of Apollonius Pergæus, or as an excellent ſyſtem of this important part of mathematics. It is marked with the ſame features as the *loci plani*, the moſt anxious ſolicitude to exhibit the very text of Apollonius, even in the propoſitions belonging to the books which had been completely loſt. Theſe could be recovered in no other way but by a thorough knowledge of the preciſe plan propoſed by the author, and by taking it for granted that the author had accurately accompliſhed this plan. In this manner did Viviani proceed in the firſt attempt which was made to reſtore the conics of Apollonius; and he has given us a detail of the proceſs of his conjectures, by which we may form an opinion of its juſtneſs, and of the probability how far he has attained the deſired object. Dr Simſon's view in his performance was ſomething different, deviating a little in this one caſe from his general track. He was not altogether pleaſed with the work of Viviani, even as augmented by the eighth book added by Halley, and his wiſh was to reſtore the ancient original. But, in the mean time, an academical text book for conic ſections was much wanted. He was much diſſatisfied with thoſe in common uſe; and he was not inſenſible of the advantage reſulting from the conſideration of theſe ſections, independent of the cone firſt introduced by Dr Wallis. He therefore compoſed this excellent treatiſe as an elementary book, not to ſuperſede, but to prepare for the ſtudy of Apollonius; and accordingly accommodates it to this purpoſe, and gives ſeveral important propoſitions in ther proper places, *expreſsly as reſtitutions of Apollonius*, whom he keeps conſtantly in view through the whole work.

Much about this time Dr Simſon ſeriouſly began to prepare a perfect edition of Euclid's Elements. The intimate acquaintance which he had by this time acquired with all the original works of the ancient geometers, and their ancient commentators and critics, encouraged him to hope that he could reſtore to his original luſtre this leader in mathematical ſcience; and the errors which had crept into this celebrated work, and which ſtill remained in it, appeared of magnitude ſufficient to merit the moſt careful efforts for their removal. The DATA alſo, which were in like manner the introduction to the whole art of geometrical inveſtigation, ſeemed to call more loudly for his amending hand. For it appears that the Saracens, who have preſerved to us the writings of the ancients, have contented themſelves with admiring theſe celebrated works, and have availed themſelves of the knowledge which they contain; but they have ſhown no inclination to add to the ſtock, or to promote the ſciences which they had received. They could not do any thing without the ſynthetical books of the geometers; but, not meaning to go beyond the diſcoveries which they had made, they neglected all the books which related to the analytic art alone, and the greateſt part of them (about 25 out of 30) have irrecoverably periſhed. The data of Euclid have fortunately been preſerved, but the book was neglected, and the only ancient copies, which are but three or four, are miſerably erroneous and mutilated. Fortunately, it is no very arduous matter to reinſtate this work in its original perfection. The plan is preciſe, both in its extent and its method. It had been reſtored, therefore, with ſucceſs by more than one author. But Dr Simſon's comprehenſive view of the whole analytical ſyſtem pointed out to him many occaſions for amendment. He therefore made its inſtitution a joint taſk with that of the elements. All the lovers of true geometry will acknowledge their obligations to him for the edition of the Elements and data which he publiſhed about 1758. The text is corrected with the moſt judicious and ſcrupulous care, and the notes are ineſtimable, both for their information, and for the tendency which they muſt have to form the mind of the ſtudent to a true judgment and taſte in mathematical ſubjects. The more accompliſhed reader will perhaps be ſometimes diſpoſed to ſmile at the axiom which ſeems to pervade the notes, "that a work of Euclid muſt be ſuppoſed without error or defect." If this was not the caſe, Euclid has been obliged to his editor in more inſtances than one. Nor ſhould his greateſt admirers think it impoſſible that in the progreſs of human improvement, a geometrical truth ſhould occur to one of theſe latter days, which eſcaped the notice of even the Lincean Euclid. Such merit, however, Dr Simſon nowhere claims, but lays every blame of error, omiſſion, or obſcurity, to the charge of Proclus, Theon, and other editors and commentators of the renowned Grecian.

There is another work of Apollonius on which Dr Simſon has beſtowed great pains, and has reſtored, as we imagine, *omnibus numeris perfectum*, viz. the SECTIO DETERMINATA; one of thoſe performances which are of indiſpenſible uſe in the application of the ancient analyſis. This alſo ſeems to have been an early taſk, though we do not know the date of his labours on it. It did not appear till after his death, being then publiſhed along with the great work, the Poriſms of Euclid, at the expence of the late Earl Stanhope, a nobleman intimately converſant with the ancient geometry, and zealous for its reception among the mathematicians of the preſent age. He had kept up a conſtant correſpondence with Dr Simſon on mathematical ſubjects; and at his death in 1768, engaged Mr Clow profeſſor of logic in the univerſity of Glaſgow, to whoſe care the Doctor had left all his valuable papers, to make a ſelection of ſuch as would ſerve to ſupport and increaſe his well-earned reputation as THE RESTORER of ANCIENT GEOMETRY.

We have been thus particular in our account of Dr Simſon's labours in theſe works, becauſe his manner of execution, while it does honour to his inventive powers, and ſhows his juſt taſte in mathematical compoſition, alſo confirms our former aſſertion, that he carried his reſpect for the ancient geometers to a degree of ſuperſtitious idolatry, and that his fancy, unchecked, viewed them as incapable of error or imperfection. This is diſtinctly to be ſeen in the emendations which he has given of the texts, particularly in his editions of Euclid. Not only every imperfection of the reading is aſcribed to the ignorance of copyiſts, and every indiſtinctneſs in the conception, inconcluſiveneſs in the reaſoning, and defect in the method, is aſcribed to the ignorance or miſtake of the commentators; but it is all along aſſumed that the work was perfect in its kind; and that by exhibiting a perfect work, we reſtore the genuine original. This is ſurely gratuitous; and it is very poſſible that it has, in ſome inſtances, made Dr Simſon fail of his anxious purpoſe, and give us even a better than the original. It has undoubtedly made him fail in what *ſhould have been* his great purpoſe, viz. to give the world a connected ſyſtem of the ancient geometrical analyſis; ſuch as would, in the firſt place, exhibit it in its moſt engaging form, elegant, perſpicuous, and comprehenſive; and, in the next place, ſuch as ſhould engage the mathematicians of the preſent age to adopt it as the moſt certain and ſucceſsful conductor in thoſe laborious and difficult reſearches in which the demands of modern ſcience continually engage them. And this might have been expected, in the province of ſpeculative geometry at leaſt, from a perſon of ſuch extenſive knowledge of the properties of figure, and who had ſo eminently ſucceeded in the many trials which he had made of its powers. We might have expected that he would at leaſt have exhibited in one ſyſtematic point of view, what the ancients had done in ſeveral detached branches of the ſcience, and how far they had proceeded in the ſolution of the ſeveral ſucceſſive claſſes of problems; and we might have hoped, that he would have inſtructed us in what manner we ſhould apply that method to the ſolution of problems of a more elevated kind, daily preſented

ſented to us in the queſtions of phyſico-mathematical ſcience. By this he would have acquired diſtinguiſhed honour, and ſcience would have received the moſt valuable improvement. But Dr Simſon has done little of all this; and we cannot ſay that great helps have been derived from his labours by the eminent mathematicians of this age, who are ſucceſsfully occupied in advancing our knowledge of nature, or in improving the arts of life. He has indeed contributed greatly to the entertainment of the ſpeculative mathematician, who is more delighted with the conſcious exerciſe of his own reaſoning powers, than with the final reſult of his reſearches. Yet we are not even certain that Dr Simſon has done this to the extent he wiſhed and hoped. He has not engaged the liking of mathematicians to this analyſis, by preſenting it in the moſt agreeable form. His own extreme anxiety to tread in the very footſteps of the original authors, has, in a thouſand inſtances, precluded him from uſing his own extenſive knowledge, that he might not employ principles which were not of a claſs inferior to that of the queſtion in hand. Thus, of neceſſity, did the method appear trammelled. We are deterred from employing a proceſs which appears to reſtrain us in the application of the knowledge which we have already acquired; and, diſguſted with the tedious, and perhaps indirect path, by which we muſt arrive at an object which we ſee clearly over the hedge, and which we could reach by a few ſteps, of the ſecurity of which we are otherwiſe perfectly aſſured. Theſe prepoſſeſſions are indeed founded on miſtake; but the miſtake is ſuch, that all fall into it, till experience has enlarged their views. This circumſtance alone has hitherto prevented mathematicians from acquiring that knowledge of the ancient analyſis which would enable them to proceed in their reſearches with certainty, diſpatch, and delight. It is therefore deeply to be regretted, that this eminent genius has occupied, in this ſuperſtitious palæology, a long and buſy life, which might have been employed in original works of infinite advantage to the world, and honour to himſelf.

Our readers will, it is hoped, conſider theſe obſervations as of general ſcientific importance, and as intimately connected with the hiſtory of mathematics; and therefore as not improperly introduced in the biographical account of one of the moſt eminent writers on this ſcience. Dr Simſon claimed our notice as a mathematician; and his affectionate admiration of the ancient analyſis is the prominent feature of his literary character. By this he is known all over Europe; and his name is never mentioned by any foreign author without ſome very honourable alluſion to his diſtinguiſhed geometrical elegance and ſkill. Dr James Moor, profeſſor of Greek in the univerſity of Glaſgow, no leſs eminent for his knowledge in ancient geometry than for his profeſſional talents, put the following appoſite inſcription below a portrait of Dr Simſon:

Geometriam, sub Tyranno barbaro sæva
Servitute diu squalentem, in Libertatem
Et decus antiquum vindicavit
Unus.

Yet it muſt not be underſtood that Dr Simſon's predilection for the geometrical analyſis of the ancients did ſo far miſlead him as to make him neglect the ſymbolical analyſis of the preſent times; on the contrary, he was completely maſter of it, as has been already obſerved, and frequently employed it. In his academical lectures to the ſtudents of his upper claſſes, he uſed to point out its proper province (which he by no means limited by a ſcanty boundary), and in what caſes it might be applied with ſafety and advantage even to queſtions of pure geometry. He once honoured the writer of this article with the ſight of a very ſhort diſſertation on this ſubject (perhaps the one referred to in the preface to his Conic Sections). In this piece he was perhaps more liberal than the moſt zealous partiſans of the ſymbolical analyſis could deſire, admitting as a ſufficient equation of the Conic Sections $L=\frac{p^2 c}{x^2}$, where L is the *latus rectum*, x is the diſtance of any point of the curve from the focus, p is the perpendicular drawn from the focus to the tangent in the given point, and c is the chord of the equicurve circle drawn through the focus. Unfortunately this diſſertation was not found among his papers. He ſpoke in high terms of the Analytical Works of Mr Cotes, and of the two Bernoullis. He was conſulted by Mr M'Laurin during the progreſs of his ineſtimable Treatiſe of Fluxions, and contributed not a little to the reputation of that work. The ſpirit of that moſt ingenious algebraic demonſtration of the fluxions of a rectangle, and the very proceſs of the argument, is the ſame with Dr Simſon's in his diſſertation on the limits of quantities. It was therefore from a thorough acquaintance with the ſubject, and by a juſt taſte, that he was induced to prefer his favourite analyſis, or, to ſpeak more properly, to exhort mathematicians to employ it in its own ſphere, and not to become ignorant of geometry, while he ſucceſsfully employed the ſymbolical analyſis in caſes which did not require it, and which ſuffered by its admiſſion. It muſt be acknowledged, however, that in his later years, the diſguſt which he felt at the artificial and ſlovenly employment on ſubjects of pure geometry, ſometimes hindered him from even looking at the moſt refined and ingenious improvements of the algebraic analyſis which occur in the writings of Euler, D'Alembert, and other eminent maſters. But, when properly informed of them, he never failed to give them their due praiſe; and we remember him ſpeaking, in terms of great ſatisfaction, of an improvement of the infiniteſimal calculus, by D'Alembert and De la Grange, in their reſearches concerning the propagation of ſound, and the vibrations of muſical cords.

And that Dr Simſon not only was maſter of this calculus and the ſymbolical calculus in general, but held them in proper eſteem, appears from two valuable diſſertations to be found in his poſthumous works; the one on logarithms, and the other on the limits of ratios. The laſt, in particular, ſhows how completely he was ſatisfied with reſpect to the ſolid foundation of the method of fluxions; and it contains an elegant and ſtrict demonſtration of all the applications which have been made of the method by its illuſtrious author to the objects of pure geometry.

We hoped to have given a much more complete and inſtructive account of this eminent geometer and his works, by the aid of a perſon fully acquainted with both, and able to appreciate their value; but an accident has deprived us of this aſſiſtance, when it was too late to procure an equivalent: and we muſt requeſt our readers to accept of this very imperfect account, ſince we cannot do juſtice to Dr Simſon's merit, unleſs almoſt equally

equally converſant in all the geometry of the ancient Greeks.

The life of a literary man rarely teems with anecdote; and a mathematician, devoted to his ſtudies, is perhaps more abſtracted than any other perſon from the ordinary occurrences of life, and even the ordinary topics of converſation. Dr Simſon was of this claſs; and, having never married, lived entirely a college life. Having no occaſion for the commodious houſe to which his place in the univerſity entitled him, he contented himſelf with chambers, good indeed, and ſpacious enough for his ſober accommodation, and for receiving his choice collection of mathematical writers, but without any decoration or commodious furniture. His official ſervant ſufficed for valet, footman, and chambermaid. As this retirement was entirely devoted to ſtudy, he entertained no company in his chambers, but in a neighbouring houſe, where his apartment was ſacred to him and his gueſts.

Having in early life devoted himſelf to the reſtoration of the works of the ancient geometers, he ſtudied them with unremitting attention; and, retiring from the promiſcuous intercourſe of the world, he contented himſelf with a ſmall ſociety of intimate friends, with whom he could lay aſide every reſtraint of ceremony or reſerve, and indulge in all the innocent frivolities of life. Every Friday evening was ſpent in a party at whiſt, in which he excelled, and took delight in inſtructing others, till increaſing years made him leſs patient with the dulneſs of a ſcholar. The card-party was followed by an hour or two dedicated ſolely to playful converſation. In like manner, every Saturday he had a leſs ſelect party to dinner at a houſe about a mile from town. The Doctor's long life gave him occaſion to ſee the *dramatis perſonæ* of this little theatre ſeveral times completely changed, while he continued to give it a perſonal identity: ſo that, without any deſign or wiſh of his own, it became, as it were, his own houſe and his own family, and went by his name. In this ſtate did the preſent writer firſt ſee it, with Dr Simſon as its father and head, reſpected and beloved by every branch; for, as it was for relaxation, and not for the enjoyment of his acknowledged ſuperiority, that he continued this habit of his early youth; and as his notions "of a fine talk" did not conſiſt in the pleaſure of having "toſſed and gored a good many to-day," his companions were as much at their eaſe as he wiſhed to be himſelf; and it was no ſmall part of their entertainment (and of his too), to ſmile at thoſe innocent deviations from common forms, and thoſe miſtakes with reſpect to life and manners, which an almoſt total retirement from the world, and inceſſant occupation in an abſtract ſcience, cauſed this venerable preſident frequently to exhibit. Theſe are remembered with a more affecting regret, that they are now "with the days that are paſt," than the moſt pithy apophthegms, uſhered in with an emphatical, "Why, Sir!" or "No, Sir!" which precludes all reply. Dr Simſon never exerted his preſidial authority, unleſs it were to check ſome infringment of good breeding, or any thing that appeared unfriendly to religion or purity of manners; for theſe he had the higheſt reverence. We have twice heard him ſing (he had a fine voice and moſt accurate ear) ſome lines of a Latin hymn to the Divine Geometer, and each time the rapturous tear ſtood in his eye.

But we aſk the reader's pardon for this digreſſion; it is not however uſeleſs, ſince it paints the man as much as any recital of his ſtudies; and to his acquaintances we are certain that it will be an acceptable memorandum. To them it was often matter of regret, that a perſon of ſuch eminent talents, which ſhould have made him ſhine equally in any line of life, ſhould have allowed himſelf to be ſo completely devoted to a ſtudy which abſtracted him from the ordinary purſuits of men, unfitted him for the active enjoyment of life, and kept him out of thoſe walks which they frequented, and where they would have rejoiced to meet him.

Dr Simſon was of an advantageous ſtature, with a fine countenance; and even in his old age had a graceful carriage and manner, and always, except when in mourning, dreſſed in white cloth. He was of a cheerful diſpoſition; and though he did not make the firſt advances to acquaintance, had the moſt affable manner, and ſtrangers were at perfect eaſe in his company. He enjoyed a long courſe of uninterrupted health; but towards the cloſe of life ſuffered from an acute diſeaſe, and was obliged to employ an aſſiſtant in his profeſſional labours for a few years preceding his death, which happened in 1768, at the age of 81. He left to the univerſity his valuable library, which is now arranged apart from the reſt of the books, and the public uſe of it is limited by particular rules. It is conſidered as the moſt choice collection of mathematical books and manuſcripts in the kingdom, and many of them are rendered doubly valuable by Dr Simſon's notes.

SIN, a breach or tranſgreſſion of ſome divine law or command.

SINAI, or SINA, a famous mountain of Arabia Petræa, upon which God gave the law to Moſes. It ſtands in a kind of peninſula, formed by the two arms of the Red ſea, one of which ſtretches out towards the north, and is called the *gulf of Kolſum;* the other extends towards the eaſt, and is called the *gulf of Elan*, or the *Elanitiſh ſea*. At this day the Arabians call Mount Sinai by the name of *Tor*, that is, the "mountain," by way of excellence; or *Gibel* or *Jibel Mouſa*, "the mountain of Moſes." It is 260 miles from Cairo, and generally it requires a journey of ten days to travel thither. The wilderneſs of Sinai, where the Iſraelites continued encamped for almoſt a year, and where Moſes erected the tabernacle of the covenant, is conſiderably elevated above the reſt of the country; and the aſcent to it is by a very craggy way, the greateſt part of which is cut out of the rock; then one comes to a large ſpace of ground, which is a plain ſurrounded on all ſides by rocks and eminences, whoſe length is nearly 12 miles. Towards the extremity of this plain, on the north ſide, two high mountains ſhow themſelves, the higheſt of which is called *Sinai* and the other *Horeb*. The tops of Horeb and Sinai have a very ſteep aſcent, and do not ſtand upon much ground, in compariſon to their extraordinary height: that of Sinai is at leaſt one-third part higher than the other, and its aſcent is more upright and difficult.

Niebuhr's Travels, vol. i. p. 192.

Two German miles and a half up the mountain ſtands the convent of St Catharine. The body of this monaſtery is a building 120 feet in length and almoſt as many in breadth. Before it ſtands another ſmall building, in which is the only gate of the convent, which remains always ſhut, except when the biſhop is here.

here. At other times, whatever is introduced within the convent, whether men or proviſions, is drawn up by the roof in a baſket, and with a cord and a pulley. The whole building is of hewn ſtone; which, in ſuch a deſert, muſt have coſt prodigious expence and pains. Near this chapel iſſues a fountain of very good freſh water; it is looked upon as miraculous by ſome who cannot conceive how water can flow from the brow of ſo high and barren a mountain. Five or ſix paces from it they ſhow a ſtone, the height of which is four or five feet, and breadth about three, which, they ſay, is the very ſtone whence Moſes cauſed the water to guſh out. Its colour is of a ſpotted gray, and it is, as it were, ſet in a kind of earth where no other rock appears. This ſtone has twelve holes or channels, which are about a foot wide, whence it is thought the water came forth for the Iſraelites to drink.

Much has been ſaid of the writings to be ſeen at Sinai and in the plain about it; and ſuch were the hopes of diſcoveries reſpecting the wanderings of the Iſraelites from theſe writings, that Dr Clayton, biſhop of Clogher, offered 500l. ſterling to defray the expences of journey to any man of letters who would undertake to copy them. No man, we believe, undertook this taſk: and the accurate Daniſh traveller Niebuhr found no writings there, but the names of perſons who had viſited the place from curioſity, and of Egyptians who had choſen to be buried in that region.

SINAPIS, Mustard, a genus of plants belonging to the claſs tetradynamia, and to the order ſiliquoſa; and in the natural ſyſtem ranged under the 39th order, *Siliquoſæ*. See Botany *Index*.

SINAPISM, in *Pharmacy*, an external medicine, in form of a cataplaſm, compoſed chiefly of muſtard ſeed pulveriſed, and other ingredients mentioned in the preceding article.

SINCERITY, honeſty of intention, freedom from hypocriſy. See Moral Philosophy, N° 157.

SINCIPUT, in *Anatomy*, the forepart of the head, reaching from the forehead to the coronal ſuture.

SINDY, a province of Hindoſtan Proper, bounded on the weſt by Makran, a province of Perſia; on the north by the territories of the king of Candahar; on the north-eaſt by thoſe of the Seiks; on the eaſt by a ſandy deſert; and on the ſouth-eaſt by Cutch. It extends along the courſe of the river Sinde or Indus from its mouth to Behker or Bhakor, on the frontiers of Moultan. Reckoned that way, it is 300 miles long; and its breadth, in its wideſt part, is about 160. In many particulars of ſoil and climate, and in the general appearance of the ſurface, Sindy reſembles Egypt; the lower part of it being compoſed of rich vegetable mould, and extended into a wide dell; while the upper part of it is a narrow ſlip of country, confined on one ſide by a ridge of mountains, and on the other by a ſandy deſert, the river Indus, equal at leaſt to the Nile, winding through the midſt of this level valley, and annually overflowing it. During great part of the ſouth weſt monſoon, or at leaſt in the months of July, Auguſt, and part of September, which is the rainy ſeaſon in moſt other parts of India, the atmoſphere is here generally clouded; but no rain falls except very near the ſea. Indeed, very few ſhowers fall during the whole year; owing to which, and the neighbourhood of the ſandy deſerts, which bound it on the eaſt and on the north-weſt, the heats are ſo violent, and the winds from thoſe quarters ſo pernicious, that the houſes are contrived ſo as to be occaſionally ventilated by means of apertures on the tops of them, reſembling the funnels of ſmall chimneys. When the hot winds prevail, the windows are cloſely ſhut; and the loweſt part of the current of air, which is always the hotteſt, being thus excluded, a cooler, becauſe more elevated part, deſcends into the houſe through the funnels. By this contrivance alſo vaſt clouds of duſt are excluded: the entrance of which would alone be ſufficient to render the houſes uninhabitable. The roofs are compoſed of thick layers of earth inſtead of terraces. Few countries are more unwholeſome to European conſtitutions, particularly the lower part of the Delta. The prince of this province is a Mahometan, tributary to the king of Candahar. He reſides at Hydrabad, although Tatta is the capital. The Hindoos, who were the original inhabitants of Sindy, are by their Mahometan governors treated with great rigour, and denied the public exerciſe of their religion; and this ſeverity drives vaſt numbers of them into other countries. The inland parts of Sindy produce ſaltpetre, ſal ammoniac, borax, bezoar, lapis lazuli, and raw ſilk. They have alſo manufactories of cotton and ſilk of various kinds; and they make fine cabinets, inlaid with ivory, and finely lackered. They alſo export great quantities of butter, clarified and wrapt up in duppas, made of the hides of cattle. The ladies wear hoops of ivory on both their arms and legs, which when they die are burnt with them. They have large black cattle, excellent mutton, and ſmall hardy horſes. Their wild game are deer, hares, antelopes, and foxes, which they hunt with dogs, leopards, and a ſmall fierce creature called a ſhiahguſh.

SINE, or *Right* SINE *of an Arch*, in *Trigonometry*, is a right line drawn from one end of that arch, perpendicular to the radius drawn to the other end of the arch; being always equal to half the cord of twice the arch. See Trigonometry and Geometry.

SINECURE, a nominal office, which has a revenue without any employment.

SINEW, a tendon, that which unites the muſcles to the bones.

SINGING, the action of making divers inflections of the voice, agreeable to the ear, and correſpondent to the notes of a ſong or piece of melody. See Melody.

The firſt thing to be done in learning to ſing, is to raiſe a ſcale of notes by tones and ſemitones to an octave, and deſcend by the ſame notes; and then to riſe and fall by greater intervals, as a third, fourth, fifth, &c. and to do all this by notes of different pitch. Then theſe notes are repreſented by lines and ſpaces, to which the ſyllables *fa*, *ſol*, *la*, *mi*, are applied, and the pupil taught to name each line and ſpace thereby; whence this practice is called *ſol-faing*, the nature, reaſon, effects, &c. whereof, ſee under the article Solfaing.

SINGING of Birds. It is worthy of obſervation, that the female of no ſpecies of birds ever ſings: with birds it is the reverſe of what occurs in human kind. Among the feathered tribe, all the cares of life fall to the lot of the tender ſex; theirs is the fatigue of incubation; and the principal ſhare in nurſing the helpleſs brood: to alleviate theſe fatigues, and to ſupport her under them, nature hath given to the male the ſong, with all the little blandiſhments and ſoothing arts; theſe he fondly exerts (even after courtſhip) on ſome ſpray contiguous to the neſt, during the time his mate is performing her parental duties. But that ſhe ſhould be ſilent is alſo another wiſe proviſion of nature, for her ſong would diſcover her neſt; as would a gaudineſs of plumage, which, for the ſame reaſon, ſeems to have been denied her.

On the ſong of birds ſeveral curious experiments and obſervations have been made by the Hon. Daines Barrington. See *Phil. Tranſ.* vol. lxiii.

SINGULAR NUMBER, in *Grammar*, that number of nouns and verbs which ſtands oppoſed to plural. See GRAMMAR, Nº 14.

SINISTER, ſomething on or towards the left hand. Hence ſome derive the word *ſiniſter à ſinendo;* becauſe the gods, by ſuch auguries, permit us to proceed in our deſigns.

SINISTER, is ordinarily uſed among us for unlucky; though, in the ſacred rites of divination, the Romans uſed it in an oppoſite ſenſe. Thus *avis ſiniſtra*, or a bird on the left hand, was eſteemed a happy omen: whence, in the law of the 12 tables, *Ave ſiniſtra populi magiſter eſto.*

SINISTER, in *Heraldry*. The ſiniſter ſide of an eſcutcheon is the left-hand ſide; the ſiniſter chief, the left angle of the chief; the ſiniſter baſe, the left-hand part of the baſe.

SINISTER Aſpect, among aſtrologers, is an appearance of two planets happening according to the ſucceſſion of the ſigns; as Saturn in Aries, and Mars in the ſame degree of Gemini.

SINISTRI, a ſet of ancient heretics, thus called becauſe they held the left hand in abhorrence, and made it a point of religion not to receive any thing therewith.

SINKING FUND, a proviſion made by parliament, conſiſting of the ſurpluſage of other funds, intended to be appropriated to the payment of the national debt; on the credit of which very large ſums have been borrowed for public uſes.

As the funding ſyſtem had been adopted in other countries long before it was reſorted to in Great Britain, a proviſion of this kind had appeared neceſſary at a much earlier period, and had been eſtabliſhed in Holland in 1655, and in the eccleſiaſtical ſtates in 1685. Theſe funds were both formed by the reduction of the intereſt on the public debts, and by appropriating the annual ſum thus ſaved to the gradual diſcharge of the principal.

In the reign of King William, when the mode of providing for extraordinary expences was firſt adopted in this country, the particular tax on which money was borrowed, generally produced much more than was ſufficient to pay the annual intereſt, and the ſurplus was applied in ſinking the principal, which was generally effected in a few years. Had this plan been purſued, there never could have been any great accumulation of public debts; but, as the expenditure increaſed, and the neceſſity of loans of ſtill greater amount became more frequent, it was found difficult to provide for the annual intereſt of the ſums thus borrowed; and the repayment of the principal was either put off to a diſtant period, or left without any proviſion to the chance of more flouriſhing times.

Some of the effects of an accumulating public debt ſoon became evident in the diſcount at which all government ſecurities ſold, and in the difficulties experienced in providing for the annual expenditure; the propriety of reducing, and even of wholly diſcharging, the debt, was generally acknowledged; and the plan of a ſinking fund was recommended in a pamphlet publiſhed in 1701. In 1713 Mr Archibald Hutchiſon preſented to George I. a plan for payment of the public debts. In 1715 different projects for this purpoſe were publiſhed by Edward Leigh, Mr Aſgill, and others. And in 1717 a plan for the gradual diſcharge of the debt was actually adopted, which was afterwards generally known by the name of the ſinking fund.

For a few years the fund was ſtrictly applied to the purpoſes for which it was eſtabliſhed; and ſo well were its nature and importance then underſtood, that money was at the ſame time borrowed for extraordinary expences. In 1724, the ſum of 15,144l. 19s. was taken from the fund, to make good the loſs to the treaſury from the reduction of the value of gold coin; and within 12 years from its eſtabliſhment it was charged with the intereſt of new loans. In 1733, the groſs ſum of half a million was taken from it towards the ſupplies, at which time the medium annual produce of the fund for five years had been 1,212,000l. This amount would have fully diſcharged the debt which then exiſted, but the alienation of it was continued.

This was ſucceeded by the conſolidated fund, one object of which was, to lay the foundation of a new ſinking fund, and conſiſting, like the old one, in the application of the principle of compound intereſt. On this occaſion Mr Pitt conſulted the late Dr Price, who communicated three plans, one of which was afterwards adopted, but with ſuch alterations as greatly affected its efficacy, and which it had been ſince found neceſſary to correct. By the act paſſed for carrying this ſcheme into execution, the annual ſum of 1,000,000l. was placed in the hands of commiſſioners, to be iſſued in four equal quarterly payments, and to be applied either in paying off ſuch redeemable annuities as were at or above par, or in the purchaſe of annuities below par, at the market-price.

On the 17th of February, 1792, Mr Pitt propoſed that the ſum of 400,000l. ſhould be iſſued in addition to the million, for the purpoſe of accelerating the operation of the fund: and ſtated that it might be expected that 25 millions of 3 per cents would be paid off by the year 1800; and that in the year 1808, the fund would amount to 4,000,000l. per annum, the ſum to which it was then reſtricted. The injudicious reſtriction of the fund to 4,000,000l. per annum, was done away by an act paſſed in 1802, which directed that the produce of the two funds ſhould continue to accumulate, without any limitation as to its amount, and be from time to time applied, according to the former proviſions, in the redemption or purchaſe of ſtock, until the whole of the perpetual redeemable annuities, exiſting at the time of paſſing the act, ſhall have been completely paid off. At the ſame time, the annual grant of 200,000l. in aid of the fund, was made a permanent charge, to be iſſued in quarterly payments from the conſolidated fund, in the ſame manner as the original million per annum. In conſequence of theſe improvements, the increaſe of the fund has been much greater than it was originally

originally eſtimated; and on the 1ſt of February, 1806, was as follows:

Annual charge by act of 26 Geo. III. - -	L.1,000,000	0	0
Ditto 42 Geo. III. -	200,000	0	0
Annuities for 99 and 96 years, expired 1792 - -	54,880	14	6
Short annuities, expired 1787	25,000	0	0
Life annuities, unclaimed and expired - -	50,308	5	7
Dividend on 98,386,402l. at 3 per cent. - -	2,951,592	1	2
Ditto on 2,617,400l. at 4 per cent.	104,696	0	0
Ditto on 142,000l. at 5 per cent.	7,100	0	0
One per cent. on capitals erected ſince 1723 -	3,202,672	1	10
Total,	L.7,596,249	3	1

This ſum is excluſive of the fund for the reduction of the public debt of Ireland, which at the above period amounted to 479,537l. 8s. and of the fund for reduction of the imperial debt, which amounted to 56,960l. 9s. 4d.

The progreſs of the fund from the commencement of its operation on 1ſt Auguſt 1786, to the 1ſt February 1806, will appear from the following ſtatement of the total amount of the ſtock redeemed by the commiſſioners up to the latter period.

Conſolidated 3 per cent. annuities	L.39,922,421
Reduced 3 per cent. annuities	51,493,981
Old South ſea annuities	3,492,000
New South ſea annuities	2,783,000
Three per cents 1751 -	695,000
Conſolidated 4 per cent. annuities	2,617,400
Navy 5 per cent. annuities	142,000
Total,	L.101,145,802

The total ſum which had been paid for this amount of ſtock was, 62,842,782l. 7s. 10d. the conſolidated 3 per cents having been bought up on an average at 61l. per cent. and the reduced at ſomewhat leſs.

The progreſs already made by the fund, and the important effect it has had in ſupporting the value of the government ſecurities at a time when it has been neceſſary to borrow unprecedented ſums in almoſt every year, ſufficiently demonſtrate the great utility of this meaſure. As its increaſe will be continually augmenting, it will, if ſteadily perſevered in, and faithfully applied, become ultimately capable of diſcharging a debt of any amount with which it is poſſible to ſuppoſe the country will ever be encumbered.

SINOPLE, in *Heraldry*, denotes vert, or green colour in armories.—Sinople is uſed to ſignify love, youth, beauty, rejoicing, and liberty; whence it is that letters of grace, ambition, legitimation, &c. are always ſealed with green wax.

SINUOSITY, a ſeries of bends and turns in arches or other irregular figures, ſometimes jutting out and ſometimes falling in.

SINUS, in *Anatomy*, denotes a cavity in certain bones and other parts, the entrance whereof is very narrow, and the bottom wider and more ſpacious.

Sinus, in *Surgery*, a little cavity or ſacculus, frequently formed by a wound or ulcer, wherein pus is collected.

SIPHON. See Hydrodynamics.

SIPHONANTHUS, a genus of plants belonging to the claſs of tetrandria and order of monogynia. See Botany *Index*.

SIPONTUM, Sepuntum, or *SIPUS*, in *Ancient Geography*, a town of Apulia, ſo denominated (according to Strabo) from the great quantity of *ſepiæ* or cuttleſiſh that are thrown upon the coaſt. Diomede is ſuppoſed by the ſame author to have been the founder of this place; which appears from Livy to have become a colony of Roman citizens. In the early ages of Chriſtian hierarchy, a biſhop was fixed in this church; but, under the Lombards, his ſee was united to that of Beneventum. Being again ſeparated, Sipontum became an archiepiſcopal dioceſe in 1094, about which time it was ſo ill treated by the Barbarians, that it never recovered its ſplendour, but ſunk into ſuch miſery, that in 1260 it was a mere deſert, from the want of inhabitants, the decay of commerce, and the inſalubrity of the air. Manfred having taken theſe circumſtances into conſideration, began in 1261 to build a new city on the ſea-ſhore, to which he removed the few remaining Sipontines. (See the article Manfredonia). Sipontum was ſituated at the diſtance of a mile from the ſhore. Excepting a part of its Gothic cathedral, ſcarce one ſtone of the ancient city now remains upon another.

SIPUNCULUS, in *Natural Hiſtory*, a genus of the claſs of vermes, and order inteſtina. See Helminthology *Index*.

SIR, the title of a knight or baronet, which, for diſtinction's ſake, as it is now given indiſcriminately to all men, is always prefixed to the knight's Chriſtian name, either in ſpeaking or writing to them.

SIRCAR, any office under the government in Hindoſtan. It is ſometimes uſed for the ſtate of government itſelf. Likewiſe a province, or any number of pergunnahs placed under one head in the government books, for conveniency in keeping accounts. In common uſage in Bengal, the under banyans of European gentlemen are called *ſircars*.

SIRE, a title of honour formerly given to the king of France as a mark of ſovereignty.

Sire, was likewiſe anciently uſed in the ſame ſenſe with *ſieur* and *ſeigneur*, and applied to barons, gentlemen, and citizens.

SIRENS, in fabulous hiſtory, certain celebrated ſongſtreſſes who were ranked among the demigods of antiquity. Hyginus places their birth among the conſequences of the rape of Proſerpine. Others make them daughters of the river Acheloüs and one of the muſes *. The number of the Sirens was three, and their names were *Parthenope*, *Lygea*, and *Leucoſia*. Some make them half women and half fiſh; others half women and half birds. There are antique repreſentations of them ſtill ſubſiſting under both theſe forms. Pauſanias tells us, that the Sirens, by the perſuaſion of Juno, challenged the Muſes to a trial of ſkill in ſinging; and theſe having vanquiſhed them, plucked the golden feathers from the wings of the Sirens, and formed them into

* *Ovid Met.* lib. iv.

crowns, with which they adorned their own heads. The Argonauts are ſaid to have been diverted from the enchantment of their ſongs by the ſuperior ſtrains of Orpheus: Ulyſſes, however, had great difficulty in ſecuring himſelf from ſeduction. See *Odyſ.* lib. xii.

Pope, in his notes to the twelfth book of the Odyſſey, obſerves, the critics have greatly laboured to explain what was the foundation of this fiction of the Sirens. We are told by ſome, that the Sirens were queens of certain ſmall iſlands named *Sirenuſæ*, that lie near Capræa in Italy, and chiefly inhabited the promontory of Minerva, upon the top of which that goddeſs had a temple, as ſome affirm, built by Ulyſſes. Here there was a renowned academy, in the reign of the Sirens, famous for eloquence and the liberal ſciences, which gave occaſion to the invention of this fable of the ſweetneſs of the voice and attracting ſongs of the Sirens. But why then are they fabled to be deſtroyers, and painted in ſuch dreadful colours? We are told, that at laſt the ſtudents abuſed their knowledge, to the colouring of wrong, the corruption of manners, and the ſubverſion of government: that is, in the language of poetry, they were feigned to be tranſformed into monſters, and with their muſic to have enticed paſſengers to their ruin, who there conſumed their patrimonies, and poiſoned their virtues with riot and effeminacy. The place is now called *Maſſa*. Some writers tell us of a certain bay, contracted within winding ſtraits and broken cliffs, which, by the ſinging of the winds and beating of the waters, returns a delightful harmony, that allures the paſſenger to approach, who is immediately thrown againſt the rocks, and ſwallowed up by the violent eddies. Thus Horace, moraliſing, calls idleneſs a *Siren*.

——*Vitanda eſt improba Siren*
Deſidia.——

But the fable may be applied to all pleaſures in general, which, if too eagerly purſued, betray the incautious into ruin; while wiſe men, like Ulyſſes, making uſe of their reaſon, ſtop their ears againſt their inſinuations.

The learned Mr Bryant ſays, that the Sirens were Cuthite and Canaanitiſh prieſts, who had founded temples in Sicily, which were rendered infamous on account of the women who officiated. They were much addicted to cruel rites, ſo that the ſhores upon which they reſided are deſcribed as covered with the bones of men deſtroyed by their artifice. *Virgil. Æneid.* lib. v. ver. 864.

All ancient authors agree in telling us, that Sirens inhabited the coaſt of Sicily. The name, according to Bochart, who derives it from the Phœnician language, implies a ſongſtreſs. Hence it is probable, ſays Dr Burney, that in ancient times there may have been excellent ſingers, but of corrupt morals, on the coaſt of Sicily, who, by ſeducing voyagers, gave riſe to this fable. And if this conjecture be well founded, he obſerves, the Muſes are not the only pagan divinities who preſerved their influence over mankind in modern times; for every age has its Sirens, and every Siren her votaries; when beauty and talents, both powerful in themſelves, are united, they become ſtill more attractive.

SIREN, in *Zoology*, a genus of animals belonging to the claſs of *amphibia* and the order of *meantes*. It is a biped, naked, and furniſhed with a tail; the feet are brachiated with claws. This animal was diſcovered by Dr Garden in Carolina; it is found in ſwampy and muddy places, by the ſides of pools, under the trunks of old trees that hang over the water. The natives call it by the name of *mud-iguana*. Linnæus firſt apprehended, that it was the larva of a kind of lizard; but as its fingers are furniſhed with claws, and it makes a croaking noiſe, he concluded from theſe properties, as well as from the ſituation of the anus, that it could not be the larva of the lizard, and therefore formed of it a new genus under the name of *ſiren*. He was alſo obliged to eſtabliſh for this uncommon animal a new order called *meantes* or *gliders*; the animals of which are amphibious, breathing by means of gills and lungs, and furniſhed with arms and claws.

Phil. Tranſ. vol. lvi. p. 189.

SIREX, a genus of inſects belonging to the order of *hymenopteræ*. See ENTOMOLOGY *Index*.

SIRIUM, a genus of plants belonging to the claſs of tetrandria and order of monogynia. See BOTANY *Index*.

SIRIUS, in *Aſtronomy*, a bright ſtar in the conſtellation Canis. See ASTRONOMY, Nº 403, &c.

SIRLET, FLAVIUS, an eminent Roman engraver on precious ſtones: his Laocoon, and repreſentations in miniature of antique ſtatues at Rome, are very valuable and ſcarce. He died in 1737.

SIROCCO, a periodical wind which generally blows in Italy and Dalmatia every year about Eaſter. It blows from the ſouth-eaſt by ſouth: it is attended with heat, but not rain; its ordinary period is twenty days, and it uſually ceaſes at ſunſet. When the ſirocco does not blow in this manner, the ſummer is almoſt free from weſterly winds, whirlwinds, and ſtorms. This wind is prejudicial to plants, drying and burning up the buds; though it hurts not men any otherwiſe than by cauſing an extraordinary weakneſs and laſſitude; inconveniences that are fully compenſated by a plentiful fiſhing, and a good crop of corn on the mountains. In the ſummer time, when the weſterly wind ceaſes for a day, it is a ſign that the ſirocco will blow the day following, which uſually begins with a ſort of whirlwind.

Fortis's Travels into Dalmatia, p. 277.

SISKIN. See FRINGILLA, ORNITHOLOGY *Index*.

SISON, BASTARD STONE PARSLEY, a genus of plants belonging to the claſs of pentandria, and to the order of digynia; and in the natural ſyſtem arranged under the 45th order, *Umbellatæ*. See BOTANY *Index*.

SISTRUM, or CISTRUM, a kind of ancient muſical inſtrument uſed by the prieſts of Iſis and Oſiris. It is deſcribed by Spon as of an oval form, in manner of a racket, with three ſticks traverſing it breadthwiſe; which playing freely by the agitation of the whole inſtrument, yielded a kind of ſound which to them ſeemed melodious. Mr Malcom takes the ſiſtrum to be no better than a kind of rattle. Oiſelius obſerves, that the ſiſtrum is found repreſented on ſeveral medals, and on taliſmans.

SISYMBRIUM, WATER-CRESSES, a genus of plants belonging to the claſs of *tetradynamia*, and to the order of *ſiliquoſa*; and in the natural ſyſtem ranged under the 39th order, *Siliquoſæ*. See BOTANY *Index*.

SISYPHUS, in fabulous hiſtory, one of the deſcendants of Eolus, married Merope, one of the Pleiades, who bore him Glaucus. He reſided at Epyra in Peloponneſus, and was a very crafty man. Others ſay, that he was a Trojan ſecretary, who was puniſhed for diſcovering

vering ſecrets of ſtate; and others again, that he was a notorious robber, killed by Theſeus. However, all the poets agree that he was puniſhed in Tartarus for his crimes, by rolling a great ſtone to the top of a hill, which conſtantly recoiled, and, rolling down inceſſantly, renewed his labour.

SISYRINCHIUM, a genus of plants belonging to the claſs of *gynandria*, and order of *triandria;* and in the natural ſyſtem ranged under the 5th order, *Enſatæ*. See BOTANY *Index*.

SITE, denotes the ſituation of an houſe, &c. and ſometimes the ground-plot or ſpot of earth on which it ſtands.

SITTA, NUTHATCH, a genus of birds belonging to the order of *picæ*. See ORNITHOLOGY *Index*.

SITOPHYLAX, Σιτοφυλαξ, formed from σιτος, "corn," and φυλαξ, "keeper," in antiquity, an Athenian magiſtrate, who had the ſuperintendence of the corn, and was to take care that nobody bought more than was neceſſary for the proviſion of his family. By the Attic laws, particular perſons were prohibited from buying more than fifty meaſures of wheat a man; and that ſuch perſons might not purchaſe more, the ſitophylax was appointed to ſee the laws properly executed. It was a capital crime to prevaricate in it. There were 15 of theſe *ſitophylaces*, ten for the city, and five for the Piræus.

SITUS, in *Algebra* and *Geometry*, denotes the ſituation of lines, ſurfaces, &c. Worſius delivers ſome things in geometry, which are not deduced from common analyſis, particularly matters depending on the *ſitus* of lines and figures. Leibnitz has even founded a particular kind of analyſis upon it, called *calculus ſitus*.

SIVA, a name given by the Hindoos to the Supreme Being, when conſidered as the avenger or deſtroyer. Sir William Jones has ſhown that in ſeveral reſpects the character of Jupiter and Siva are the ſame. As Jupiter overthrew the Titans and giants, ſo did Siva overthrow the Daityas, or children of Diti, who frequently rebelled againſt Heaven; and as during the conteſt the god of Olympus was furniſhed with lightning and thunderbolts by an eagle, ſo Brahma, who is ſometimes repreſented riding on the Garuda, or eagle, preſented the god of deſtruction with fiery ſhafts. Siva alſo correſponds with the Stygian Jove, or Pluto; for, if we can rely on a Perſian tranſlation of the Bhágavat, the ſovereign of Pátála, or the infernal regions, is the king of ſerpents, named *Seſhanaga*, who is exhibited in painting and ſculpture, with a diadem and ſceptre, in the ſame manner as Pluto. There is yet another attribute of Siva, or Mahádéva, by which he is viſibly diſtinguiſhed in the drawings and temples of Bengal. To deſtroy, according to the Vedantis of India, the Sufis of Perſia, and many philoſophers of our European ſchools, is only to generate and reproduce in another form. Hence the god of deſtruction is holden in this country to preſide over generation, as a ſymbol of which he rides on a white bull. Can we doubt that the loves and feats of Jupiter Genitor (not forgetting the white bull of Europa), and his extraordinary title of Lapis, for which no ſatisfactory reaſon is commonly given, have a connection with the Indian philoſophy and mythology?

*atic Re-
rches.*

SIUM, WATER PARSNEP, a genus of plants belonging to the claſs of *pentandria*, and order of *digynia*, and in the natural ſyſtem ranging under the 44th order, *Umbellatæ*. See BOTANY *Index*.

Siwa.

SIWA, or SIWAH, a town in Egypt to the weſtward of Alexandria, built on a ſmall fertile ſpot, ſurrounded on all ſides by deſert land. A conſiderable portion of this ſpace is filled with date trees, but there are alſo plantains, pomegranates, figs, apricots, and olives; and the gardens are in a very flouriſhing condition. The people cultivate rice, which is of a reddiſh colour, and different from that of the Delta. The reſt of the land furniſhes abundance of wheat for the conſumption of the inhabitants.

The greateſt curioſity about Siwa is a ruin of undoubted antiquity, meaſuring 32 feet in length, 18 in height, and 15 in breadth, which does not appear ever to have been much larger. Mr Horneman eſtimates the dimenſions of it at 36 feet long, 24 feet wide, and 27 high, which agrees with no other traveller whatever; and indeed Mr Horneman himſelf allows that the jealouſy of the natives prevented him from purſuing any plan of accurate examination or admeaſurement. The people of Siwa have no tradition reſpecting this edifice, nor attribute any quality to it, but that of concealing treaſures, and as the haunt of demons. It has, however, been ſuppoſed, that Siwa is the *Siropum* of Pliny, and that this building was coeval with the temple of Jupiter Ammon, and a dependency on it; yet neither the natives of Siwa, nor the various tribes of Arabs who frequent that place, know any thing of the ruins of that temple, about which Mr Browne made every poſſible enquiry.

The complexion of the people of Siwa is generally darker than that of the Egyptians, and their dialect is alſo different. They do not habitually make uſe of ſnuff or tobacco. Their ſect is that of Malik. The dreſs of the lower claſs is very ſimple, as they are almoſt naked; among thoſe whoſe coſtume was diſcernible, it approaches nearer to that of the Arabs of the deſert than the Egyptians or Moors. Their clothing conſiſts of a ſhirt of white cotton, with large ſleeves reaching to the feet, a red cap without a turban, and ſhoes of the ſame colour. Some earthen ware made by themſelves, and a few mats, form the chief part of their houſehold furniture, none but the higher ranks being poſſeſſed of copper utenſils. They ſometimes purchaſe a few ſlaves from the Mourzouk caravan. The reſt of their wants are ſupplied from Cairo or Alexandria, whither their dates are tranſported, both in a dry ſtate, and beaten into maſh, which, when good, greatly reſembles a ſweet meat. They do not eat large quantities of animal food, and bread known to us is uncommon. They drink plentifully of the liquor extracted from the date tree, which they call *date-tree water*, though it has frequently the power of inebriating in the ſtate in which they drink it. Their animals are the hairy ſheep and goat of Egypt, the aſs, and a very ſmall number of oxen and camels. The women wear veils as in Egypt. After the rains, the ground in the vicinity of Siwa is covered with ſalt for many weeks.

Siwa has ſometimes been compared to a bee hive, which it very much reſembles, whether in reſpect to the general appearance of the eminence covered with buildings, the ſwarm of its people crowded together, or the confuſed noiſe, or hum and buz from its narrow paſſages and ſtreets, and which reach the ear at a conſiderable diſtance. North-weſt of the town there is a ſtratum of ſalt extending a full mile, and near it ſalt is found on the ſurface. There are numerous ſprings, and frequently a ſpring of water perfectly ſweet is found within a few paces of one that is ſalt. The people, according to Horneman, are obtruſive and thieviſh. Siwa is ſituated in 29° 12′ N. Lat. and 44° 54′ E. Long.

SIX-CLERKS, officers in chancery of great account, next in degree below the twelve maſters, whoſe buſineſs it is to enrol commiſſions, pardons, patents, warrants, &c. which paſs the great ſeal, and to tranſact and file all proceedings by bill, anſwer, &c. They were anciently *clerici*, and forfeited their places, if they married; but when the conſtitution of the court began to alter, a law was made to permit them to marry, Stat. 14. and 15. Hen. VIII. cap. 8. They are alſo ſolicitors for parties in ſuits depending in the court of chancery. Under them are ſix deputies and 60 clerks, who, with the under clerks, do the buſineſs of the office.

SIX NATIONS. See NIAGARA.

SIXTH, in *Muſic*, one of the ſimple original concords, or harmonical intervals. See INTERVAL.

SIXTUS V. POPE, was born the 13th December, 1521, in La Marca, a village in the ſeigniory of Montalto. His father, Francis Peretti, was a gardener, and his mother a ſervant maid. He was their eldeſt child, and was called Felix. At the age of nine he was hired out to an inhabitant of the village to keep ſheep; but diſobliging his maſter, he was ſoon after degraded to be keeper of the hogs. He was engaged in this employment when Father Michael Angelo Selleri, a Franciſcan friar, aſked the road to Aſcoli, where he was going to preach. Young Felix conducted him thither, and ſtruck the father ſo much with his converſation and eagerneſs for knowledge, that he recommended him to the fraternity to which he had come. Accordingly he was received among them, inveſted with the habit of a lay brother, and placed under the ſacriſtan, to aſſiſt in ſweeping the church, lighting the candles, and other offices of that nature; for which he was to be taught the reſponſes, and the rudiments of grammar. His progreſs in learning was ſo ſurpriſing, that at the age of 14 he was thought qualified to begin his noviciate, and was admitted the year following to make his profeſſion.

He purſued his ſtudies with ſuch unwearied aſſiduity, that he was ſoon reckoned equal to the beſt diſputants. He was ordained prieſt in 1545; when he aſſumed the name of Father Montalto; ſoon after he took his doctor's degree, and was appointed profeſſor of theology at Sienna. It was then that he ſo effectually recommended himſelf to Cardinal di Carpi, and his ſecretary Boſſius, that they ever remained his ſteady friends. Meanwhile the ſeverity and obſtinacy of his temper inceſſantly engaged him in diſputes with his monaſtic brethren. His reputation for eloquence, which was now ſpread over Italy, about this time gained him ſome new friends. Among theſe were the Colonna family, and Father Ghiſilieri, by whoſe recommendation he was appointed inquiſitor-general at Venice: but he exerciſed that office with ſo much ſeverity, that he was obliged to flee precipitately from that city. Upon this he went to Rome, where he was made procurator-general of his order, and ſoon after accompanied Cardinal Buon Compagnon into Spain, as a chaplain and conſultor to the inquiſition. There he was treated with great reſpect, and liberal offers were made him to induce him to continue in Spain, which, however, he could not be prevailed on to accept.

In the mean time, news were brought to Madrid that Pius IV. was dead, and that Father Ghiſilieri, who had been made Cardinal Alexandrino by Paul IV. had ſucceeded him under the name of Pius V. Theſe tidings filled Montalto with joy, and not without reaſon, for he was immediately inveſted by the pontiff with new dignities. He was made general of his order, biſhop of St Agatha, was ſoon after raiſed to the dignity of cardinal, and received a penſion. Abut this time he was employed by the pope to draw up the bill of excommunication againſt Queen Elizabeth.

He began now to caſt his eyes upon the papacy; and, in order to obtain it, formed and executed a plan of hypocriſy with unparalleled conſtancy and ſucceſs. He became humble, patient, and affable. He changed his dreſs, his air, his words, and his actions, ſo completely, that his moſt intimate friends declared him a new man. Never was there ſuch an abſolute victory gained over the paſſions; never was a fictitious character ſo long maintained, nor the foibles of human nature ſo artfully concealed. He courted the ambaſſadors of every foreign power, but attached himſelf to the intereſts of none; nor did he accept a ſingle favour that would have laid him under any peculiar obligation. He had formerly treated his relations with the greateſt tenderneſs, but he now changed his behaviour altogether. When his brother Anthony came to viſit him, he lodged him in an inn, and ſent him home next day, charging him to inform his family that he was now dead to his relations and the world.

When Pius V. died in 1572, he entered the conclave with the other cardinals, but ſeemed altogether indifferent about the election, and never left his apartment except to his devotion. When ſolicited to join any party, he declined it, declaring that he was of no conſequence, and that he would leave the choice of a pope entirely to perſons of greater knowledge and experience. When Cardinal Buon Compagnon, who aſſumed the name of Gregory XIII. was elected, Montalto aſſured him that he never wiſhed for any thing ſo much in his life, and that he would always remember his goodneſs, and the favours he had conferred on him in Spain. But the new pope treated him with the greateſt contempt, and deprived him of his penſion. The cardinals alſo, deceived by his artifices, paid him no greater reſpect, and uſed to call him, by way of ridicule, the Roman beaſt; the aſs of La Marca.

He now aſſumed all the infirmities of old age; his head hung down upon his ſhoulders; he tottered as he walked, and ſupported himſelf on a ſtaff. His voice became feeble, and was often interrupted by a cough ſo exceedingly ſevere, that it ſeemed every moment to threaten his diſſolution. He interfered in no public tranſactions, but ſpent his whole time in acts of devotion and benevolence. Mean time he conſtantly employed the ableſt ſpies, who brought him intelligence of every particular.

When Gregory XIII. died in 1585, he entered the conclave with the greateſt reluctance, and immediately ſhut himſelf up in his chamber, and was no more thought of than if he had not exiſted. When he went to maſs, for which purpoſe alone he left his apartment, he appeared perfectly indifferent about the event of the election. He joined no party, yet flattered all.

He knew early that there would be great diviſions in the conclave, and he was aware that when the leaders of the different parties were diſappointed in their own views, they all frequently agreed in the election of ſome old and infirm cardinal, the length of whoſe life would merely enable them to prepare themſelves ſufficiently for the next vacancy. Theſe views directed his conduct, nor was he miſtaken in his hopes of ſucceſs.

Three cardinals, the leaders of oppoſite factions, being unable to procure the election which each of them wiſhed, unanimouſly agreed to make choice of Montalto. When they came to acquaint him with their intention, he fell into ſuch a violent fit of coughing that every perſon thought he would expire on the ſpot. He told them that his reign would laſt but a few days; that, beſides a continual difficulty of breathing, he wanted ſtrength to ſupport ſuch a weight, and that his ſmall experience rendered him very unfit for ſo important a charge. He conjured them all three not to abandon him, but to take the whole weight of affairs upon their own ſhoulders; and declared that he would never accept the mitre upon any other terms: "If you are reſolved," added he, "to make me pope, it will only be placing yourſelves on the throne. For my part, I ſhall be ſatisfied with the bare title. Let the world call me pope, and I make you heartily welcome to the power and authority." The cardinals ſwallowed the bait, and exerted themſelves ſo effectually that Montalto was elected. He now pulled off the maſk which he had worn for 14 years. No ſooner was his election ſecured, than he ſtarted from his ſeat, flung down his ſtaff in the middle of the hall, and appeared almoſt a foot taller than he had done for ſeveral years.

When he was aſked, according to cuſtom, if he would accept of the papacy, he replied, "It is trifling to aſk whether I will accept what I have already accepted.—However, to ſatiſfy any ſcruple that may ariſe, I tell you that I accept it with great pleaſure, and would accept another if I could get it; for I find myſelf able, by the Divine aſſiſtance, to manage two papacies." His former complaiſance and humility diſappeared, together with his infirmities, and he now treated all around him with reſerve and haughtineſs. The firſt care of Sixtus V. the name which Montalto aſſumed, was to correct the abuſes, and put a ſtop to the enormities, which were daily committed in every part of the eccleſiaſtical ſtate. The lenity of Gregory's government had introduced a general licentiouſneſs of manners, which burſt forth with great violence, after that pontiff's death. It had been uſual with former popes to releaſe delinquents on the day of their coronation, who were therefore accuſtomed to ſurrender themſelves voluntary priſoners immediately after the election of the pope. At preſent, however, they were fatally diſappointed.—When the governor of Rome and the keeper of St Angelo waited on his Holineſs, to know his intention in this particular, he replied, "What have you to do with pardons, and releaſing of priſoners? Is it not ſufficient that our predeceſſor has ſuffered the judges to remain unemployed theſe 13 years? Shall we alſo ſtain our pontificate with the ſame neglect of juſtice? We have too long ſeen, with inexpreſſible concern, the prodigious degree of wickedneſs that reigns in the ſtate, to think of granting pardons. Let the priſoners be brought to a ſpeedy trial, and puniſhed as they deſerve, to ſhow the world that Divine Providence has called us to the chair of St Peter, to reward the good, and chaſtiſe the wicked: that we bear not the ſword in vain, but are the miniſters of God, and a revenger to execute wrath on them that do evil."

He appointed commiſſioners to inſpect the conduct of the judges, diſplaced thoſe who were inclined to lenity, and put others of ſevere diſpoſitions in their room. He offered rewards to any perſon who could convict them of corruption or partiality. He ordered the ſyndics of all the towns and ſigniories to make out a complete liſt of the diſorderly perſons within their diſtricts, and threatened the ſtrapado for the ſmalleſt omiſſion. In conſequence of this edict, the ſyndic of Albino was ſcourged in the market-place, becauſe he had left his nephew, an incorrigible libertine, out of his liſt.

He made very ſevere laws againſt robbers and aſſaſſins. Adulterers, when diſcovered, ſuffered death; and they who willingly ſubmitted to the proſtitution of their wives, a cuſtom then common in Rome, received the ſame puniſhment. He was particularly careful of the purity of the female ſex, and never forgave thoſe who attempted to debauch them.

His execution of juſtice was as prompt as his edicts were rigorous. A Swiſs happening to give a Spaniſh gentleman a blow with his halberd, was ſtruck by him ſo rudely with a pilgrim's ſtaff that he expired on the ſpot. Sixtus informed the governor of Rome that he was to dine early, and that juſtice muſt be executed on the criminal before he ſat down to table. The Spaniſh ambaſſador and four cardinals intreated him not to diſgrace the gentleman by ſuffering him to die on a gibbet, but to order him to be beheaded. "He ſhall be hanged (replied Sixtus), but I will alleviate his diſgrace by doing him the honour to aſſiſt perſonally at his death." He ordered a gibbet to be erected before his own windows, where he continued ſitting during the whole execution. He then called to his ſervants to bring in dinner, declaring that the act of juſtice which he had juſt ſeen had increaſed his appetite. When he roſe from table, he exclaimed, "God be praiſed for the good appetite with which I have dined!"

When Sixtus aſcended the throne, the whole eccleſiaſtical ſtate was infeſted with bands of robbers, who from their numbers and outrages, were exceedingly formidable; by his prudent and vigorous conduct, however, he in a ſhort time extirpated the whole of theſe banditti.

Nor was the vigour of his conduct leſs conſpicuous in his tranſactions with foreign nations. Before he had been pope two months he quarrelled with Philip II. of Spain, Henry III. of France, and Henry king of Navarre. His intrigues indeed in ſome meaſure influenced all the councils of Europe.

After his acceſſion to the pontificate he ſent for his family to Rome, with expreſs orders that they ſhould appear in a decent and modeſt manner. Accordingly, his ſiſter Camilla came thither, accompanied by her daughter and two grandchildren. Some cardinals, in order to pay court to the pope, went out to meet her, and introduced her in a very magnificent dreſs. Sixtus pretended not to know her, and aſked two or three times

times who ſhe was: Upon this one of the cardinals ſaid, “ It is your ſiſter, holy father.” “ I have but one ſiſter (replied Sixtus with a frown), and ſhe is a poor woman at Le Grotte; if you have introduced her in this diſguiſe, I declare I do not know her; yet I think I would know her again, if I ſaw her in the clothes ſhe uſed to wear.”

Her conductors at laſt found it neceſſary to carry her to an inn, and ſtrip her of her finery. When Camilla was introduced a ſecond time, Sixtus embraced her tenderly, and ſaid, “ Now we know indeed that it is our ſiſter: nobody ſhall make a princeſs of you but ourſelves.” He ſtipulated with his ſiſter, that ſhe ſhould neither aſk any favour in matters of government, nor intercede for criminals, nor interfere in the adminiſtration of juſtice; declaring that every requeſt of that kind would meet with a certain refuſal. Theſe terms being agreed to, and punctually obſerved, he made the moſt ample proviſion not only for Camilla but for his whole relations.

This great man was alſo an encourager of learning. He cauſed an Italian tranſlation of the Bible to be publiſhed, which raiſed a good deal of diſcontent among the Catholics. When ſome cardinals reproached him for his conduct in this reſpect, he replied, “ It was publiſhed for the benefit of you cardinals who cannot read Latin.”

Sixtus died in 1590, after having reigned little more than five years. His death was aſcribed to poiſon, ſaid to have been adminiſtered by the Spaniards; but the ſtory ſeems rather improbable.

It was to the indulgence of a diſpoſition naturally formed for ſeverity, that all the defects of this wonderful man are to be aſcribed. Clemency was a ſtranger to his boſom; his puniſhments were often too cruel, and ſeemed ſometimes to border on revenge. Paſquin was dreſſed one morning in a very naſty ſhirt, and being aſked by Marforio why he wore ſuch dirty linen? replied, that he could get no other, for the pope had made his waſherwoman a princeſs, alluding to Camilla, who had formerly been a laundreſs. The pope ordered ſtrict ſearch to be made for the author of this lampoon, and offered him his life and a thouſand piſtoles if he would diſcover himſelf. The author was ſimple enough to make his appearance and claim the reward. “ It is true (ſaid the pope) we made ſuch a promiſe, and we ſhall keep it; your life ſhall be ſpared, and you ſhall receive the money preſently: but we have reſerved to ourſelves the power of cutting off your hands and boring your tongue through, to prevent your being ſo witty for the future.” It is needleſs to add, that the ſentence was immediately executed. This, however, is the only inſtance of his reſenting the many ſevere ſatires that were publiſhed againſt him.

But though the conduct of Sixtus ſeldom excites love, it generally commands our eſteem, and ſometimes our admiration. He ſtrenuouſly defended the cauſe of the poor, the widow, and the orphan: he never refuſed audience to the injured, however wretched or forlorn their appearance was. He never forgave thoſe magiſtrates who were capable of partiality or corruption; nor ſuffered crimes to paſs unpuniſhed, whether committed by the rich or the poor. He was frugal, temperate, ſober, and never neglected to reward the ſmalleſt favour which had been conferred on him before his exaltation.

When he mounted the throne, the treaſury was not only exhauſted, but in debt: at his death it contained five millions of gold.

Rome was indebted to him for ſeveral of her greateſt embelliſhments, particularly the Vatican library: it was by him, too, that trade was firſt introduced into the Eccleſiaſtical State.

SIYA-GHUSH, the caracal of Buffon, an animal of the cat kind. See FELIS, MAMMALIA *Index*.

SIZAR, or SIZER, in Latin *Sizator*, an appellation by which the loweſt order of ſtudents in the univerſities of Cambridge and Dublin are diſtinguiſhed, is derived from the word *ſize*, which in Cambridge, and probably in Dublin likewiſe, has a peculiar meaning. To *ſize*, in the language of the univerſity, is to get any ſort of victuals from the kitchens, which the ſtudents may want in their own rooms, or in addition to their commons in the hall, and for which they pay the cooks or butchers at the end of each quarter. A ſize of any thing is the ſmalleſt quantity of that thing which can be thus bought: two ſizes, or a part of beef, being nearly equal to what a young perſon will eat of that diſh to his dinner; and a ſize of ale or beer being equal to half an Engliſh pint.

The ſizars are divided into two claſſes, viz. ſubſizatores or ſizars, and ſizatores or proper ſizars. The former of theſe are ſupplied with commons from the table of the fellows and fellow commoners; and in former times, when theſe were more ſcanty than they are now, they were obliged to ſupply the deficiency by ſizing, as is ſometimes the caſe ſtill. The proper ſizars had formerly no commons at all, and were therefore obliged to ſize the whole. In St John's college they have now ſome commons allowed them for dinner, from a benefaction, but they are ſtill obliged to ſize their ſuppers: in the other colleges they are allowed a part of the fellow-commons, but muſt ſize the reſt; and from being thus obliged to ſize the whole or part of their victuals, the whole order derived the name of *ſizars*.

In Oxford, the order ſimilar to that of ſizar is denominated *ſervitor*, a name evidently derived from the menial duties which they perform. In both univerſities theſe orders were formerly diſtinguiſhed by round caps and gowns of different materials from thoſe of the penſioners or commoners, the order immediately above them. But about 30 years ago the round cap was entirely aboliſhed in both ſeminaries. There is ſtill, however, in Oxford, we believe, a diſtinction in the gowns, and there is alſo a trifling difference in ſome of the ſmall colleges in Cambridge; but in the largeſt colleges the dreſs of the penſioners and ſizars is entirely the ſame.

In Oxford, the ſervitors are ſtill obliged to wait at table on the fellows and gentlemen-commoners; but much to the credit of the univerſity of Cambridge, this moſt degrading and diſgraceful cuſtom was entirely aboliſhed about 10 or 12 years ago, and of courſe the ſizars of Cambridge are now on a much more reſpectable footing than the ſervitors of Oxford.

The ſizars are not upon the foundation, and therefore while they continue ſizars are not capable of being elected fellows; but they may at any time, if they chooſe, become penſioners; and they generally ſit for ſcholarſhips immediately before they take their firſt degrees. If ſucceſsful, they are then on the foundation, and are entitled to become candidates for fellowſhips when they have got that degree. In the mean time, while they continue ſizars, beſides free commons they enjoy many benefactions, which have been made at different times, under the name of *ſizar's prœtor*, *exhibitions*, &c. and the rate of tuition, the rent of rooms, and other things of that ſort within their reſpective colleges, is leſs than to the other orders. But though their education is thus obtained at a leſs expence, they are not now conſidered as a menial order; for ſizars, penſioner-ſcholars, and even ſometimes fellow-commoners, mix together with the utmoſt cordiality. It is worthy of remark, that at every period this order has ſupplied the univerſity with its moſt diſtinguiſhed officers; and that many of the moſt illuſtrious members of the church, many of the moſt diſtinguiſhed men in the other liberal profeſſions, have, when under-graduates, been ſizars, when that order was on a leſs reſpectable footing than it is now.

SIZE, the name of an inſtrument uſed for finding the bigneſs of fine round pearls. It conſiſts of thin pieces or leaves, about two inches long, and half an inch broad, faſtened together at one end by a rivet. In each of theſe are round holes drilled of different diameters. Thoſe in the firſt leaf ſerve for meaſuring pearls from half a grain to ſeven grains; thoſe of the ſecond, for pearls from eight grains or two carats to five carats, &c.; and thoſe of the third, for pearls from ſix carats and a half to eight carats and a half.

SIZE, is alſo a ſort of paint, varniſh, or glue, uſed by painters, &c.

The ſhreds and parings of leather, parchment, or vellum, being boiled in water and ſtrained, make ſize. This ſubſtance is much uſed in many trades.—The manner of uſing ſize is to melt ſome of it over a gentle fire; and ſcraping as much whiting into it as will juſt colour it, let them be well incorporated together; after which you may whiten frames, &c. with it. After it dries, melt the ſize again, and put more whiting and whiten the frames, &c. ſeven or eight times, letting it dry between each time: but before it is quite dry, between each waſhing with ſize, you muſt ſmooth and wet it over with a clean bruſh-pencil in fair water.

To make gold-ſize. Take gum-anime and aſphaltum, of each one ounce; minium, litharge of gold, and amber, of each half an ounce: reduce all into a very fine powder, and add to them four ounces of linſeed oil, and eight ounces of drying oil: digeſt them over a gentle fire that does not flame, ſo that the mixture may only ſimmer, but not boil; leſt it ſhould run over and ſet the houſe on fire, ſtir it conſtantly with a ſtick till all the ingredients are diſſolved and incorporated, and do not leave off ſtirring till it becomes thick and ropy; after being ſufficiently boiled, let it ſtand till it is almoſt cold, and then ſtrain it through a coarſe linen cloth, and keep it for uſe.—To prepare it for working, put what quantity you pleaſe in a horſe-muſcle ſhell, adding as much oil of turpentine as will diſſolve it; and making it as thin as the bottom of your ſeed-lac varniſh, hold it over a candle, and then ſtrain it through a linen-rag into another ſhell; add to theſe as much vermilion as will make it of a darkiſh red: if it is too thick for drawing, you may thin it with ſome oil of turpentine. The chief uſe of this ſize is for laying on metals.

The beſt gold ſize for burniſhing is made as follows: Take fine bole, what quantity you pleaſe; grind it finely on a piece of marble, then ſcrape into it a little beef ſuet; grind all well together; after which mix in a ſmall proportion of parchment ſize, with a double proportion of water, and it is done.

To make ſilver-ſize. Take tobacco-pipe clay in fine powder, into which ſcrape ſome black-lead and a little Genoa ſoap, and grind them all together with parchment ſize as already directed.

SKATING, an exerciſe on ice, both graceful and healthy. Although the ancients were remarkable for their dexterity in moſt of the athletic ſports, yet ſkating ſeems to have been unknown to them. It may therefore be conſidered as a modern invention; and probably it derived its origin in Holland, where it was practiſed, not only as a graceful and elegant amuſement, but as an expeditious mode of travelling when the lakes and canals were frozen up during winter. In Holland long journeys are made upon ſkates with eaſe and expedition; but in general leſs attention is there paid to graceful and elegant movements, than to the expedition and celerity of what is called *journey ſkating*. It is only in thoſe countries where it is conſidered as an amuſement, that its graceful attitudes and movements can be ſtudied; and there is no exerciſe whatever better calculated to ſet off the human figure to advantage. The acquirement of moſt exerciſes may be attained at an advanced period of life; but to become an expert ſkater, it is neceſſary to begin the practice of the art at a very early age. It is difficult to reduce the art of ſkating to a ſyſtem. It is principally by the imitation of a good ſkater that a young practitioner can form his own practice. The Engliſh, though often remarkable for feats of agility upon ſkates, are very deficient in gracefulneſs: which is partly owing to the conſtruction of the ſkates. They are too much curved in the ſurface which embraces the ice, conſequently they involuntarily bring the uſers of them round on the outſide upon a quick and ſmall circle; whereas the ſkater, by uſing ſkates of a different conſtruction, leſs curved, has the command of his ſtroke, and can enlarge or diminiſh the circle according to his own wiſh and deſire. The metropolis of Scotland has produced more inſtances of elegant ſkaters than perhaps any other country whatever; and the inſtitution of a ſkating club about 50 years ago, has contributed not a little to the improvement of this elegant amuſement. We are indebted for this article to a gentleman of that club, who has made the practice and improvement of ſkating his particular ſtudy; and as the nature of our work will not permit the inſertion of a full treatiſe on ſkating, we ſhall preſent our readers with a few inſtructions.

Thoſe who wiſh to be proficients ſhould begin at an early period of life; and ſhould firſt endeavour to throw off the fear which always attends the commencement of an apparently hazardous amuſement. They will ſoon acquire a facility of moving on the inſide: when they have done this, they muſt endeavour to acquire the movement on the outſide of the ſkates; which is nothing more than throwing themſelves upon the outer edge of the ſkate, and making the balance of their body tend towards that ſide, which will neceſſarily enable them to form a ſemicircle. In this, much aſſiſtance may be derived from placing a bag of lead-ſhot in the pocket next to the foot employed in making the outſide ſtroke, which will produce an artificial poiſe of the body, which afterwards will become natural by practice. At the commencement of the outſide ſtroke, the knee of the employed limb ſhould be a little bended, and gradually brought to a rectilineal poſition when the ſtroke is completed. When the practitioner becomes expert in forming the ſemicircle with both feet, he is then to join them together, and proceed progreſſively and alternately with both feet, which will carry him forward with a graceful movement. Care ſhould be taken to uſe very little muſcular exertion, for the impelling motion ſhould proceed from the mechanical impulſe of the body thrown into ſuch a poſition as to regulate the ſtroke. At taking the outſide ſtroke, the body ought to be thrown forward eaſily, the unemployed limb kept in a direct line with the body, and the face and eyes directly looking forward: the unemployed foot ought to be ſtretched towards the ice, with the toes in a direct line with the leg. In the time of making the curve, the body muſt be gradually, and almoſt imperceptibly, raiſed, and the unemployed limb brought in the ſame manner forward; ſo that, at finiſhing the curve, the body will bend a ſmall degree backward, and the unemployed foot will be about two inches before the other, ready to embrace the ice and form a correſpondent curve. The muſcular movement of the whole body muſt correſpond with the movement of the ſkate, and ſhould be regulated ſo as to be almoſt imperceptible to the ſpectators. Particular attention ſhould be paid in carrying round the head and eyes with a regular and imperceptible motion; for nothing ſo much diminiſhes the grace and elegance of ſkating as ſudden jerks and exertions, which are too frequently uſed by the generality of ſkaters. The management of the arms likewiſe deſerves attention. There is no mode of diſpoſing of them more gracefully in ſkating outſide, than folding the hands into each other, or uſing a muff.

There are various feats of activity and manœuvres uſed upon ſkates; but they are ſo various that we cannot pretend to detail them. Moving on the outſide is the primary object for a ſkater to attain; and when he becomes an adept in that, he will eaſily acquire a facility in executing other branches of the art. There are few exerciſes but will afford him hints of elegant and graceful attitudes. For example, nothing can be more beautiful than the attitude of drawing the bow and arrow whilſt the ſkater is making a large circle on the outſide: the manual exerciſe and military ſalutes have likewiſe a pretty effect when uſed by an expert ſkater.

SKELETON, in *Anatomy*, the dried bones of any animal joined together by wires, or by the natural ligament dried, in ſuch a manner as to ſhow their poſition when the creature was alive.

We have, in the Philoſophical Tranſactions, an account of a human ſkeleton, all the bones of which were ſo united, as to make but one articulation from the back to the os ſacrum, and downwards a little way. On ſawing ſome of them, where they were unnaturally joined, they were found not to cohere throughout their whole ſubſtance, but only about a ſixth of an inch deep all round. The figure of the trunk was crooked, the ſpinæ making the convex, and the inſide of the vertebræ the concave part of the ſegment. The whole had been found in a charnel-houſe, and was of the ſize of a full grown perſon.

SKIDS, or SKEEDS, in ſea-language, are long compaſſing pieces of timber, notched below ſo as to fit cloſely upon the wales, extending from the main-wale to the top of the ſide, and retained in this poſition by bolts or ſpike-nails. They are intended for preſerving the planks of the ſide, when any heavy body is hoiſted or lowered.

SKIE, ISLE OF. See SKYE.

SKIFF, a ſmall boat reſembling a yawl, uſually employed for paſſing rivers.

SKIMMER, BLACK. See RHYNCHOPS, ORNITHOLOGY *Index*.

SKIMMIA, a genus of plants belonging to the tetrandria claſs; and in the natural method ranking under the 40th order, *Perſonatæ*. See BOTANY *Index*.

SKIN, in *Anatomy*, the general covering of the body of any animal. See ANATOMY, N° 74.

SKIN, in *Commerce*, is particularly uſed for the membrane ſtripped off the animal to be prepared by the tanner, ſkinner, parchment-maker, &c. and converted into leather, &c. See TANNING.

SKINNER, STEPHEN, an Engliſh antiquarian, was born in 1622. He travelled, and ſtudied in ſeveral foreign univerſities during the civil wars; and in 1654, returned and ſettled at Lincoln, where he practiſed phyſic with ſucceſs until the year 1667, when he died of a malignant fever. His works were collected in folio in 1671, by Mr Henſhaw, under the title of *Etymologicon Linguæ Anglicanæ*, &c.

SKIPPER, or SAURY, a ſpecies of fiſh. See ESOX, ICHTHYOLOGY *Index*.

SKIRMISH, in *War*, a ſlight engagement between ſmall parties, without any regular order; and is therefore eaſily diſtinguiſhed from a *battle*, which is a general engagement between two armies continued for ſome time.

SKIRMISH Bay, the name given by Lieutenant Broughton to a bay in an iſland which was diſcovered by him in latitude 43° 48′ ſouth, and in longitude 183° eaſt. The Chatham armed tender worked up into the bay, and came to anchor about a mile from the ſhore. When the captain and ſome of the people landed, they found the natives ſo extremely inhoſpitable, that ſelf-preſervation made it neceſſary to fire upon them. The land is of conſiderable magnitude, whether iſland or continent, and what they ſaw of it extended nearly 40 miles from eaſt to weſt, and the appearance of the country they regarded as very promiſing. The natives reſemble thoſe of New Zealand, from which they are diſtant about 100 leagues, but their ſkins were deſtitute of any marks, and they ſeemed to be cleanly in their perſons. Their dreſſes were of ſeal ſkin, while ſome had fine mats faſtened round the waiſt. Mr Broughton ſays, "on our firſt landing, their ſurpriſe and exclamations can hardly be imagined; they pointed to the ſun, and then to us, as if to aſk whether we had come from thence?" The arms they made uſe of were clubs, ſpears, and a ſmall weapon reſembling the patoo of New Zealand.

SKULL, in *Anatomy*, the bony caſe in which the brain is encloſed. See ANATOMY, N° 11, &c.

SKULL-*Cap*. See SCUTELLARIA, BOTANY *Index*.

SKY, the blue expanſe of air or atmoſphere. For the reaſon of its blue colour and concave figure, ſee OPTICS, N° 223.

SKYE, one of the greateſt of the Weſtern iſlands of Scotland, ſo called from *Skianach*, which in the Erſe dialect ſignifies *winged*, becauſe the two promontories of Valerneſs and Toterniſh, by which it is bounded on the north-weſt and north-eaſt, are ſuppoſed to reſemble wings. The iſland lies between the ſhire of Roſs and the weſtern part of Lewis. According to the computation of Mr Pennant, Dr Johnſon, and Dr Campbell, it is 60 miles in length, and nearly the ſame in width where broadeſt; according to others it is 50 miles in length, and in ſome places 30 broad. The iſland of Skye was formerly divided between two proprietors; the ſouthern part belonged to the laird of Macleod, ſaid to be lineally deſcended from Leod ſon to the black prince of Man, but part of this diviſion has fallen into other hands: the northern diſtrict is the property of Lord Macdonald, whoſe anceſtor was Donald, king or lord of the iſles, and chief of the numerous clan of Macdonalds, who are counted the moſt warlike of all the Highlanders. Skye is part of the ſhire of Inverneſs, and formerly belonged to the dioceſe of the Iſles: on the ſouth it is parted from the main land by a channel three leagues in breadth; though, at the ferry of Glenelg, it is ſo narrow that a man may be heard calling for the boat from one ſide to the other. Skye is well provided with a variety of excellent bays and harbours.

The face of the country is roughened with mountains, ſome of which are ſo high as to be covered with ſnow on the top at midſummer; in general, their ſides are clothed with heath and graſs, which afford good paſturage for ſheep and black cattle. Between the mountains there are ſome fertile valleys, and the greater part of the land towards the ſea-coaſt is plain and arable. The iſland is well watered with a great number of rivers, above 30 of which afford ſalmon; and ſome of them produce black muſcles in which pearls are bred, particularly the rivers Kilmartin and Ord: Martin was aſſured by the proprietor of the former, that a pearl hath been found in it valued at 20l. ſterling. Here is alſo a conſiderable number of freſh-water lakes well ſtored with trout and eels. The largeſt of theſe lakes takes its denomination from St Columba, to whom is dedicated a chapel that ſtands upon a ſmall iſle in the middle of the lake. Skye likewiſe affords ſeveral cataracts, that roar down the rocks with great impetuoſity. That the iſland has been formerly covered with woods, appears from the large trunks of fir and other trees daily dug out of the bogs and peat-marſhes in every part of the country.

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From the height of the hills, and proximity of the ſea, the air ſeldom continues long of the ſame temperature; ſometimes it is dry, oftener moiſt, and in the latter end of winter and beginning of ſpring cold and piercing; at an average, three days in twelve throughout the year ſcarcely free from rain, far leſs from clouds. Theſe, attracted by the hills, ſometimes break in uſeful and refreſhing ſhowers; at other times ſuddenly burſting, pour down their contents with tremendous noiſe, in impetuous torrents that deluge the plains below, and render the ſmalleſt rivulet impaſſable; which, together with the ſtormy winds ſo common in this country in the months of Auguſt and September, frequently blaſt the hopes, and diſappoint the expectations, of the huſbandman. Snow has been often known to lie on the ground from three to ſeven weeks; and on the higheſt hills, even in the middle of June, ſome ſpots of it are to be ſeen. To this various temperature of the air, and uncertainty of weather, the fevers and agues, headachs, rheumatiſms, colds, and dyſenteries, which are the prevailing diſtempers, may be aſcribed. That it is far, however, from being unwholeſome, is ſufficiently evinced by experience; for the inhabitants are, in general, as ſtrong and healthy, and arrive at as advanced an age, as thoſe who live in milder climates, and under a ſerener ſky. The gout is ſcarcely known in this iſland.

The ſoil is generally black, though it likewiſe affords clay of different colours; ſuch as white, red, and blue, and in ſome places fuller's earth. It is, however, much leſs adapted for agriculture than for paſture, and ſeldom, unleſs, in very good years, ſupplies itſelf with a ſufficiency of proviſions. Yet, though the ſoil is not very fertile or rich, it might with proper management be made to produce more plentiful crops. But the generality of the farmers are ſo prejudiced in favour of old cuſtoms, and indeed ſo little inclined to induſtry, that they will not eaſily be prevailed on to change them for better; eſpecially if the alteration or amendment propoſed be attended with expence. Therefore, with reſpect to improvements in agriculture, they are ſtill much in the ſame ſtate as they were 20 or 30 years ago. Ploughs, on a new and improved model, that in compariſon to the advantages derived from them might be had at a moderate expence, have lately been introduced into ſeveral diſtricts around, where their good effects are manifeſt in improving the crops and diminiſhing the labour of man and beaſt; but the laird of Raaſay and one other gentleman are the only perſons in Portree that have uſed them. The *caſcroim*, a crooked kind of ſpade, is almoſt the only inſtrument for labouring the ground uſed among the ordinary claſs of tenants. The average crops of corn are 8000 bolls.

When Mr Knox viſited this iſland in 1786, the number of inhabitants amounted to 15,000; but between 1790-98, according to the Statiſtical Hiſtory of Scotland, the population is only 14,470.

Various minerals are found in Skye, but none have been wrought to any advantage. Near the village of Sartle, the natives find black and white marcaſites, and variegated pebbles. The Appleſglen, in the neighbourhood of Lochfallart, produces beautiful agates of different colours: ſtones of a purple hue are, after great rains, found in the rivulets: cryſtal, of different colours and forms, abounds in ſeveral parts of the iſland, as well as black and white marble, free-ſtone, lime-ſtone, and talc: ſmall red and white coral is found on the ſouthern and weſtern coaſts in great abundance. The fuel conſiſts chiefly of peat and turf, which are impregnated with iron ore; and coal has been diſcovered in ſeveral diſtricts; but it does not appear to be worth working.

The wild birds of all ſorts moſt common in the country, are, ſolan geeſe, gulls, cormorants, cranes, wild geeſe, and wild ducks; eagles, crows, ravens, rooks, cuckoos, rails, woodcocks, moor-fowl, partridges, plover, wild pigeons, and blackbirds, owls, hawks, ſnipes, and a variety of ſmall birds. In mild ſeaſons, the cuckoo and rail appear in the latter end of April; the former diſappears always before the end of June; the latter ſometimes not till September. The woodcock comes in October, and frequently remains till March. The tame ſorts of fowl are geeſe, ducks, turkeys, cocks, pullets, and tame pigeons.

The black cattle are here expoſed to all the rigours of the ſevere winter, without any other provender than the tops of the heath and the alga marina; ſo that they appear like mere ſkeletons in the ſpring; though, as the graſs grows up, they ſoon become plump and juicy, the beef being ſweet, tender, and finely interlarded.—The amphibious animals are ſeals and otters. Among the reptiles may be reckoned vipers, aſps, frogs, toads, and three different kinds of ſerpents; the firſt ſpotted black and white, and very poiſonous; the ſecond yellow, with brown ſpots; and the third of a brown colour, the ſmalleſt and leaſt poiſonous.

Whales, and cairbans or ſun-fiſh, come in ſometimes to the ſounds after their prey, but are rarely purſued with any ſucceſs. The fiſhes commonly caught on the coaſt are herrings, ling, cod, ſkate, haddock, mackerel, lythe, ſye, and dog-fiſh. The average price of ling at home is 13l 13s. per ton; when ſold, one by one, if freſh, the price is from 3d. to 5d.; if cured, from 5d. to 7d. The barrel of herrings ſeldom ſells under 19s. which is owing to the great difficulty of procuring ſalt, even ſometimes at any price; and the ſame cauſe prevents many from taking more than are ſufficient for their own uſe.

The kyle of Scalpe teems with oyſters, in ſuch a manner, that after ſome ſpring-tides, 20 horſe-loads of them are left upon the ſands. Near the village of Bernſtill, the beach yields muſcles ſufficient to maintain 60 perſons per day; this providential ſupply helps to ſupport many poor families in times of ſcarcity.

The people are ſtrong, robuſt, healthy, and prolific. They generally profeſs the Proteſtant religion; are honeſt, brave, innocent, and hoſpitable. They ſpeak the language, wear the habit, and obſerve the cuſtoms that are common to all the Hebrides. The meconium in new-born infants is purged away with freſh butter: the children are bathed every morning and evening in water, and grow up ſo ſtrong, that a child of 10 months is able to walk alone: they never wear ſhoes or ſtockings before the age of eight or ten, and night-caps are hardly known; they keep their feet always wet; they lie on beds of ſtraw or heath, which laſt is an excellent reſtorative: they are quick of apprehenſion, ingenious, and very much addicted to muſic and poetry. They eat heartily of fiſh; but ſeldom regale themſelves with fleſh-meat: their ordinary food conſiſts of butter, cheeſe, milk, potatoes, colewort, brochan, and a diſh called *oon*, which indeed is no other than the froth of boiled milk or whey raiſed with a ſtick like that uſed in making chocolate.

A ſort of coarſe woollen cloth called *cloa*, or *caddoes*, the manufacture of their wives, made into ſhort jackets and trouſers, is the common dreſs of the men. The philibeg is rarely worn, except in ſummer and on Sundays; on which days, and ſome other occaſions, thoſe in better circumſtances appear in tartans, a bonnet, and ſhort hoſe, and ſome in a hat, ſhort coat, waiſtcoat, and breeches, of Scotch or Engliſh manufacture. The women are in general very cleanly, and ſo exceſſively fond of dreſs, that many maid-ſervants are often known to lay out their whole wages that way.

There are two fairs held annually at Portree, to which almoſt every part of Skye ſends cattle. The firſt is held in the end of May, and the ſecond in the end of July. The fair commonly continues from Wedneſday till the Saturday following. The commodities which are ſold in theſe are horſes, cows, ſheep, goats, hides, butter, cheeſe, fiſh, and wool. The cattle ſold in theſe fairs ſwim over to the main land through a mile or half a mile of ſea. Thouſands of theſe are yearly exported, at from 2l. to 3l. each. Many of them are driven to England, where they are fatted for the market, and counted delicious eating.

In Skye appear many ruins of Daniſh forts, watch-towers, beacons, temples, and ſepulchral monuments. All the forts are known by the term *Dun*; ſuch as Dun-Skudborg, Dun-Derig, Dun-Skerineſs, Dun-David, &c.

SKY-Colour. To give this colour to glaſs, ſet in the furnace a pot of pure metal of fritt from rochetta or barilla, but the rochetta fritt does beſt; as ſoon as the metal is well purified, take for a pot of twenty pounds of metal ſix ounces of braſs calcined by itſelf; put it by degrees at two or three times into the metal, ſtirring and mixing it well every time, and diligently ſkimming the metal with a ladle: at the end of two hours the whole will be well mixed, and a proof may be taken: if the colour be found right, let the whole ſtand 24 hours longer in the furnace, and it will then be fit to work, and will prove of a moſt beautiful ſky colour.

SLAB, an outſide ſappy plank or board ſawed off from the ſides of a timber-tree. The word is alſo uſed for a flat piece of marble.

SLAB Line, in ſea-language, a ſmall cord paſſing up behind a ſhip's main-ſail, or fore-ſail, and being reeved through a block attached to the lower part of the yard, is thence tranſmitted in two branches to the foot of the ſail, to which it is faſtened. It is uſed to truſs up the ſail as occaſion requires, and more particularly for the convenience of the pilot or ſteerſman, that they may look forward beneath it as the ſhip advances.

SLACK-WATER, in ſea-language, denotes the interval between the flux and reflux of the tide, or between the laſt of the ebb and the firſt of the flood, during which the current is interrupted, and the water apparently remains in a ſtate of reſt.

SLACKEN, in *Metallurgy*, a term uſed by miners to expreſs a ſpongy and ſemivitrified ſubſtance which is mixed with the ores of metals, to prevent their fuſion. It is the ſcoria or ſcum ſeparated from the ſurface of the former fuſions of metals. To this is frequently added limeſtone, and ſometimes a kind of coarſe iron ore, in the running of the poorer gold ores.

SLATE, a ſtone of a compact texture and laminated ſtructure, ſplitting into fine plates, ſome varieties of which are employed for covering houſes. See *Clay-Slate*, under MINERALOGY, p. 185. See alſo GEOLOGY.

SLAVE. See SLAVERY.

I.
Slavery defined.

SLAVERY is a word, of which, though generally underſtood, it is not eaſy to give a proper definition. An excellent moral writer has defined it to be "an obligation to labour for the benefit of the maſter, without the contract or conſent of the ſervant." But may not be be properly called a ſlave who has given up his freedom to diſcharge a debt which he could not otherwiſe pay, or who has thrown it away at a game of hazard? In many nations, debts have been legally diſcharged in this manner; and in ſome ſavage tribes, ſuch is the univerſal ardour for gaming, that it is no uncommon thing for a man, after having loſt at play all his other property, to ſtake, on a ſingle throw of dice, himſelf, his wife, and his children (A). That perſons who have thus loſt their liberty are ſlaves, will hardly be denied; and ſurely the infatuated gameſter is a ſlave by his own contract. The debtor, too, if he was aware of the law, and contracted debts larger than he could reaſonably expect to be able to pay, may juſtly be conſidered as having come under an obligation to labour for the benefit of a maſter *with his own conſent;* for every man is anſwerable for all the known conſequences of his voluntary actions.

This definition of ſlavery ſeems to be defective as well as inaccurate. A man may be under an obligation to labour through life for the benefit of a maſter, and yet that maſter have no right to diſpoſe of him by ſale, or in any other way to make him the property of a third perſon; but the word *ſlave*, as uſed among us, always denotes a perſon who may be bought, and ſold like a beaſt in the market (B). In its original ſenſe, indeed, it was of the ſame import with *noble, illuſtrious;* but vaſt numbers of the people among whom it had that ſignification being, in the decline of the Roman empire, ſold by their countrymen to the Venetians, and by them diſperſed over all Europe, the word *ſlave* came to denote a perſon in the loweſt ſtate of ſervitude, who was conſidered as the abſolute property of his maſter. See PHILOLOGY, N° 220.

2 I ualities o nk in- e able.

As nothing can be more evident than that all men have, by the law of nature, an equal right to life, liberty, and the produce of their own labour (ſee RIGHT, N° 5.), it is not eaſy to conceive what can have firſt led one part of them to imagine that they had a right to enſlave another. Inequalities of rank are indeed inevitable in civil ſociety; and from them reſults that ſervitude which is founded in contract, and is of temporary duration. (See MORAL PHILOSOPHY, N° 141.). He who has much property has many things to attend to, and muſt be diſpoſed to hire perſons to aſſiſt and ſerve him; while thoſe who have little or no property muſt be equally willing to be hired for that purpoſe. And if the maſter be kind, and the ſervant faithful, they will both be happier in this connection than they could have been out of it. But from a ſtate of ſervitude, where the ſlave is at the abſolute diſpoſal of his maſter in all things, and may be transferred without his own conſent from one proprietor to another, like an ox or an aſs, happineſs muſt be for ever baniſhed. How then came a traffic ſo unnatural and unjuſt as that of ſlaves to be originally introduced into the world?

The common anſwer to this queſtion is, that it took its riſe among ſavages, who, in their frequent wars with each other, either maſſacred their captives in cold blood, or condemned them to perpetual ſlavery. In ſupport of this opinion we have heard it obſerved, that the Latin word *ſervus*, which ſignifies not a *hired* ſervant, but a *ſlave*, is derived from *ſervare*, "to preſerve;" and that ſuch men were called *ſervi*, becauſe they were captives, whoſe lives were preſerved on the condition of their becoming the property of the victor.

3 Origin of ſlavery.

That ſlavery had its origin from war, we think extremely probable (C), nor are we inclined to controvert this etymology of the word *ſervus;* but the traffic in men prevailed almoſt univerſally long before the Latin language or Roman name was heard of; and there is no good evidence that it began among ſavages. The word עבד, in the Old Teſtament, which in our verſion is rendered *ſervant*, ſignifies literally a *ſlave*, either born in the family or bought with money, in contradiſtinction to שכיר, which denotes a hired ſervant: and as Noah makes uſe of the word עבר in the curſe which he denounces upon Ham and Canaan immediately after the deluge, it would appear that ſlavery had its origin before that event. If ſo, there can be little doubt but that it began among thoſe violent perſons whom our tranſlators have called *giants* *, though the original word נפלים literally ſignifies *aſſaulters of others*. Thoſe wretches ſeem firſt to have ſeized upon women, whom they forcibly compelled to miniſter to their pleaſures; and from this kind of violence the progreſs was natural to that by which they enſlaved their weaker brethren among the men, obliging them to labour for their benefit, without allowing them fee or reward.

4 Prior to the deluge.

* Gen. vi. 4.

4 Nimrod enſlaved his captives.

After the deluge the firſt dealer in ſlaves ſeems to have been Nimrod. "He began," we are told, "to be a mighty one in the earth, and was a mighty hunter before the Lord." He could not, however, be the firſt hunter of wild beaſts; for that ſpecies of hunting muſt have been practiſed from the beginning; nor is it probable that his dexterity in the chaſe, which was then the univerſal employment, could have been ſo far ſuperior to that of all his contemporaries, as to entitle him to the appellation of "the mighty hunter before the Lord." Hence moſt commentators have concluded, that he was a hunter of men; an opinion which they think receives ſome countenance from the import of his name, the word *Nimrod* ſignifying a rebel. Whatever be

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(A) Aleam (quod mirere) ſobrii inter ſeria exercent, tanta lucrandi perdendive temeritate, ut cum omnia defecerunt, extremo ac noviſſimo jactu de libertate et corpore contendant. Victus voluntariam ſervitutem adit; quamvis junior, quamvis robuſtior, alligari ſe ac venire patitur.—*Tacitus de Mor. Germ.*

The ſavages of North America are equally addicted to gaming with the ancient Germans, and the negroes on the Slave Coaſt of Guinea perhaps ſtill more.

(B) The Roman orator's definition of *ſlavery*, Parad. V. is as accurate as any that we have ſeen. "Servitus eſt obedientia fracti animi et abjecti et arbitrio carentis ſuo;" whether the unhappy perſon fell into that ſtate with or without his own contract or conſent.

(C) In the article SOCIETY, the reader will find another account of the origin of ſlavery, which we think likewiſe probable, though we have not transferred it to this place; as it would, in our opinion, be wrong to give to one writer what we know to belong to another. It may be proper, however, to obſerve here, that between the two articles there is no contradiction, as barbarous wars were certainly *one* ſource of ſlavery.

be in this, there can be little doubt but that he became a mighty one by violence; for being the ſixth ſon of his father, and apparently much younger than the other five, it is not likely that his inheritance exceeded theirs either in extent or in population. He enlarged it, however, by conqueſt; for it appears from Scripture, that he invaded the territories of Aſhur the ſon of Shem, who had ſettled in Shinar; and obliging him to remove into Aſſyria, he ſeized upon Babylon, and made it the capital of the firſt kingdom in the world. As he had great projects in view, it ſeems to be in a high degree probable that he made bond-ſervants of the captives whom he took in his wars, and employed them in building or repairing the metropolis of his kingdom; and hence we think is to be dated the origin of poſtdiluvian ſlavery.

6
Slavery in the days of Abraham.

That it began thus early can hardly be queſtioned; for we know that it prevailed univerſally in the age of Abraham, who was born within ſeventy years after the death of Nimrod. That patriarch had three hundred and eighteen ſervants or ſlaves, born in his own houſe, and trained to arms, with whom he purſued and conquered the four kings who had taken captive his brother's ſon †. And it appears from the converſation which took place between him and the king of Sodom after the battle, that both believed the conqueror had a right to conſider his priſoners as part of his ſpoil. "Give me (ſays the king) the *perſons*, and take the *goods* to thyſelf." It is indeed evident from numberleſs paſſages of ſcripture, that the domeſtics whom our tranſlators call *ſervants* were in thoſe days univerſally conſidered as the moſt valuable part of their maſter's property, and claſſed with his flocks and herds. Thus when the ſacred hiſtorian deſcribes the wealth of Abraham, he ſays, that "he had ſheep and oxen, and he-aſſes, and men-ſervants, and maid-ſervants, and ſhe-aſſes, and camels." And when Abimelech wiſhed to make ſome reparation to the patriarch for the unintended injury that he had done him, "he took ſheep and oxen, and men-ſervants, and women-ſervants, and gave them unto Abraham, and reſtored to him Sarah his wife." The riches and power of Iſaac and Jacob are eſtimated in the very ſame manner. Of the former it is ſaid, that "the man waxed great, and went forward and grew, until he became very great: for he had poſſeſſion of flocks, and poſſeſſion of herds, and great ſtore of ſervants, וצבדה of ſlaves; and the Philiſtines envied him." The latter, we are told, "increaſed exceedingly, and had much cattle, and maid-ſervants, and men-ſervants, and camels, and aſſes ‡."

† Gen. xiv.

‡ Gen. xii. 16. xx. 14. xxiv. 35. xxvi 13. 14. xxx 43.

That the practice of buying and ſelling ſervants thus early begun among the patriarchs deſcended to their poſterity, is known to every attentive reader of the Bible. It was expreſsly authoriſed by the Jewiſh law, in which are many directions how ſuch ſervants were to be treated. They were to be bought only of the heathen; for if an Iſraelite grew poor and ſold himſelf either to diſcharge a debt, or to procure the means of ſubſiſtence, he was to be treated not as a ſlave צבך, but as a hired ſervant שביך, and reſtored to freedom at the year of Jubilee. "Both thy bond-men and thy bond-maids (ſays Moſes) ſhall be of the heathen that are round about you: of them ſhall ye buy bond-men and bond-maids. And ye ſhall take them as an inheritance for your children after you, to inherit them for a poſſeſſion; they ſhall be your bond-men for ever ||." Unlimited as the power thus given to the Hebrews over their bond-ſervants of heathen extraction appears to have been, they were ſtrictly prohibited from acquiring ſuch property by any other means than fair purchaſe: "he that *ſtealeth* a man and ſelleth him," ſaid their great lawgiver, "ſhall ſurely be put to death §."

7
Authoriſe
by the M
ſaic law.

|| Lev. xx
39, 40,
46.

§ Lev. x
16.

8
Spread c
the whol
world.

Whilſt ſlavery, in a mild form, was permitted among the people of God, a much worſe kind of it prevailed among the heathen nations of antiquity. With other abominable cuſtoms, the traffic in men quickly ſpread from Chaldea into Egypt, Arabia, and over all the eaſt, and by degrees found its way into every known region under heaven (D).

Of this hateful commerce we ſhall not attempt to trace the progreſs through every age and country, but ſhall content ourſelves with taking a tranſient view of it among the Greeks and Romans, and a few other nations, in whoſe cuſtoms and manners our readers muſt be intereſted.

9
Slavery a
mong th
Greeks a

One can hardly read a book of the Iliad or Odyſſey, without perceiving that, in the age of Homer, all priſoners of war were liable to be treated as ſlaves, and compelled, without regard to their rank, ſex, or years, to labour for their maſters in offices of the vileſt drudgery. So univerſally was this cruel treatment of captives admitted to be the right of the victor, that the poet introduces Hector in the very act of taking a tender and perhaps laſt farewell of his wife, when it was ſurely his buſineſs to afford her every conſolation in his power, telling her, as a thing of courſe which could not be concealed, that, on the conqueſt of Troy, ſhe would be compelled

> To bear the victor's hard commands, or bring
> The weight of water from Hyperia's ſpring (E).
> POPE.

At that early period, the Phœnicians, and probably the Greeks themſelves, had ſuch an eſtabliſhed commerce in ſlaves, that, not ſatisfied with reducing to bondage their priſoners of war, they ſcrupled not to kidnap in cold blood

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(D) If credit be due to a late account of China, the people of that vaſt empire have never made merchandiſe of men or women. The exception, however, is ſo ſingular, that we ſhould be glad to ſee it better authenticated; for it is apparent from works of the moſt undoubted credit, that over all the other eaſtern countries with which we are acquainted ſlavery has prevailed from time immemorial, and that ſome of the Indian nations make long journeys into Africa for the ſole purpoſe of buying ſlaves.

(E) In thoſe early times drawing water was the office of the meaneſt ſlaves. This appears from Joſhua's curſe upon the Gibeonites who had deceived him.—"Now therefore ye are curſed, and there ſhall none of you be freed from being bond-men, and hewers of wood, and drawers of water, for the houſe of my God." To this ſtate of bondage Homer makes Hector ſay, that Andromache would *neceſſarily* be brought upon the deſtruction of Troy; κρατερη δ' επικεισετ' αναγκη.—*Iliad.* lib. vi.

blood perſons who had never kindled their reſentment, in order to ſupply their foreign markets. In the 14th book of the Odyſſey, Ulyſſes repreſents himſelf as having narrowly eſcaped a ſnare of this kind laid for him by a falſe Phœnician, who had doomed the hero to Libyan ſlavery: and as the whole narrative, in which this circumſtance is told, is an artful fiction, intended to have the appearance of truth to an Ithacan peaſant, the practice of kidnapping ſlaves could not then have appeared incredible to any inhabitant of that iſland.

Such were the manners of the Greeks in the heroic age; nor were they much improved in this reſpect at periods of greater refinement. Philip of Macedon having conquered the Thebans, not only ſold his captives, but even took money for permitting the dead to be buried *; and Alexander, who had more generoſity than Philip, afterwards razed the city of Thebes, and ſold the inhabitants, men, women, and children, for ſlaves †. This cruel treatment of a brave people may indeed be ſuppoſed to have proceeded, in the firſt inſtance, from the avarice of the conqueror; and in the ſecond, from the momentary reſentment of a man who was ſavage and generous by turns, and who had no command of his paſſions. We ſhall not poſitively aſſign it to other cauſes; but from the manner in which the Spartans behaved to their ſlaves, there is little reaſon to imagine that had they received from the Thebans the ſame provocation with Alexander, they would have treated their captives with greater lenity. "At Sparta (ſays a humane and elegant writer) ſlaves were treated with a degree of rigour that is hardly conceivable; although to them, as their huſbandmen and artificers, their proud and idle maſters were indebted for all the neceſſaries of life. The Lacedæmonian youth, trained up in the practice of deceiving and butchering thoſe poor men, were from time to time let looſe upon them, in order to ſhow their proficiency in ſtratagem and maſſacre. And once, without any provocation, and merely for their own amuſement, we are told that they murdered three thouſand in one night, not only with the connivance of law, but by its avowed permiſſion. Such, in promoting the happineſs of one part of ſociety and the virtue of another, are the effects of ſlavery."

ſeattie's Moral ſcience, vol. ii.

It has been ſaid, that in Athens and Rome ſlaves were better treated than in Sparta: but in the former city their treatment cannot have been good, or their lives comfortable, when the Athenians reliſhed that tragedy of Euripides in which Hecuba, the wife of Priam, is introduced as lamenting that ſhe was chained like a dog at Agamemnon's gate? Of the eſtimation in which ſlaves were held in Rome, we may form a tolerable notion from the well-known fact, that one of thoſe unhappy beings was often chained at the gate of a great man's houſe, to give admittance to the gueſts invited to a feaſt *. In the early periods of the commonwealth it was cuſtomary, in certain ſacred ſhews exhibited on ſolemn occaſions, to drag through the circus a ſlave, who had been ſcourged to death holding in his hand a fork in the form of a gibbet †. But we need not multiply proofs of the cruelty of the Romans to their ſlaves. If the inhuman combats of the gladiators (ſee GLADIATORS) admit of any apology on account of the martial ſpirit with which they were thought to inſpire the ſpectators, the conduct of Vedius Pollio muſt have proceeded from the moſt wanton and brutal cruelty. This man, who flouriſhed not in the earlieſt periods of the republic, when the Romans were little better than a ſavage banditti, but in the poliſhed age of Auguſtus, frequently threw ſuch ſlaves as gave him the ſlighteſt offence into his fiſhponds to fatten his lampreys; and yet he was ſuffered to die in peace! The emperor, indeed, upon coming to the knowledge of his cruelty, ordered his lampreys to be deſtroyed, and his ponds to be filled up; but we do not recollect that any other puniſhment was inflicted on the ſavage maſter. Till the reign of the ſame emperor the depoſitions of ſlaves were never admitted in the courts of judicature; and then they were received only when perſons were accuſed of treaſonable practices.

10 Romans.

11 Origin of Roman ſlavery.

The origin of ſlavery in Rome was the ſame as in every other country. Priſoners of war were of courſe reduced to that ſtate, as if they had been criminals. The dictator Camillus, one of the moſt accompliſhed generals of the republic, ſold his Hetrurian captives to pay the Roman ladies for the jewels which they had preſented to Apollo. Fabius, whoſe cautious conduct ſaved his country when Hannibal was victorious in Italy, having ſubdued Tarentum, reduced 30,000 of the citizens to ſlavery, and ſold them to the higheſt bidder. Coriolanus, when driven from Rome, and fighting for the Volſci, ſcrupled not to make ſlaves of his own countrymen; and Julius Cæſar, among whoſe faults wanton cruelty has never been reckoned, ſold at one time fifty-three thouſand captives for ſlaves. Nor did the ſlaves in Rome conſiſt only of foreigners taken in war. By one of the laws of the twelve tables, creditors were empowered to ſeize their inſolvent debtors, and keep them in their houſes till, by their ſervices or labour, they had diſcharged the ſum they owed: and in the beginning of the commonwealth they were authoriſed to ſell ſuch debtors, and even to put them to death (F). The children of ſlaves were the property not of the commonwealth, or of their own parents, but of their maſters; and thus was ſlavery perpetuated in the families of ſuch unhappy

* Juſtin. lib. iii. cap. 4.

† Juſtin et Arrian.

* *Kames's Sketches.*

† *Cicero de Div.* lib. i. cap. 26.

(F) After a certain number of citations, the law granted to the debtor thirty days of grace to raiſe the ſum for which he was accountable. The words of the law are: "Æris confeſſi, rebuſque jure judicatis, triginti dies juſti ſunto. Poſt dein manum endojacito.—Vincito aut nervo, aut compedibus." When the debt is confeſſed, and the trial paſſed, let there be thirty days of forbearance; afterwards lay hands on him; bind him either with a cord or fetters." After the thirty days were expired, if the debtor had not diſcharged the debt, he was led to the prætor, who delivered him over to the mercy of his creditors; theſe bound him and kept him in chains for the ſpace of ſixty days. Afterwards, for three market-days ſucceſſively, the debtor was brought to the tribunal of the prætor; then a public crier proclaimed in the forum the debt for which the priſoner was detained. It often happened, that rich perſons redeemed the priſoner by paying his debts; but if nobody appeared in behalf of the debtor after the third market-day, the creditor had a right to inflict the puniſhments appointed by the law. "Tertiis nundinis capite unhappy men as fell into that ſtate, whether through the chance of war or the cruelty of a ſordid creditor (G). The conſequence was, that the number of ſlaves belonging to the rich patricians was almoſt incredible. Caius Cæcilius Iſidorus, who died about ſeven years before the Chriſtian era, left to his heirs 4116 ſlaves; and if any one of thoſe wretched creatures made an unſucceſsful attempt to regain his liberty, or was even ſuſpected of ſuch a deſign, he was marked on the forehead with a red-hot iron (H). In Sicily, during the moſt flouriſhing periods of the commonwealth, it ſeems to have been cuſtomary for maſters to mark their ſlaves in this manner; at leaſt we know that ſuch was the practice of Damophilus, who, not ſatisfied with this ſecurity, ſhut up his ſlaves every night in cloſe priſons, and led them out like beaſts in the morning to their daily labour in the field. Hence aroſe the ſervile war in Sicily.

12 Its duration.

Though many laws were enacted by Auguſtus and other patriotic emperors to diminiſh the power of creditors over their inſolvent debtors; though the influence of the mild ſpirit of Chriſtianity tended much to meliorate the condition of ſlaves, even under Pagan maſters; and though the emperor Adrian made it capital to kill a ſlave without a juſt reaſon, yet this infamous commerce prevailed univerſally in the empire for many ages after the converſion of Conſtantine to the religion of Chriſt. It was not indeed completely aboliſhed even in the reign of Juſtinian; and in many countries which had once been provinces of the empire it continued long after the empire itſelf had fallen to pieces.

13 Slavery among the ancient Germans.

It has already been obſerved, that among the ancient Germans it was not uncommon for an ardent gameſter to loſe his perſonal liberty by a throw of the dice. This was indeed a ſtrong proof of ſavage manners; but the general condition of ſlaves among thoſe ſavages ſeems to have been much better than among the poliſhed Greeks and Romans. In Germany the ſlaves were generally attached to the ſoil, and only employed in tending cattle, and carrying on the buſineſs of agriculture; for the menial offices of every great man's houſe were performed by his wife and children. Such ſlaves were ſeldom beaten, or chained, or impriſoned. Sometimes indeed they were killed by their maſters in a fit of ſudden paſſion; but none were conſidered as materials of commerce, except thoſe who had originally been freemen, and loſt their freedom by play. Theſe, indeed, the ſucceſsful gameſter was very ready to ſell, both becauſe he felt them an uſeleſs burden, and becauſe their preſence continually put him in mind of that ſtate to which a throw of the dice might one day reduce himſelf.

Such is the account which Tacitus gives * of ſlavery among the ancient Germans. The Anglo-Saxons, however, after they were ſettled in this iſland ſeem not to have carried on that traffic ſo honourably. By a ſtatute of Alfred the Great †, the purchaſe of a *man*, a *horſe*, or an *ox*, without a voucher to warrant the ſale, was ſtrictly forbidden. That law was, doubtleſs, enacted to prevent the *ſtealing* of *men* and cattle; but it ſhows us that ſo late as the ninth or tenth century a man, when fairly purchaſed, was, in England, as much the property of the buyer as the horſe on which he rode, or the ox which dragged his plough. In the ſame country, now ſo nobly tenacious of freedom and the rights of man, a ſpecies of ſlavery ſimilar to that which prevailed among the ancient Germans ſubſiſted even to the end of the ſixteenth century. This appears from a commiſſion iſſued by Queen Elizabeth in 1574, for inquiring into the lands and goods of all her *bond-men* and *bond-women* in the counties of Cornwall, Devon, Somerſet, and Glouceſter, in order to compound with them for their manumiſſion, that they might enjoy their lands and goods as freemen ‡. In Scotland there certainly exiſted an order of ſlaves or bond-men, who tilled the ground, were attached to the ſoil, and with it were transferable from one proprietor to another, at a period ſo late as the thirteenth century; but when or how thoſe villains, as they were called, obtained their freedom, ſeems to be unknown to every lawyer and antiquary of the preſent day. Coalliers and ſalters were, in the ſame country, ſlaves till little more than 30 years ago, that they were manumitted by an act of the Britiſh legiſlature, and reſtored to the rights of freemen and citizens. Before that period the ſons of coalliers could follow no buſineſs but that of their fathers; nor were they at liberty to ſeek employment in any other mines than thoſe to which they were attached by birth, without the conſent of the lord of the manor, who, if he had no uſe for their ſervices himſelf, transferred them by a written deed to ſome neighbouring proprietor.

14 In England and

15 Scotland.

* *De Mor. Germ.* 24, 25.

† *Wilkin's Collection of Laws from Ethelbert to Henry III.*

‡ *Kames's Sketches*, book i. ſketch 5.

16 Slavery among the Carthaginians.

That the ſavage nations of Africa were at any period of

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capite pœnas data aut trans Tiberim peregre venumduito;" that is, "Let him on the third market-day be puniſhed with death, or ſold beyond the Tiber as a ſlave." If there were ſeveral creditors, they were allowed, in conſequence of this ſevere law, to divide the body of the priſoner into ſeveral parts, and ſhare it among them in proportion to the ſum which they demanded.

(G) This is evident from the ſtory of Appius and Virginia. See ROME, N° 113.

(H) How capriciouſly and unjuſtly this infamous mark was impreſſed, we learn from the ſtory of Reſtio. This man being proſcribed, and a reward offered for his head by the triumvirs Octavianus, Antony, and Lepidus, concealed himſelf from the fury of the tyrants in the beſt way that he could. A ſlave whom he had marked with the hot iron having found out the place of his retreat, conducted him to a cave, and there ſupported him for ſome time with what he earned by his daily labour. At length a company of ſoldiers coming that way, and approaching the cave, the faithful ſlave, alarmed at the danger his maſter was in, followed them cloſe, and falling upon a poor peaſant, killed him in their preſence, and cut off his head, crying out, "I am now revenged on my maſter for the marks with which he has branded me." The ſoldiers, ſeeing the infamous marks on his forehead, and not doubting but he had killed Reſtio, ſnatched the head out of his hand, and returned with it in all haſte to the triumvirs. They were no ſooner gone, than the ſlave conveyed his maſter to the ſea-ſide, where they had the good luck to find one of Sextus Pompeius's veſſels, which tranſported them ſafe into Sicily.

of hiſtory exempted from this opprobrium of our nature which ſpread over all the reſt of the world, the enlightened reader will not ſuppoſe. It is indeed in that vaſt country that ſlavery has in every age appeared in its uglieſt form. We have already obſerved, that about the era of the Trojan war, a commerce in ſlaves was carried on between Phœnicia and Libya : and the Carthaginians, who were a colony of Phœnicians, and revered the cuſtoms, manners, and religion of their parent ſtate, undoubtedly continued the Tyrian traffic in human fleſh with the interior tribes of Africa. Of this we might reſt aſſured, although we had no other evidence of the fact than what reſults from the practice of human ſacrifices ſo prevalent in the republic of Carthage. The genuine inſtincts of nature are often ſubdued by dire ſuperſtition, but they cannot be wholly eradicated ; and the rich Carthaginian, when a human victim was demanded from him to the gods, would be ready to ſupply the place of his own child by the ſon of a poor ſtranger, perfidiouſly purchaſed at whatever price. That this was, indeed, a very common practice among them, we learn from the teſtimony of various hiſtorians *, who aſſure us, that when Agathocles the tyrant of Syracuſe had overthrown their generals Hanno and Bomilcar, and threatened Carthage itſelf with a ſiege, the people attributed their misfortunes to the juſt anger of Saturn for having been worſhipped, for ſome years, by the ſacrifices of children meanly born and ſecretly *bought*, inſtead of thoſe of noble extraction. Theſe ſubſtitutions of one offering for another were conſidered as a profane deviation from the religion of their forefathers ; and therefore to expiate the guilt of ſo horrid an impiety, a ſacrifice of 200 children of the firſt rank was on that occaſion made to the bloody god. As the Carthaginians were a commercial people, we cannot ſuppoſe that they purchaſed ſlaves only for ſacrifices. They undoubtedly condemned many of their priſoners of war to the ſtate of ſervitude, and either ſold them to foreigners, or diſtributed them among their ſenators and the leaders of their armies. Hanno, who endeavoured to uſurp the ſupreme power in Carthage whilſt that republic was engaged in war with Timoleon in Sicily †, armed 20,000 of his ſlaves in order to carry his nefarious purpoſe into execution : and Hannibal, after his deciſive victory at Cannæ, ſold to the Greeks many of his priſoners whom the Roman ſenate refuſed to redeem ‡. That illuſtrious commander was indeed more humane, as well as more politic, than the generality of his countrymen. Before his days it was cuſtomary with the Carthaginians either to maſſacre their captives in cold blood, that they might never again bear arms againſt them, or to offer them in ſacrifice as a grateful acknowledgement to the gods by whoſe aſſiſtance they believed that they were vanquiſhed ; but this was not always done even by their moſt ſuperſtitious or moſt unprincipled leaders. Among other rich ſpoils which Agathocles, after his victory already mentioned, found in the camp of Hanno and Bomilcar, were twenty thouſand pair of fetters and manacles, which thoſe generals had provided for ſuch of the Sicilian priſoners as they intended to preſerve alive and reduce to a ſtate of ſlavery.

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17
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With the ancient ſtate of the other African nations we are but very little acquainted. The Numidians, Mauritanians, Getulians, and Garamantes, are indeed mentioned by the Roman hiſtorians, who give us ample details of the battles which they fought in attempting to preſerve their national independence ; but we have no particular account of their different manners and cuſtoms in that age when Rome was diſputing with Carthage the ſovereignty of the world. All the African ſtates of which we know any thing, were in alliance with one or other of thoſe rival republics ; and as the people of thoſe ſtates appear to have been leſs enlightened than either the Romans or the Carthaginians, we cannot ſuppoſe that they had purer morals, or a greater regard for the ſacred rights of man, than the powerful nations by whom they were either protected or oppreſſed. They would, indeed, inſenſibly adopt their cuſtoms ; and the ready market which Marius found for the priſoners taken in the town Capſa, although Salluſt acknowledges ‡ that the ſale was contrary to the laws of war, ſhows that ſlavery was then no ſtrange thing to the Numidians. It ſeems indeed to have prevailed through all Africa from the very firſt peopling of that unexplored country ; and we doubt if in any age of the world the unhappy negro was abſolutely ſecure of his perſonal freedom, or even of not being ſold to a foreign trader.

‡ *Bell. Jug.* cap. 91.

18
Slave-trade with the coaſt of Guinea begun not by the Portugueſe,

It is the common opinion that the practice of making ſlaves of the negroes is of a very modern date ; that it owes its origin to the incurſions of the Portugueſe on the weſtern coaſt of Africa ; and that but for the cunning or cruelty of Europeans, it would not now exiſt, and would never have exiſted. But all this is a complication of miſtakes. A learned writer has lately proved, with a force of evidence which admits of no reply *, that from the coaſt of Guinea a great trade in ſlaves was carried on by the Arabs ſome hundreds of years before the Portugueſe embarked in that traffic, or had even ſeen a woolly-headed negro. Even the wandering Arabs of the deſert, who never had any friendly correſpondence with the Chriſtians of Europe, have from time immemorial been ſerved by negro ſlaves. "The Arab muſt be poor indeed (ſays M. Saugnier) not to have at leaſt one negro ſlave. His ſole occupation is the care of the herd. They are never employed in war, but they have it in their power to marry. Their wives, who are captive negreſſes, do all the domeſtic work, and are roughly treated by the Arabian women, and by the Arabs themſelves. Their children are ſlaves like them, and put to all kinds of drudgery." Surely no man whoſe judgment is not completely warped by prejudice, will pretend that thoſe roving tribes of ſavages, ſo remarkable for their independent ſpirit and attachment to ancient cuſtoms, learned to enſlave the negroes from the Europeans. In all probability they have, without interruption, continued the practice of ſlavery from the days of their great anceſtor Iſhmael ; and it ſeems evident, that *none of the European nations had ever ſeen a woolly-headed negro till the year* 1100, when the cruſaders fell in with a ſmall party of them near the town of Hebron in Judea, and were ſo ſtruck with the novelty of their appearance, that the army burſt into a general fit of laughter ||. Long before the cruſades, however, we know with certainty that the natives of Guinea had been expoſed to ſale in foreign countries. In 651 the Mahometan Arabs of Egypt ſo haraſſed the king of Nubia or Ethiopia, who was a Chriſtian, that he agreed to ſend them annually, by way of tribute, a *vaſt number of Nubian or Ethio-*

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* *Whittaker's Review of Gibbon's Roman Hiſtory,*

19
But by the Arabs at an early period.

Saugnier and Briſſon's Voyages.

|| *Malmſbury,* fol. p. 83.

pian ſlaves into Egypt. Such a tribute as this at that time, we are told, was more agreeable to the khalif than any other, as the Arabs then made *no ſmall account of thoſe ſlaves* [*].

The very propoſal of ſuch a tribute, and the eſtimation in which black ſlaves were held in Egypt, ſhows that a commerce in bond-ſervants could not then be a new branch of trade either to the Arabs or the Ethiopians; but the vaſt number which the Ethiopian monarch was now compelled to furniſh every year, induced him to feed this great drain upon his ſubjects from the natives of the neighbouring countries. "He ranged accordingly into all that vaſt *blank of geography* upon the map of the world, the ſpreading boſom of the African continent; and even puſhed through it to its fartheſt extremities in the weſt. He thus brought the blacks of Guinea, for the firſt time, into the ſervice and families of the eaſt; and the ſlaves which he paid in tribute to the Arabs, whether derived from the nearer neighbourhood of Ethiopia, fetched from the mediterranean regions of Africa, or brought from the diſtant ſhores of the Atlantic, were all denominated *Ethiopians*, from the country by which they were conveyed into Egypt [†]. "At this time, therefore, according to Mr Whitaker, began that kind of traffic in human fleſh

"Which ſpoils unhappy Guinea of its ſons."

20 The negroes have enſlaved one another from time immemorial.

There are not many authors from whom, in queſtions of antiquity, we differ with greater heſitation; but, as we meet with a female Ethiopian ſlave in the Eunuch of Terence, we cannot help ſuſpecting that Guinea was occaſionally "ſpoiled of its ſons" at a much earlier period. At any rate, from the obſervations made by the European travellers who firſt penetrated into that continent, it appears undeniable that ſlavery muſt have prevailed from time immemorial among ſuch of the tribes as had never carried on any commerce with foreign nations. When Battel firſt viſited the Giagas [*], thoſe people had never before ſeen a white man; yet they welcomed him and the Engliſh, with whom he had come, to their country, invited them to bring their goods on ſhore, and without heſitation loaded the ſhips with ſlaves. The Giagas were indeed waging war with the kingdom of Benguela; and being cannibals, who prefer human fleſh to all others, the ſlaves whom they had ſold to the Engliſh were probably priſoners whom they would have killed and eaten if they had not found an opportunity of otherwiſe diſpoſing of them to greater advantage. But as they had not been incited by the Europeans to eat their priſoners, there can be no reaſon to ſuppoſe that by the Europeans they had been firſt induced to ſell them; for we have ſeen that this kind of commerce prevailed in Africa among people much more poliſhed than the Giagas ſo early as in the reign of Jugurtha.

That it was not introduced among the negroes either by the Arabs or by the Portugueſe, appears ſtill more evident from the behaviour of the Dahomans at the conqueſt of Whidah, and from the manner in which the people of Angola at the earlieſt ſtage of their foreign trade procured a ſupply of ſlaves for the Portugueſe market. The greater part of the ſlaves whom the Angolans exported from St Paulo de Loanda were brought from interior countries, ſome hundreds of leagues diſtant, where they could not have been regularly purchaſed had that commerce been till then unknown in thoſe countries. The Dahomans, in the beginning of the year 1727, had never ſeen a white man: and when their victorious prince and his army, in their route through Whidah, firſt met with ſome Europeans in the town of Sabi, they were ſo ſhocked at their complexion and their dreſs, that they were afraid to approach them, and could not be perſuaded that they were men till they heard them ſpeak, and were aſſured by the Whidaneſe that theſe were the merchants who purchaſed all the ſlaves that were ſold in Guinea [‡]. Slavery, therefore, if it prevailed among the Dahomans before that period, could not have been introduced among them by European or Arabian intrigues: but we are aſſured by Snelgrave, who was then in the army, that thoſe people treated their captives with ſuch horrid cruelty as was ſhocking to the natives of the ſea-coaſt, and leaves no room for doubt but that ſlavery had been practiſed among them from the earlieſt ages. A great part of their priſoners were ſacrificed to their gods or eaten by the ſoldiers; and when our author expreſſed to a colonel of the guard ſome ſurpriſe that a prince ſo enlightened as the ſovereign of Dahomy ſhould ſacrifice ſo many men whom he might have ſold to great advantage, he was gravely told, that it had been the cuſtom of their nation, from time immemorial, to offer, after victory, a certain number of priſoners to the gods; and that they ſelected the old men for victims, becauſe they were of leſs value at market, and more dangerous from their experience and cunning, than the young men. To thoſe perſons who fancy that the wars between the African princes are carried on for the ſole purpoſe of ſupplying the European ſhips with ſlaves, it may be proper to remark, that one of the kings of Dahomy ſlaughtered at once not only all the captives taken in war, but alſo 127 priſoners of different kinds, that he might have a ſufficiency of ſkulls to adorn the walls of his palace; though at the very time of that maſſacre he *knew* that there were ſix ſlave-ſhips in the road of Whidah, from which he could have got for every prime ſlave a price little ſhort of thirty pounds ſterling [§].

Theſe facts, and numberleſs others which the reader will find detailed in the 13th volume of the Modern Univerſal Hiſtory, by writers who were at the greateſt pains to procure authentic information; who were neither biaſſed by intereſt nor blinded by enthuſiaſm; and who appear to have held the infamous traffic in utter abhorrence—prove beyond the poſſibility of doubt, that ſlavery of the worſt kind muſt have prevailed among all the negro nations before they were viſited either by the Portugueſe or by the Arabs (1). Theſe two nations may

[*] *Modern Univerſal Hiſtory*, vol. i. 525.

[†] *Whitaker's Review.*

[*] *Modern Univerſal Hiſtory*, vol. xiii. chap. 47. ſect. 2.

[‡] *Modern Univerſa Hiſtory*, vol. xiii.

[§] *Dalzel' Hiſtory of the Kingdom of D homy.*

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(1) The ſame thing appears from the voyages of M. Saugnier, who had an opportunity of converſing with many tribes of negroes, and who always ſpeaks of ſlavery as an eſtabliſhed practice among them; adding, that ſuch as are ſold for crimes are put to death by their own countrymen if they fly from their maſter. It appears likewiſe in a ſtill more ſtriking light from Dalzel's Hiſtory of Dahomy, where we are told that all the Dahomans,

may indeed have been the firſt who dragged the unhappy negro from his native continent, and made his ſlavery doubly ſevere, by compelling him to labour, without his own conſent, for maſters whom he hardly conſidered as human beings.

On the beginning of this commerce, or the dreadful cruelty with which it has been carried on to the preſent day, it is impoſſible to reflect without horror: but there is ſome conſolation, however ſmall, in knowing that its original authors were not Europeans. The purchaſe of Guinea blacks for ſlaves by foreign nations commenced ages before the Portugueſe had laid that country open to the intercourſe of Europe. Even after they had made many incurſions into it, the inhabitants were as regularly purchaſed for ſlaves by ſome of the adjoining ſtates as they are now by the maritime Europeans.

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view,
185.

"The Arabs of Egypt having reduced all the north of Africa, and carrying with them their love of black ſervants, would be ſure to open a ready communication for themſelves to their country. They certainly had one ſo early as 1512, and before the Europeans had any for that purpoſe (K). They went from Barbary by a route that was ſo much practiſed, as to be denominated expreſsly 'the way of the camels.' Meeting together at the town of Cape Cantin, or that of Valadie near it, the commercial caravan traverſed the vaſt deſerts, thoſe of Sarra, which run like the tropic of Cancer over them in a long line acroſs the country; to a place of great population called Hoden, the *Waden* or *Hoden* of our maps, and a little to the ſouth-weſt of Cape Blanco. From Hoden they turned to the left, and puſhed directly into the interior of the continent, to reach Tegazza, the *Tagazel* or *Tagaza* of our maps, and lying nearly eaſt of Hoden. Here aſſuredly they did, as the caravan does certainly at this day; and added to the other wares upon their camels a quantity of ſalt from thoſe mines of rock-ſalt, which are extraordinary enough to be noticed as rocks in our maps. This they carried, as they ſtill carry it, to Tanbut, the *Tombut* of the maps, and a town in the heart of the African continent. And from this town they turned on the right for the ſea coaſt again, and reached it in the great kingdom of Mele, the *Melli* of our maps, to the ſouth of the Gambia, and juſt at the ſpringing as it were of that grand arch of ſea which curves ſo deeply into the body of the land, and conſtitutes the extenſive gulf of Guinea. At Melli and at Tombut they received a meaſure of gold for a meaſure of ſalt. The caravan collects gold at Tombut to the preſent time; but at Melli they purchaſed gold, and alſo ſilver, in pieces as large as pebbles. And at Hoden they had *a great mart for ſlaves*; the blacks being brought thither from the countries adjoining, and bartered away to the traders. Such was the Slave Coaſt and the Gold Coaſt of former days. The ſtaple commodity of Hoden is only transferred now to Whidah; and diverted from the Arabs of Barbary to the Chriſtians of Europe," by whom the negroes are carried to the continent of America or to the Sugar Iſlands in the Weſt Indies. In theſe countries they are all ſold like beaſts in a market; but they experience very different degrees of ſervitude from the different maſters who hold them as property. Such of them as are reconciled to the appearance of white men, or have been born in the European colonies, feel themſelves as happy under a humane maſter as they could be in their native continent (L); and we believe that few of them in ſuch circumſtances have expreſſed a deſire to return."

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which is
now tranſferred to
the Europeans.

23
Condition
of ſlaves in
the French
Weſt Indies
under the
old government.

In the French Weſt India iſlands, before the late revolution in the mother country, which has produced in all its dependencies anarchy and maſſacre, the condition of the negro ſlaves was better than that of the bondmen among the ancient Germans. "Thoſe of them who cultivated the plantations were attached to the ſoil, and could not be drawn off to pay debts, or be ſold ſeparately from the eſtate on which they lived. This gave them a laſting property in their huts and little ſpots of ground, which they might ſafely cultivate without dread of being turned out of poſſeſſion, or transferred contrary to their intereſt and feelings from one proprietor to another. They were under the protection of law as ſoon as they arrived in the colony. Proper miſſionaries were appointed for the purpoſe of training them up to a certain degree of religious knowledge, and ample funds were allotted for the maintenance of thoſe eccleſiaſtics. On ill treatment received from his maſter, or on being deprived of his allowance of food and raiment, the ſlave was directed to apply to the king's at-

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mans, from the loweſt to the higheſt, acknowledge the right of the ſovereign to diſpoſe of their perſons and properties at pleaſure; and where we learn, that the ſovereign himſelf aſſured Mr Abſon the Engliſh governor at Whidah, that all his anceſtors had from time immemorial put to death every priſoner of war whom they could not ſell as a ſlave.

(K) In the year 1442, Anthony Gonſalez, a Portugueſe adventurer, reſtored to their native country ſome Mooriſh priſoners whom he had two years before forcibly carried off from the coaſt of Africa. He landed them at *Rio del-Oro*, and received from the Moors in exchange ten blacks and a quantity of gold duſt. This tranſaction proves, that a commerce in black ſervants was then regularly carried on by the Moors and not by the Portugueſe. So early as the year 1502, the Spaniards began to employ a few negroes in the mines of Hiſpaniola; but in the year following, Ovando, the governor of that iſland, forbade the further importation of them, alleging that they taught the Indians all manner of wickedneſs, and rendered them leſs tractable than formerly: and it was not till the year 1517 that the ſupply of negroes to the Spaniſh American plantations became an eſtabliſhed and regular branch of commerce. *Edwards's Hiſtory of the Weſt Indies*, Book IV. chap. ii.

(L) "I have obſerved many of my ſlaves go on board the veſſel with joy, on my aſſurance that they would be well treated and happy on the plantation where I was going to ſend them. When the Banbarans find that they are truſted by the whites, they never think of making their eſcape, chooſing to be the ſlaves of *Europeans* rather than of a *black man* who would treat them with the greateſt cruelty. *Voyages to the Coaſt of Africa by Meſſrs Saugnier and Briſſon*, p. 332. 335. Engliſh Tranſlation.

torney, who was obliged to proſecute the maſter forthwith. That officer was alſo bound to proſecute, if by any other means he heard of the abuſe; the law adding as the reaſon, *This we will to be obſerved, to check the abuſe of power in the maſter*[*]."

[*] *Ramſay's Eſſay on the Treatment and Converſion of Slaves*, Sect. v.

24 In the Britiſh iſlands.

We wiſh it were in our power to ſay, that in the Britiſh Weſt India colonies ſlaves are equally protected by law as they were in the French iſlands under the old government, and that the ſame care is taken of their moral and religious improvement. This, however, we are afraid, cannot be ſaid with truth. In the iſland of Jamaica, before the paſſing of the *conſolidated ſlave act*, not many years ago, a white man, whether proprietor or not, who had killed a negro, or by an act of ſeverity been the cauſe of his death, was, for the firſt offence, intitled to benefit of clergy, and not liable to capital puniſhment till a repetition of the crime. By the preſent law, it is enacted, "That if any perſon, whether owner or ſuperintendant of ſlaves, ſhall be convicted of having, by any act of paſſion or cruelty, occaſioned the death of any negro, it ſhall be capital for the *firſt* offence: and for the greater ſecurity of the property, and as a check on thoſe who may have the puniſhment of ſlaves in their power, it is particularly required, that every ſurgeon or doctor belonging to each eſtate ſhall ſwear to the cauſe of the death of each negro, to the beſt of his knowledge and belief; and if any negro dies, and is interred by the owner or overſeer, without the doctor's having ſeen or been ſent for to ſuch negro, in this caſe the owner or overſeer cauſing the negro to be ſo interred is liable to a proſecution for ſuch conduct."

M'Neil's Obſervations on the Treatment of Negroes in the iſland of Jamaica.

This law muſt doubtleſs be productive of good effects; but being a colonial act, it cannot have the vigour of the *Code Noir;* nor do we know of any attorney in the iſland who is *obliged* to defend the rights of the negroes, or proſecute the maſter whoſe cruelty has by any means come to his knowledge. The juſtices and veſtry of each pariſh are indeed conſtituted *a council of protection*, for the expreſs purpoſe of making full enquiry into the barbarities exerciſed on ſlaves, and bringing the authors to puniſhment at the public expence; and by a new ſlave act of Grenada, the juſtices are required annually to nominate three freeholders to be *guardians of the ſlaves*, who are to take an oath to ſee the law duly executed[†]. Theſe are benevolent regulations; but we doubt if protection can be ſo promptly afforded by a council of guardians as by an individual attorney who has no other employment. In ſome of the other Britiſh iſlands, we have been confidently told that the unfortunate ſons of Africa have no protection whatever againſt the tyranny of a ſordid owner, or the caprice of a boyiſh overſeer (M); though it is added, that the humanity of many maſters more than ſupplies the want of laws in every reſpect but that of improvement, and that the attachment of others has in them a like effect. In ſome caſes good ſenſe, a regard for their reputation, and a well-informed conviction of their intereſt, induce men to treat their ſlaves with diſcretion and humanity. The ſlaves of many a planter poſſeſs advantages beyond what the labourer even of Britain enjoys[‡];" yet theſe advantages all depend upon the good will of his maſter; and in no part of the Britiſh colonies are the ſlaves attached to the ſoil. This ſingle circumſtance, together with the total neglect of their moral and religious culture, makes their ſituation much leſs eligible than was that of the French ſlaves under the old government; and affords a ſtriking proof of what the humane author whom we have juſt quoted well obſerves, that "thoſe men and nations whom liberty hath exalted, and who therefore ought to regard it tenderly in others, are conſtantly for reſtraining its bleſſings within their own little circle, and delight more in augmenting the train of their dependants than in adding to the rank of fellow-citizens, or in diffuſing the benefits of freedom among their neighbours."

[†] *Edwards's Hiſtory of the Weſt Indies*, book iv. chap. v.

[‡] *Ramſay's Eſſays*, p. 60. and 91.

25 The lawfulneſs of ſlavery inquired into.

Having given this ample detail of the riſe and progreſs of ſlavery in the world, and ſhown that it has prevailed in every age, and under all religions, we ſhall now proceed to enquire whether a practice ſo general be in any inſtance lawful; and if it be, how it muſt be modified, in order to be rendered conſiſtent with the rights of man and the immutable laws of virtue.

That in a ſtate of nature one man has a right to ſeize upon another, and to compel him by force to labour for his ſubſiſtence, is a poſition which we believe has never been ſeriouſly maintained. But independent communities ſtand to each other in the very ſame relation that individuals do in a ſtate of nature; and therefore if in ſuch a ſtate the man of greater bodily ſtrength or mental ſagacity would have no right to convert his weaker neighbour into perſonal property, neither can the more powerful and enlightened nation have a right to carry off by force, or entice by fraud, the ſubjects of a weaker and more barbarous community for the purpoſe of reducing them to a ſtate of ſervitude. This is a truth ſo obvious as to admit neither of proof nor of denial.

26 The common apology for it inſufficient.

In thus ſtating the caſe between two independent nations, we have in our eye that traffic in ſlaves which is carried on between the civilized Europeans and the barbarous Africans: and the utmoſt length which we think an apologiſt for that trade can go is to contend, that we may lawfully purchaſe ſlaves in thoſe countries where from time immemorial they have been a common branch of commerce. But the European right to purchaſe cannot be better than the African right to ſell; and we have never yet been informed what gives one African a right to ſell another. Such a right cannot be natural, for the reaſon which we have elſewhere aſſigned (ſee RIGHT): neither can it be adventitious; for adventitious rights are immediately derived from the municipal law, which is the public will of the ſtate. But the ſtate has no authority to deprive an innocent man of his perſonal freedom, or of the produce of his own labour; for it is only to ſecure theſe, by protecting the weak

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(M) In Barbadoes there is ſaid to be a law for the protection of ſlaves, which is the moſt inſolent trifling with juſtice and humanity that the writer of this article has ever ſeen. It is enacted, forſooth, "That if any man ſhall, of *wantonneſs*, or only of *bloody-mindedneſs*, or *cruel intention*, *wilfully kill* a negro or other ſlave, if his own, he ſhall pay into the public treaſury *fifteen pounds ſterling!* See *Dickſon's Letters on Slavery*, p. 4.

weak from the violence of the ſtrong, that ſtates are formed, and individuals united under civil government.

27 No man has a right to give himſelf up to the abſolute diſpoſal of another.

It may perhaps be ſaid, that by patiently ſubmitting to governments which authorize the traffic in human fleſh, men virtually give up their perſonal liberty, and veſt their governors with a right to ſell them as ſlaves: but no man can veſt another with a right which he poſſeſſes not himſelf; and we ſhall not heſitate to affirm, that in a ſtate of nature where all have equal rights, no individual can ſubmit himſelf to the abſolute diſpoſal of another without being guilty of the greateſt crime. The reaſon is obvious. From the relation in which men ſtand to one another as fellow-creatures, and to God as their common Creator, there are duties incumbent upon each peculiar to himſelf; in the performance of which he can be guided only by his own reaſon, which was given him for that very purpoſe. But he who renounces his perſonal freedom, and ſubmits unconditionally to the caprice of a maſter, impiouſly attempts to ſet himſelf free from the obligation of that law which is interwoven with his very being, and chooſes a director of his conduct different from that which God has aſſigned him. A man therefore cannot put himſelf in a ſtate of unconditional ſervitude; and what he cannot do for himſelf, he ſurely cannot authorize others to do for him either by a tacit or by an open conſent.

28 What kind of ſlavery may be employed as a puniſhment.

Theſe conſiderations have often made us regret that writers, for whoſe talents and integrity we have the higheſt reſpect, ſhould, without accurately defining what they mean by ſlavery, have peremptorily affirmed, that, conſiſtently with the law of nature men may be reduced to that ſtate as a puniſhment for crimes, or to diſcharge debts which they cannot otherwiſe pay. That a criminal, who has forfeited his life to the laws of his country, may have his puniſhment commuted for hard labour, till death in the courſe of nature ſhall put a period to his terreſtrial exiſtence, is a truth which we apprehend cannot be controverted; but to make ſuch a commutation of puniſhments conſiſtent with the laws of nature and of nature's God, it appears to us that the kind and degree of labour muſt be preciſely aſcertained, and the conduct of the criminal not left to the capricious direction of any individual.

Puniſhments can be juſtly inflicted only for one or other of two ends, or for both. They may be calculated either to reform the criminal or to be a warning to the innocent; and thoſe which moſt effectually anſwer both theſe purpoſes are ſurely to be preferred to ſuch as anſwer but one of them. For this reaſon we conſider hard labour as a much fitter puniſhment for moſt crimes than death: but to entitle it to preference, the kind and degree of the labour muſt be aſcertained by the law; for if theſe circumſtances be omitted, and the offender delivered over as a ſlave to the abſolute diſpoſal and caprice of a private maſter, the labour to which he is condemned, inſtead of operating to his reformation, may be converted into the means of tempting him to the commiſſion of new crimes. A young woman, in the ſtate of ſervitude, would hardly be able to maintain her virtue againſt the ſolicitations of a maſter who ſhould promiſe her liberty or a remiſſion of toil upon her yielding to his deſires; and the felon, who had long been accuſtomed to a life of vagrancy and idleneſs, would not ſtrenuouſly object to the perpetration of any wickedneſs to obtain his freedom, or even a diminution of his daily taſk. Indeed ſuch temptations might be thrown in his way, as human nature could not reſiſt but by means of much better principles than felons can be ſuppoſed to poſſeſs. He might be ſcourged into compliance; or his labour might be ſo increaſed as to make him for a little reſpite eagerly embrace the moſt nefarious propoſal which his maſter could make: for being abſolute property, there is no earthly tribunal to which he could appeal for juſtice; and felons do not commonly ſupport themſelves under trials by pious meditations on a future ſtate.

By reaſoning in this way, we are far from meaning to inſinuate that ſlave-holders in general torture their ſlaves into the commiſſion of crimes. God forbid! Many of them we know to be religious, humane, and benevolent: but they are not infallible; and ſome of them may be inſtigated, ſome of them undoubtedly have been inſtigated, by avarice and other worſe principles, to compel creatures, who are ſo abſolutely their dependents, to execute deeds of darkneſs too hazardous for themſelves. But the morality or immorality of any action, and the moral fitneſs of any ſtate, are to be judged of by their natural tendency, if the one were univerſally practiſed and the other univerſally prevalent (ſee Moral Philosophy, N° 156.): and as the natural tendency of abſolute domeſtic ſlavery among ſuch creatures as men is to throw the moſt powerful temptations to vice in the way both of maſter and of ſlave, it muſt be in every inſtance, even when employed as a puniſhment, inconſiſtent with the fundamental principles of moral virtue.

29 Children not the property of their parents.

Some writers indeed have maintained, and the civil law ſeems to ſuppoſe, that children are the property of their parents, and may by them be ſold as ſlaves in caſes of urgent neceſſity: but if we duly conſider how property is acquired (ſee Property), and attend to the natural conſequences of ſlavery, we ſhall ſoon be convinced that this opinion is very ill founded. The rights of parents reſult from their duties; and it is certainly the duty of that man who has been the inſtrument of bringing into the world an intellectual and moral being, to do every thing in his power to render the exiſtence of that being happy both in the preſent life and in that which is to come. If this duty be conſcientiouſly diſcharged, the parent has a manifeſt right to the gratitude, love, and reaſonable obedience, of his child; but he cannot, in conſequence of any duty performed, claim a right to transfer that child as property to the uncontrolled diſpoſal of any private maſter; for this plain reaſon, that the man who is conſidered as the private property of another, cannot reaſonably be ſuppoſed to enjoy happineſs in this world, and is under many temptations to do what muſt neceſſarily render him miſerable in the next. See Moral Philosophy, N° 138.

If criminals cannot be lawfully reduced to a ſtate of abſolute private ſlavery, much leſs ſurely can it be lawful to reduce inſolvent debtors and priſoners of war to that ſtate. Many a virtuous man, who has contracted debts with the faireſt proſpect of paying them, has been ſuddenly rendered inſolvent by fire, by ſhipwreck, or by the bankruptcy of others with whom he was neceſſarily engaged in the courſe of his trade. Such a man can be conſidered in no reſpect as criminal. He has been indeed unfortunate; but it would be groſsly unjuſt, as

30 Fraudulent bankrupts may be compelled to labour for the benefit of their creditors.

well as ſhockingly cruel, to add to his misfortune by reducing him to a ſtate to which we have juſt ſeen that the vileſt felon cannot be reduced without a violation of the laws of morality. Fraudulent bankrupts indeed, of whom we daily ſee many, might with great propriety and the ſtricteſt juſtice be compelled to extenuate their debts by labouring for the benefit of thoſe whom they have injured; and criminals of other deſcriptions might be made to work for the benefit of the public: but in both caſes the taſk to be performed ſhould be aſcertained by the law, and the perſons of the labourers be protected by the ſtate. If ſuch can be called ſlaves, their ſlavery is undoubtedly conſiſtent with every principle of virtue and religion; for they ſuffer nothing but the due reward of their deeds. Priſoners of war, however, can upon no honeſt principle be reduced even to this ſtate of mitigated bondage; for they are ſo far from incurring guilt by fighting for their country, that even to their enemies their courage and conduct in ſuch a cauſe muſt appear worthy of reward. A victorious general has certainly a right to prevent the priſoners taken in battle from again drawing their ſwords againſt him during the continuance of the war; but there are many ways by which this may be done effectually without chaining the unfortunate captives to the oar, or ſelling them like cattle to private purchaſers, by whom they may be treated with capricious cruelty, and driven to the perpetration of the greateſt crimes.

31 Two objections to our concluſions.

To theſe concluſions, and the reaſoning on which they are built, we are aware it may be objected, that if private ſlavery were in every inſtance unlawful and inconſiſtent with the fundamental principles of morality, it would not have prevailed among the ancient patriarchs, and far leſs have been authoriſed by the Jewiſh law.

32 The former anſwered.

In reply to this objection, it may be obſerved, that Abraham, Iſaac, and Jacob, though excellent men, were not characters abſolutely perfect; that as their practice does not authoriſe polygamy or inceſt among us, it will not authoriſe the reducing of our fellow-creatures to a ſtate of hopeleſs ſervitude; and that from the circumſtances of the age in which they lived, many things were permitted to them, and were indeed harmleſs, which are forbidden to us, and would now be pernicious. The character of Abraham appears to have been much more perfect than that of his ſon or grandſon; and was certainly equal, if not ſuperior, to that of any other mere man of whom we read either in profane or even in ſacred hiſtory. We are to remember, however, that he was born amidſt idolaters, and was probably an idolater himſelf till enlightened by the inſpiration of Jehovah, and called from his kindred and from his father's houſe. Before his converſion, he muſt have had much cattle and many ſlaves, which conſtituted the riches of that early period; and his caſe would indeed have been peculiarly hard, had he been commanded to diveſt himſelf of his ſervants, and to depart into a ſtrange country very thinly inhabited, without people to protect his flocks and herds from beaſts of prey. Nor would his loſs have contributed in any degree to the benefit of his ſlaves, who, as the ranks of men were then adjuſted, could not long have preſerved their liberty. Had they not been forcibly reduced to their former ſtate by their idolatrous countrymen, which in all probability they would have been, they muſt have ſoon ſubmitted to it, or periſhed by hunger. Let it be remembered, too, that the bond-ſervants of Abraham, though conſtituting the moſt valuable part of his property, were not conſidered as a ſpecies of inferior beings, but were treated rather as children than as ſlaves. This is evident from his ſpeaking of the ſteward of his houſe as his heir, when complaining to God of the want of ſeed. Indeed the manner in which this circumſtance is mentioned, ſhows that it was then the general practice to conſider domeſtic ſlaves as members of the family; for the patriarch does not ſay, "I will leave my ſubſtance to this Eliezer of Damaſcus;" but his words are, "Behold to me thou haſt given no ſeed; and lo, one born in my houſe is *my heir*[*]." From this mode of expreſſion we are ſtrongly inclined to think that captives taken in war were in that age of ſimplicity incorporated into the family or tribe of the conqueror, as they are ſaid to be at preſent among the North American Indians, to ſupply the place of thoſe who had fallen in battle. If ſo, ſlavery was then a very mild thing, unattended with the evils which are now in its train, and muſt often have been highly beneficial to the captive.

33 Anſwer to the other.

The other part of the objection appears at firſt ſight more formidable: but perhaps a little attention to the deſign of the Moſaic economy may enable us to remove it even more completely than this. We need not inform our theological readers, that one great purpoſe for which the poſterity of Abraham were ſeparated from the heathen nations around them, was to preſerve the knowledge of the true God in a world run headlong into idolatry. As idolatry appears to have had ſomething in its forms of worſhip extremely captivating to rude minds, and as the minds of the Iſraelites at the era of their departure from Egypt were exceedingly rude, every method was taken to keep their ſeparation from their idolatrous neighbours as complete as poſſible. With this view they were commanded to ſacrifice the animals which their Egyptian maſters had worſhipped as gods, and were taught to conſider hogs and ſuch other creatures as the heathen offered in ſacrifice, when celebrating their myſtical and magic rites, as too unclean to be eaten or even to be touched. Of this diſtinction between clean and unclean beaſts, God himſelf aſſigns the reaſon: "I am the Lord your God (ſays he), who have ſeparated you from other people; ye ſhall therefore put difference between clean and unclean beaſts, and between unclean fowls and clean[†]." For the ſame reaſon they were prohibited from intermarrying with the heathen, or having any tranſaction whatever with them as neighbours; and the ſeven idolatrous nations of Canaan they were ſtrictly commanded to exterminate. "When the Lord thy God (ſays Moſes) ſhall deliver them before thee, thou ſhalt ſmite them, and utterly deſtroy them: thou ſhalt make no covenant with them, nor ſhow mercy unto them: neither ſhalt thou make marriages with them; thy daughter thou ſhalt not give unto his ſon, nor his daughter ſhalt thou take to thy ſon; for they will turn away thy ſon from following me, that they may ſerve other gods[‡]."

Under theſe laws, it is plain that no intercourſe whatever could have place between an Iſraelite and a man of any other nation, unleſs the latter was reduced to ſuch a ſtate as that he could neither tempt the former, nor practiſe himſelf the rites of his idolatrous worſhip.

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[*] Gen. xv. 3.

[†] Lev. xx. 24, 25, 26.

[‡] Deut. vii. 2, 3, 4.

But the Iſraelites were not ſeparated from the reſt of the world for their own ſakes only: They were intended to be the repoſitaries of the lively oracles of God, and gradually ſpread the light of divine truth through other nations, till the fulneſs of time ſhould come, when in Chriſt all things were to be gathered together in one. To anſwer this end, it was neceſſary that there ſhould be ſome intercourſe between them and their Gentile neighbours; but we have ſeen that ſuch an intercourſe could only be that which ſubſiſts between maſters and their ſlaves.

Should this apology for the ſlavery which was authoriſed by the Jewiſh law be deemed fanciful, we beg leave to ſubmit to the conſideration of our readers the following account of that matter, to which the ſame objection will hardly be made. It was morally impoſſible that between nations differing ſo widely in religion, cuſtoms, and manners, as the Jews and Gentiles, peace ſhould for ever reign without interruption; but when wars broke out, battles would be fought, and priſoners would be taken. How were theſe priſoners to be diſpoſed of? Cartels for exchange were not then known: it was the duty of the Iſraelites to prevent their captives from taking up arms a ſecond time againſt them; they could not eſtabliſh them among themſelves either as artificers or as huſbandmen; for their law enjoined them to have no communication with the heathen. There was therefore no other alternative but either to maſſacre them in cold blood, or to reduce them to the condition of ſlaves. It would appear, however, that thoſe ſlaves were raiſed to the rank of citizens, or at leaſt that their burdens were much lightened, as ſoon as they were convinced of the truth of the Moſaic revelation, and received into covenant with God by the rite of circumciſion. They were then admitted to the celebration of the paſſover; concerning which one law was decreed to the ſtranger, and to him that was home-born. Indeed, when we conſider who was the legiſlator of the Jews; when we reflect upon the number of laws enacted to mitigate ſlavery among them, and call to mind the means by which the due execution of all their laws was enforced, (ſee THEOLOGY), we cannot help being of opinion that the heathen, who was reduced to ſlavery in Judea, might be happier, if he pleaſed, than when living as a freeman in his own country. But whether this be ſo or not, is a matter with which we have no concern. On account of the hardneſs of their hearts, and the peculiarity of their circumſtances, many things, of which ſlavery may have been one, were permitted to the Jews, which, if practiſed by Chriſtians, would render them highly guilty.

After treating thus largely of ſlavery in general, we need not occupy much of the reader's time with the

34 ve- de.

SLAVE-TRADE carried on by the merchants of Europe with the natives of Africa. It is well known that the Portugueſe were the firſt Europeans who embarked in this trade, and that their example was ſoon followed by the Dutch and the Engliſh. Of the riſe and progreſs of the Engliſh commerce in ſlaves, the reader will find a ſufficient account in other articles of this work *. That commerce, though long cheriſhed by the government as a ſource of national and colonial wealth, was from its commencement conſidered by the thinking part of the nation as a traffic inconſiſtent with the rights of man, and ſuſpected to be carried on by acts of violence. Theſe ſuſpicions were gradually ſpread through the people at large, and confirmed, in many inſtances, by evidence incontrovertible. Laws were in conſequence enacted to make the negroes more comfortable on what is called the middle paſſage, and to protect them againſt the wanton cruelty of their maſters in the Weſt Indies: but the humanity of the nation was rouſed; and not many years ago a number of gentlemen of the moſt reſpectable characters, finding that no adequate protection could be afforded to perſons in a ſtate of hopeleſs ſervitude, formed themſelves into a ſociety at London, for the purpoſe of procuring a total abolition of the ſlave trade. That the motives which influenced the leading men of this ſociety were of the pureſt kind, cannot, we think, be queſtioned; for their object was to deliver thoſe who had none to help them, and from whom they could expect no other reward for their labours of love than the bleſſings of them who were ready to periſh. To a cauſe truly Chriſtian, who did not pray for ſucceſs? or who but muſt have felt the moſt pungent regret, if that ſucceſs had been rendered doubtful, or even delayed, by the imprudence of ſome of the agents employed by the ſociety? This we apprehend was really the caſe. Language calculated only to exaſperate the planters could not ſerve the negroes; and the legiſlature of Great Britain would never ſuffer itſelf to be forced into any meaſure by the menaces of individuals.

See *Com- ny*, and *inea*.

35 Petitions for the abolition of it.

In the year 1793, petitions were preſented to parliament for the abolition of this inhuman traffic, which gave a pleaſing picture of the philanthropy of the nation; but, unfortunately for the cauſe of freedom, it was diſcovered that many of the names ſubjoined to thoſe petitions had been collected by means not the moſt honourable. The diſcovery, perhaps, would never have been made, had not the inſulting epithets indiſcriminately heaped upon the ſlave-holders provoked thoſe men to watch with circumſpection over the conduct of their opponents. The conſequence was, that ſuſpicions of unfair dealing on the part of the petitioners were excited in the breaſts of many who, though they ardently wiſhed well to the cauſe, choſe not to add their names to thoſe of ſchool-boys under age, and of peaſants who knew not what they were ſubſcribing. Let the rights of the Africans be maintained with ardour and firmneſs; but never let their advocates ſuppoſe that the cauſe of humanity requires the ſupport of artifice. Abſolute ſlavery, in which the actions of one man are regulated by the caprice of another, is a ſtate demonſtrably inconſiſtent with the obvious plan of the moral government of the world. It degrades the mental faculties of the ſlave, and throws, both in his way and in his maſter's, temptations to vice almoſt inſurmountable. Let theſe truths be ſet in a proper light by thoſe who have doubtleſs ſeen them exemplified; and they will ſurely have their full effect on the minds of a generous, and, we truſt, not an impious people (N). The trade will be generally aboliſhed; pains will be taken

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(N) We have not inſiſted upon the impolicy of the ſlave-trade, or endeavoured to prove that its abolition would ken to cultivate the minds of the Weſt Indian negroes; and the era may be at no great diſtance when ſlavery ſhall ceaſe through all the Britiſh dominions.

36 Objection to the abolition

But what benefit, it will be aſked, will the negroes of Africa reap from an abolition of the ſlave trade? Should any thing ſo wildly incredible happen, as that all the nations of Chriſtendom, in one common paroxyſm of philanthropy, ſhould abandon this commerce in ſervants, which has been proſecuted in all ages, and under all religions; they would only abandon it to thoſe who were originally poſſeſſed of it, who ſtill penetrate into the country, and who even puſh up to Gago at the very head of the Slave coaſt, and leave the wool-headed natives of it to Mahometan maſters, in preference to Chriſtian. Under ſuch maſters they were in Judea at the time of the cruſades. Under ſuch, as we learn from Meſſrs Saugnier, Briſſon, and others, they ſtill are in the deſerts of Africa, as well as in the iſlands of Johanna and Madagaſcar [*]; and it is univerſally known that they enſlave one another as a puniſhment for the moſt whimſical crimes. Among them, indeed, ſlavery ſeems to be reduced to a ſyſtem, and to deſcend, as it has done in more poliſhed nations, from father to ſon; for both Saugnier and Wadſtrom [†] ſpeak of particular families of negroes who are exempted from that degrading ſtate by the laws of the country.

All this we admit to be true. Moſt certainly the negroes would not be exempted from the miſeries of ſervitude, though Europe and the Weſt Indies were ſwallowed up in the ocean. The *cuſtoms* of the country, as the king of Dahomy aſſured Mr Abſon [‡], will be *made* as long as black men ſhall continue to poſſeſs their own territories, in their preſent ſtate of depravity and ignorance; and theſe cuſtoms appear to involve ſlavery of the crueleſt kind. But if ſlavery be in itſelf unlawful, is it a ſufficient excuſe for our continuing the traffic that it is carried on by the rude negroes and the ſavage Arabs?

37 of no ſtrength.

Are people, whom we ſometimes affect to conſider as an inferior order of beings, to furniſh examples of conduct to thoſe who boaſt of their advancements in ſcience, in literature, and in refinement? Or will the benevolent Lord of all things pardon us for oppreſſing our helpleſs brethren, merely becauſe they are cruelly oppreſſed by others? It is indeed true that the natives of Guinea cannot be made really free but by introducing among them the bleſſings of religion and the arts of civil life; but ſurely they would have fewer temptations than at preſent to kidnap one another, or to commence unprovoked wars for the purpoſe of making captives, were the nations of Europe to abandon the commerce in ſlaves (o). That commerce, we grant, would be continued by the Arabs, and perhaps by others of the eaſtern nations; but the ſame number of people could not be carried off by them alone that is now carried off both by them and by the Europeans.

Were it indeed poſſible to put the ſlave-trade under proper regulations, ſo as to prevent all kidnapping and unjuſt wars among the Africans, to ſupply the markets; and were it likewiſe poſſible to enſure to the negroes in the Weſt Indies mild treatment and religious inſtruction, we are far from being ſure that while the natives of Guinea continue ſo rude, and their neighbours the Arabs ſo ſelfiſhly ſavage, it would be proper to abandon at once to hordes of barbarians the whole of this commerce in bond ſervants. "The trade, which in its preſent form is a reproach to Britain, might be made to take a new ſhape, and become ultimately a bleſſing to thouſands of wretches who, left in their native country, would have dragged out a life of miſerable ignorance, unknowing the hand that framed them, unconſcious of the reaſon of which they were made capable, and heedleſs of the happineſs laid up for them in ſtore [§].

Slavery is, indeed, in every form an evil; but it ſeems to be one of thoſe many evils which, having long prevailed in the world, can be advantageouſly removed only by degrees, and as the moral cultivation of the ſlaves may enable them to ſupport the rank and diſcharge the duties of free men. This is doubtleſs the reaſon why it was not expreſsly prohibited by the divine Author of our religion, but ſuffered to vaniſh gradually before the mild influence of his Heavenly doctrines.

38 Abolitio of the ſl trade in Britain.

It has vaniſhed before theſe doctrines in moſt countries of Europe; and it affords us no ſmall gratification to have it in our power to record, what indeed muſt be freſh in the memory of our readers, that the abolition of the ſlave-trade was finally accompliſhed by the ſteady perſeverance and generous exertions of ſome of the moſt enlightened and reſpectable characters in the kingdom, who, after a long and arduous ſtruggle, obtained a decree of the legiſlature, prohibiting, after a limited period, the trade in ſlaves to be continued by ſubjects of Britain. The bill originated in the houſe of lords, and having undergone conſiderable diſcuſſion in the houſe of commons, finally paſſed on the 16th of March, and received his majeſty's aſſent

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would be *advantageous* to the ſugar-planters; for the planters ſurely underſtand their own intereſt better than thoſe can do, who, having never been in the Weſt Indies, are obliged to content themſelves with what information they can glean on the ſubject from a number of violent and contradictory publications. To countenance ſlavery under any form is undoubtedly immoral. This we know: and therefore upon this ground have we oppoſed the ſlave-trade, which cannot be continued without preferring intereſt to virtue.

(o) In a ſpeech which Mr Dalzel ſays the king of Dahomy made to Mr Abſon, when he was informed of what had paſſed in England on the ſubject of the ſlave-trade, are theſe remarkable words: "In the name of my anceſtors and myſelf, I aver that no Dahoman ever embarked in war merely for the ſake of procuring wherewithal to purchaſe your commodities." We muſt take the liberty to queſtion the truth of this ſolemn averment. That the ſlave-trade is not the *ſole* cauſe of the Dahoman wars every man will admit, who does not fancy that thoſe people have neither paſſions nor appetites, but for the commodities of Europe: but the bare affirmation of this bloody deſpot, who boaſted of having killed many thouſands at the *cuſtoms*, will not convince thoſe who have read either Wadſtrom's Eſſay on Colonization, or the evidence reſpecting the ſlave-trade given at the bar of the houſe of commons, "that no Dahoman *ever* embarked in war merely to procure ſlaves to barter for European commodities.'

[*] *Aſiatic Reſearches*, vol. ii.

[†] *Eſſay on Colonization.*

[‡] *Dalzel's Hiſtory.*

[§] *Ramſa Eſſay*, p. 292,

aſſent on the 25th March 1807. The time fixed by the bill, for the total abolition of the trade, we believe, was the beginning of the following year, viz. January 1808.

39 nger of udden numiſ- n of ves.

We canot conclude without expreſſing a hope, that the period is not very diſtant when the ſlaves in the Weſt Indies ſhall be ſo much improved in moral and religious knowledge, as that they may be ſafely truſted with their own freedom. To ſet them free in their preſent ſtate of ignorance and depravity, is one of the wildeſt propoſals that the ardour of innovation has ever made. Such freedom would be equally ruinous to themſelves and to their maſters; and we may ſay of it what Cicero ſaid of ſome unſeaſonable indulgences propoſed to be granted to the ſlaves in Sicily: *Quæ cum accidunt, nemo eſt, quin intelligat ruere illam rempublicam; hæc ubi veniunt, nemo eſt, qui ullam ſpem ſalutis reliquam eſſe arbitretur.*

Thoſe of our readers who wiſh to enter into a detail of this ſubject, may conſult, with much advantage, The Hiſtory of the Riſe, Progreſs, and Accompliſhment of the Abolition of the African Slave-Trade, by Mr Clarkſon, 2 vols 8vo.

SLAUGHTER. See MANSLAUGHTER, HOMICIDE, MURDER, &c.

SLEDGE, a kind of carriage, without wheels, for the conveyance of very weighty things, as huge ſtones, bells, &c. The ſledge for carrying criminals, condemned for high treaſon, to execution, is called HURDLE. The Dutch have a kind of ſledge on which they can carry a veſſel of any burden by land. It conſiſts of a plank of the length of the keel of a moderate ſhip, raiſed a little behind, and hollow in the middle; ſo that the ſides go a little aſlope, and are furniſhed with holes to receive pins, &c. The reſt is quite even.

SLEDGE is a large ſmith's hammer, to be uſed with both hands: of this there are two ſorts, the up-hand ſledge, which is uſed by under workmen, when the work is not of the largeſt ſort; it is uſed with both the hands before, and they ſeldom raiſe it higher than their head. But the other, which is called the about-ſledge, and which is uſed for battering or drawing out the largeſt work, is held by the handle with both hands, and ſwung round over their heads, at their arm's end, to ſtrike as hard a blow as they can.

SLEEP, that ſtate of the body in which, though the vital functions continue, the ſenſes are not affected by the ordinary impreſſions of external objects. See DREAMS and PHYSIOLOGY.

SLEEP-Walker, one who walks in his ſleep. Many inſtances might be related of perſons who were addicted to this practice; but it will be ſufficient to ſelect one remarkable inſtance from a report made to the Phyſical Society of Lauſanne, by a committee of gentlemen appointed to examine a young man who was accuſtomed to walk in his ſleep.

"The diſpoſition to ſleep-walking ſeems, in the opinion of this committee, to depend on a particular affection of the nerves, which both ſeizes and quits the patient during ſleep. Under the influence of this affection, the imagination repreſents to him the objects that ſtruck him while awake, with as much force as if they really affected his ſenſes; but does not make him perceive any of thoſe that are actually preſented to his ſenſes, except in ſo far as they are connected with the dreams which engroſs him at the time. If, during this ſtate, the imagination has no determined purpoſe, he receives the impreſſion of objects as if he were awake; only, however, when the imagination is excited to bend its attention towards them. The perceptions obtained in this ſtate are very accurate, and, when once received, the imagination renews them occaſionally with as much force as if they were again acquired by means of the ſenſes. Laſtly, theſe academicians ſuppoſe, that the impreſſions received during this ſtate of the ſenſes diſappear entirely when the perſon awakes, and do not return till the return of the ſame diſpoſition in the nervous ſyſtem.

"Their remarks were made on the Sieur Devaud, a lad thirteen years and a half old, who lives in the town of Vevey, and who is ſubject to that ſingular affection or diſeaſe called *Somnambuliſm* or ſleep-walking. This lad poſſeſſes a ſtrong and robuſt conſtitution, but his nervous ſyſtem appears to be organiſed with peculiar delicacy, and to diſcover marks of the greateſt ſenſibility and irritability. His ſenſes of ſmell, taſte, and touch, are exquiſite; he is ſubject to fits of immoderate and involuntary laughter, and he ſometimes likewiſe weeps without any apparent cauſe.

"This young man does not walk in his ſleep every night; ſeveral weeks ſometimes paſs without any appearance of a fit. He is ſubject to the diſeaſe generally two nights ſucceſſively, one fit laſting for ſeveral hours. The longeſt are from three to four hours, and they commonly begin about three or four o'clock in the morning.

"The fit may be prolonged, by gently paſſing the finger or a feather over his upper lip, and this ſlight irritation likewiſe accelerates it. Having once fallen aſleep upon a ſtaircaſe, his upper lip was thus irritated with a feather, when he immediately ran down the ſteps with great precipitation, and reſumed all his accuſtomed activity. This experiment was repeated ſeveral times.

"The young Devaud thinks he has obſerved, that, on the evenings previous to a fit, he is ſenſible of a certain heavineſs in his head, but eſpecially of a great weight in his eyelids.

"His ſleep is at all times unquiet, but particularly when the fits are about to ſeize him. During his ſleep, motions are obſervable in every part of his body, with ſtarting and palpitations; he utters broken words, ſometimes ſits up in his bed, and afterwards lies down again. He then begins to pronounce words more diſtinctly, he riſes abruptly, and acts as he is inſtigated by the dream that then poſſeſſes him. He is ſometimes in ſleep ſubject to continued and involuntary motions.

"The departure of the fit is always preceded by two or three minutes of calm ſleep, during which he ſnores. He then awakes rubbing his eyes like a perſon who has ſlept quietly.

"It is dangerous to awaken him during the fit, eſpecially if it is done ſuddenly; for then he ſometimes falls into convulſions. Having riſen one night with the intention of going to eat grapes, he left the houſe, paſſed through the town, and went to a vineyard where he expected good cheer. He was followed by ſeveral perſons, who kept at ſome diſtance from him, one of whom fired a piſtol, the noiſe of which inſtantly awakened him, and he fell down without ſenſe. He was carried home and brought to himſelf, when he recollected very well the having been awakened in the vineyard; but nothing more, except the fright at being found there alone, which had made him ſwoon.

"After the fits he generally feels a degree of laſſitude: ſometimes, though rarely, of indiſpoſition. At the end of one of thoſe fits, of which the gentlemen of the committee were witneſſes, he was affected with vomitings; but he is always ſoon reſtored.

"When he is awaked, he never for the moſt part recollects any of the actions he has been doing during the fit.

"The ſubject of his dreams is circumſcribed in a ſmall circle of objects, that relate to the few ideas with which at his age his mind is furniſhed; ſuch as his leſſons, the church, the bells, and eſpecially tales of ghoſts. It is ſufficient to ſtrike his imagination the evening before a fit with ſome tale, to direct his ſomnambuliſm towards the object of it. There was read to him while in this ſituation the ſtory of a robber; he imagined the very next moment that he ſaw robbers in the room. However, as he is much diſpoſed to dream that he is ſurrounded with them, it cannot be affirmed that this was an effect of the reading. It is obſerved, that when his ſupper has been more plentiful than uſual, his dreams are more diſmal.

"In their report, the gentlemen of the committee dwell much on the ſtate of this young man's ſenſes, on the impreſſion made upon them by ſtrange objects, and on the uſe they are of to him.

"A bit of ſtrong ſmelling wood produced in him a degree of reſtleſſneſs; the fingers had the ſame effect, whether from their ſmell or their tranſpiration. He knew wine in which there was wormwood by the ſmell, and ſaid that it was not wine for his table. Metals make no impreſſion on him.

"Having been preſented with a little common wine while he was in a ſtate of apathy, and all his motions were performed with languor, he drank of it willingly; but the irritation which it occaſioned produced a deal of vivacity in all his words, motions, and actions, and cauſed him to make involuntary grimaces.

"Once he was obſerved dreſſing himſelf in perfect darkneſs. His clothes were on a large table, mixed with thoſe of ſome other perſons; he immediately perceived this, and complained of it much; at laſt a ſmall light was brought, and then he dreſſed himſelf with ſufficient preciſion. If he is teaſed or gently pinched, he is always ſenſible of it, except he is at the time ſtrongly engroſſed with ſome other thing, and wiſhes to ſtrike the offender; however, he never attacks the perſon who has done the ill, but an ideal being whom his imagination preſents to him, and whom he purſues through the chamber without running againſt the furniture, nor can the perſons whom he meets in his way divert him from his purſuit.

"While his imagination was employed on various ſubjects, he heard a clock ſtrike, which repeated at every ſtroke the note of the cuckoo. There are cuckoos here, ſaid he; and upon being deſired, he imitated the ſong of that bird immediately.

"When he wiſhes to ſee an object, he makes an effort to lift his eyelids; but they are ſo little under his command, that he can hardly raiſe them a line or two, while he draws up his eyebrows; the iris at that time appears fixed, and his eye dim. When any thing is preſented to him, and he is told of it, he always half opens his eyes with a degree of difficulty, and then ſhuts them after he has taken what was offered to him.

"The report infers from theſe facts, and from many others relative to the different ſenſes, that their functions are not ſuſpended as to what the ſleep-walker wiſhes to ſee, that is, as to all thoſe perceptions which accord with the objects about which his imagination is occupied; that he may alſo be diſpoſed to receive thoſe impreſſions, when his imagination has no other object at the time; that in order to ſee, he is obliged to open his eyes as much as he can, but when the impreſſion is once made, it remains; that objects may ſtrike his ſight without ſtriking his imagination, if it is not intereſted in them; and that he is ſometimes informed of the preſence of objects without either ſeeing or touching them.

"Having engaged him to write a theme, ſay the committee, we ſaw him light a candle, take pen, ink, and paper, from the drawer of his table, and begin to write, while his maſter dictated. As he was writing, we put a thick paper before his eyes, notwithſtanding which he continued to write and to form his letters very diſtinctly; ſhowing ſigns, however, that ſomething was incommoding him, which apparently proceeded from the obſtruction which the paper, being held too near his noſe, gave to his reſpiration.

"Upon another occaſion, the young ſomnambuliſt aroſe at five o'clock in the morning, and took the neceſſary materials for writing, with his copy-book. He meant to have begun at the top of a page; but finding it already written on, he came to the blank part of the leaf, and wrote ſome time from the following words, *Fiunt ignari pigritia—Ils deviennent ignorans par la pareſſe*; and, what is remarkable, after ſeveral lines he perceived he had forgotten the *ſ* in the word *ignorans*, and had put erroneouſly a double *r* in *pareſſe*; he then gave over writing, to add the *ſ* he had forgotten, and to eraſe the ſuperfluous *r*.

"Another time he had finiſhed, of his own accord, a piece of writing, in order, as he ſaid, to pleaſe his maſter. It conſiſted of three kinds of writing, text, half text, and ſmall hand; each of them performed with the proper pen. He drew, in the corner of the ſame paper, the figure of a hat; he then aſked for a penknife to take out a blot of ink which he had made between two letters, and he eraſed it without injuring them. Laſtly, he made ſome arithmetical calculations with great accuracy.

"In order to explain ſome of the facts obſerved by the academicians which we have here mentioned, they eſtabliſh two general obſervations, which reſult from what they have ſaid with reſpect to the ſenſes and the dreams of this ſleep-walker.

"1. That he is obliged to open his eyes, in order to recogniſe objects which he wiſhes to ſee; but the impreſſion once made, although rapidly, is vivid enough to ſuperſede the neceſſity of his opening them again, to view the ſame objects anew; that is, the ſame objects are afterwards preſented to his imagination with as much force and preciſion as if he actually ſaw them.

"2. That his imagination, thus warmed, repreſents to him objects, and ſuch as he figures to himſelf, with as much vivacity as if he really ſaw them; and, laſtly, that all his ſenſes, being ſubordinate to his imagination, ſeem

Sleep-walker.

ſeem concentrated in the object with which it is occupied, and have at that time no perception of any thing but what relates to that object.

“ Theſe two cauſes united ſeem to them ſufficient for explaining one of the moſt ſingular facts that occurred to their obſervation, to wit, how the young Devaud can write, although he has his eyes ſhut, and an obſtacle before them. His paper is imprinted on his imagination, and every letter which he means to write is alſo painted there, at the place in which it ought to ſtand on the paper, and without being confounded with the other letters; now it is clear that his hand, which is obedient to the will of his imagination, will trace them on the real paper, in the ſame order in which they are repreſented on that which is pictured in his head. It is thus that he is able to write ſeveral letters, ſeveral ſentences, and entire pieces of writing; and what ſeems to confirm the idea, that the young Devaud writes according to the paper painted on his imagination is, that a certain ſleep-walker, who is deſcribed in the French *Encyclopédie* (article *Somnambuliſm*), having written ſomething on a paper, another piece of paper of the ſame ſize was ſubſtituted in its ſtead, which he took for his own, and made upon this blank paper the corrections he meant to have made on the other which had been taken away, preciſely in the places where they would have been.

“ It appears from the recital of another fact, that Devaud, intending to write at the top of the firſt leaf of a white paper book, *Vevey, le*— ſtopped a moment as if to recollect the day of the month, left a blank ſpace, and then proceeded to *Decembre* 1787; after which he aſked for an almanac: a little book, ſuch as is given to children for a new year's gift, was offered to him; he took it, opened it, brought it near his eyes, then threw it down on the table. An almanac which he knew was then preſented to him; this was in German, and of a form ſimilar to the almanac of Vevey: he took it, and then ſaid, ‘ What is this they have given me; here, there is your German almanac.’ At laſt they gave him the almanac of Berne; he took this likewiſe, and went to examine it at the bottom of an alcove that was perfectly dark. He was heard turning over the leaves, and ſaying 24, then a moment afterwards 34. Returning to his place, with the almanac open at the month of December, he laid it on the table and wrote in the ſpace which he had left blank the 24th. This ſcene happened on the 23d; but as he imagined it to be the 24th, he did not miſtake. The following is the explication given of this fact by the authors of the report.

“ The dates 23d, 24th, and 25th, of the month of December, had long occupied the mind of the young Devaud. The 23d and 25th were holidays, which he expected with the impatience natural to perſons of his age, for the arrival of thoſe moments when their little daily labours are to be ſuſpended. The 25th eſpecially was the object of his hopes; there was to be an illumination in the church, which had been deſcribed to him in a manner that quite tranſported him. The 24th was a day of labour, which came very diſagreeably between the two happy days. It may eaſily be conceived, how an imagination ſo irritable as that of the young Devaud would be ſtruck with thoſe pleaſing epochs. Accordingly, from the beginning of the month he had been perpetually turning over the almanac of Vevey. He calculated the days and the hours that were to elapſe before the arrival of his wiſhed-for holidays; he ſhowed to his friends and acquaintance the dates of thoſe days which he expected with ſo much impatience; every time he took up the almanac, it was only to conſult the month of December. We now ſee why that date preſented itſelf to his mind. He was performing a taſk, becauſe he imagined the day to be the Monday which had ſo long engroſſed him. It is not ſurpriſing, that it ſhould have occurred to his imagination, and that on opening the almanac in the dark he might have thought he ſaw this date which he was ſeeking, and that his imagination might have repreſented it to him in as lively a manner as if he had actually ſeen it. Neither is it ſurpriſing that he ſhould have opened the almanac at the month of December; the cuſtom of peruſing this month muſt have made him find it in the dark by a mere mechanical operation. Man never ſeems to be a machine ſo much as in the ſtate of ſomnambuliſm; it is then that habit comes to ſupply thoſe of the ſenſes that cannot be ſerviceable, and that it makes the perſon act with as much preciſion as if all his ſenſes were in the utmoſt activity. Theſe circumſtances deſtroy the idea of there being any thing miraculous in the behaviour of young Devaud with reſpect to the date and the month that he was in queſt of; and the reader, who has entered into our explanations, will not be ſurpriſed at his knowing the German almanac; the touch alone was ſufficient to point it out to him; and the proof of this is the ſhortneſs of the time that it remained in his hands.

“ An experiment was made by changing the place of the ink-ſtandiſh during the time that Devaud was writing. He had a light beſide him, and had certified himſelf of the place where his ink-holder was ſtanding by means of ſight. From that time he continued to take ink with preciſion, without being obliged to open his eyes again: but the ink-ſtandiſh being removed, he returned as uſual to the place where he thought it was: It muſt be obſerved, that the motion of his hand was rapid till it reached the height of the ſtandiſh, and then he moved it ſlowly, till the pen gently touched the table as he was ſeeking for the ink: he then perceived that a trick had been put on him, and complained of it; he went in ſearch of his ink-ſtandiſh and put it in its place. This experiment was ſeveral times repeated, and always attended with the ſame circumſtances. Does not what we have here ſtated prove, that the ſtandiſh, the paper, the table, &c. are painted on his imagination in as lively a manner as if he really ſaw them, as he ſought the real ſtandiſh in the place where his imagination told him it ought to have been? Does it not prove that the ſame lively imagination is the cauſe of the moſt ſingular actions of this ſleep-walker? And laſtly, does it not prove, that a mere glance of his eye is ſufficient to make his impreſſions as lively as durable?

“ The commitee, upon the whole, recommend to ſuch as wiſh to repeat the ſame experiments, 1. To make their obſervations on different ſleep-walkers. 2. To examine often whether they can read books that are unknown to them in perfect darkneſs. 3. To obſerve whether they can tell the hours on a watch in the dark. 4. To remove when they write the ink-ſtandiſh from its place, to ſee whether they will return to the ſame place in in order to take ink. 5. And, laſtly, to take notice whether they walk with the ſame confidence in a dark and unknown place, as in one with which they are acquainted.

"They likewiſe recommend to ſuch as would confirm or invalidate the above obſervations, to make all their experiments in the dark; becauſe it has been hitherto ſuppoſed that the eyes of ſleep-walkers are of no uſe to them."

SLEEPERS, in *Natural Hiſtory*, a name given to thoſe animals which ſleep all winter; ſuch as bears, marmots, dormice, bats, hedgehogs, ſwallows, &c. Theſe do not feed in winter, have no ſenſible evacuations, breathe little or none at all, and moſt of the viſcera ceaſe from their functions. Some of theſe animals ſeem to be dead, and others return to a ſtate like that of the fœtus before birth: in this ſtate they continue, till by an increaſe of heat the animal is reſtored to its former functions.

SLEEPERS, in a ſhip, timbers lying before and aft in the bottom of the ſhip, as the rungheads do: the lowermoſt of them is bolted to the rungheads, and the uppermoſt to the futtocks and rungs.

SLEIDAN, JOHN, an excellent German hiſtorian, born of obſcure parents, in 1506, at Sleidan, a ſmall town on the confines of the duchy of Juliers. After ſtudying ſome time in his own country, together with his townſman the learned John Sturmius, he went to France, and in 1525 entered into the ſervice of the cardinal and archbiſhop John du Bellay. He retired to Straſburg in 1542, where he acquired the eſteem and friendſhip of the moſt conſiderable perſons, particularly of James Sturmius; by whoſe advice and aſſiſtance he was enabled to write the hiſtory of his own time. He was employed in ſome public negociations; but the death of his wife, in 1555, plunged him into ſo deep a melancholy, that he loſt his memory entirely, and died the year following. In 1555 came out, in folio, *De ſtatu Religionis et Reipublicæ ſub Carolo Quinto*, &c. in 15 books; from the year 1517, when Luther began to preach, to the year of its publication; which hiſtory was preſently tranſlated into moſt of the languages of Europe. Beſides this great work, he wrote, *De quatuor ſummis Imperiis, libri tres;* with ſome other hiſtorical and political pieces.

SLEIGHT *of* HAND. See LEGERDEMAIN.

SLESWICK, an ancient and conſiderable town of Denmark, the metropolis of a duchy of the ſame name, in the province of Gottorp, the ſee of a biſhop, which was ſecularized in the year 1586. The old palace of Gottorp is cloſe to it, which was formerly the ducal reſidence, but afterwards inhabited by the governor. This town at one period was much more extenſive than it is now, having ſuffered greatly by the German wars. It is ſeated on the gulf of Sley, where there is a commodious harbour, 60 miles north-weſt of Lubeck, and 125 ſouth-weſt of Copenhagen. The people boaſt that the German language is here ſpoken with as much accuracy as at Vienna, of which, however, a good German ſcholar can alone be judge. Sleſwick has but little trade, as none but ſmall boats can have acceſs to it, the paſſage of the Sley having been long ſince choked up with ſand and mud; before which period it was both flouriſhing and populous. It is now chiefly inhabited by the officers of the caſtle, and the poorer claſſes, or the attendants on the court and on them. The preſent population is ſaid not to exceed 5000. E. Long. 10. 0. N. Lat. 54. 40.

SLESWICK, the duchy of, or *South Jutland*, is about 100 miles in length and 60 in breadth. It is bounded on the north by North Jutland, on the eaſt by the Baltic ſea, on the ſouth by Holſtein, and on the weſt by the ocean. It contains 14 cities, 17 towns, 13 caſtles, 278 pariſhes, 1480 villages, 162 farms, 116 water-mills, and 106 gentlemen's ſeats. It is a pleaſant, fertile populous country, and a ſovereign duchy. Formerly the king of Denmark had half of it, and the other belonged to the houſe of Holſtein-Gottorp; but the former having conquered this duchy, had the poſſeſſion of it confirmed to him by the treaty of the north in 1720. In 1731, a prince of Bareith-Culmbach was made governor of this duchy, who reſides at Gottorp.

SLEUT-HOUNDE, the ancient Scots name of the blood-hound. The word is from the Saxon *ſlot*, "the impreſſion that a deer leaves of its foot in the mire," and *hound*, "a dog;" ſo they derive their name from following the track. See the article *BLOOD-Hound*.

SLICH, in *Metallurgy*, the ore of any metal, particularly of gold, when it has been pounded, and prepared for farther working.

The manner of preparing the ſlich at Chremnitz in Hungary is this; they lay a foundation of wood three yards deep, upon this they place the ore, and over this there are 24 beams, armed at their bottoms with iron; theſe, by a continual motion, beat and grind the ore, till it is reduced to powder: during this operation, the ore is covered with water. There are four wheels uſed to move theſe beams, each wheel moving ſix; and the water, as it runs off, carrying ſome of the metalline particles with it, is received into ſeveral baſons, one placed behind another; and finally, after having paſſed through them all, and depoſited ſome ſediment in each, it is let off into a very large pit, almoſt half an acre in extent; in which it is ſuffered to ſtand ſo long as to depoſit all its ſediment, of whatever kind, and after this it is let out. This work is carried on day and night, and the ore taken away and replaced by more as often as occaſion requires. That ore which lies next the beams, by which it was pounded, is always the cleaneſt or richeſt.

When the ſlich is waſhed as much as they can, a hundred weight of it uſually contains about an ounce, or perhaps but half an ounce of metal, which is not all gold; for there is always a mixture of gold and ſilver, but the gold is in the largeſt quantity, and uſually is two-thirds of the mixture: they then put the ſlich into a furnace with ſome limeſtone, and ſlacken, or the ſcoria of former meltings, and run them together. The firſt melting produces a ſubſtance called *lech;* this lech they burn with charcoal, to make it lighter, to open its body, and render it porous, after which it is called *roſt;* to this roſt they add ſand in ſuch quantity as they find neceſſary, and then melt it over again.

At Chremnitz many other ways are practiſed of reducing gold out of its ore, but particularly one, in which they employ no lead during the whole operation; whereas, in general, lead is always neceſſary, after the beforementioned proceſſes. See *ORES, Reduction of.*

SLIDING RULE, a mathematical inſtrument, ſerving to work queſtions in gauging, meaſuring, &c. without

out the uſe of compaſſes; merely by the ſliding of the parts of the inſtrument one by another, the lines and diviſions whereof give the anſwer by inſpection.

This inſtrument is variouſly contrived, and applied by various authors, particularly Everard, Coggeſhall, Gunter, Hunt, and Partridge; but the moſt common and uſeful are thoſe of Everard and Coggeſhall.

SLIGO, a county in the province of Connaught, Ireland, 31 miles in length, and 29 in breadth; bounded on the eaſt by that of Leitrim, on the weſt by the county of Mayo, on the north and north-weſt by the weſtern ocean, and on the ſouth and ſouth-weſt by Roſcommon and Mayo. It contains 11,500 houſes, 41 pariſhes, 60,000 inhabitants, and ſends two members to parliament.

SLIGO, the only market town in the county, contains 8000 inhabitants, and enjoys a conſiderable trade, is ſeated on a bay of the ſame name, 30 miles weſt of Killalla, and 110 north-eaſt of Dublin. W. Long. 8. 26. N. Lat. 54. 13.

SLING, an inſtrument ſerving for caſting ſtones with great violence. The inhabitants of the Balearic iſlands were famous in antiquity for the dexterous management of the ſling; it is ſaid they uſed three kinds of ſlings, ſome longer, others ſhorter, which they uſed according as their enemies were either nearer or more remote. It is added, that the firſt ſerved them for a head-band, the ſecond for a girdle, and that the third they conſtantly carried in their hand.

SLINGING is uſed variouſly at ſea; but chiefly for hoiſting up caſks or other heavy things with ſlings, i. e. contrivances of ropes ſpliced into themſelves at either end, with one eye big enough to receive the caſk or whatever is to be ſlung. There are other ſlings, which are made longer, and with a ſmall eye at each end; one of which is put over the breech of a piece of ordnance, and the other eye comes over the end of an iron crow, which is put into the mouth of the piece, to weigh and hoiſe the gun as they pleaſe. There are alſo ſlings by which the yards are bound faſt to the croſs-tree aloft, and to the head of the maſt, with a ſtrong rope or chain, that if the tie ſhould happen to break, or to be ſhot to pieces in fight, the yard, nevertheleſs, may not fall upon the hatches.

SLINGING a Man overboard, in order to ſtop a leak in a ſhip, is done thus: the man is truſſed up about the middle in a piece of canvas, and a rope to keep him from ſinking, with his arms at liberty, a mallet in one hand and a plug, wrapped in oakum and well tarred in a tarpawling clout, in the other, which he is to beat with all diſpatch into the hole or leak.

SLOANE, SIR HANS, Baronet, eminently diſtinguiſhed as a phyſician and a naturaliſt, was of Scotch extraction, his father Alexander Sloane being at the head of that colony of Scots which King James I. ſettled in the north of Ireland, where our author was born, at Killieagh, on the 19th of April 1660. At a very early period, he diſplayed a ſtrong inclination for natural hiſtory; and this propenſity being encouraged by a ſuitable education, he employed thoſe hours which young people generally loſe by purſuing low and trifling amuſements, in the ſtudy of nature, and contemplating her works. When about ſixteen, he was attacked by a ſpitting of blood, which threatened to be attended with conſiderable danger, and which interrupted the regular courſe of his application for three years; he had, however, already learned enough of phyſic to know that a malady of this kind was not to be removed ſuddenly, and he prudently abſtained from wine and other liquors that were likely to increaſe it.

By ſtrictly obſerving this ſevere regimen, which in ſome meaſure he continued ever after, he was enabled to prolong his life beyond the ordinary bounds; being an example of the truth of his own favourite maxim, that ſobriety, temperance, and moderation, are the beſt and moſt powerful preſervatives that nature has granted to mankind.

As ſoon as he recovered from this infirmity, he reſolved to perfect himſelf in the different branches of phyſic, which was the profeſſion he had made choice of; and with this view he repaired to London, where he hoped to receive that aſſiſtance which he could not find in his own country.

On his arrival in the metropolis, he entered himſelf as a pupil to the great Stafforth, an excellent chemiſt, bred under the illuſtrious Stahl; and by his inſtructions he gained a perfect knowledge of the compoſition and preparation of the different kinds of medicines then in uſe. At the ſame time, he ſtudied botany at the celebrated garden at Chelſea, aſſiduouſly attended the public lectures of anatomy and phyſic, and in ſhort neglected nothing that he thought likely to prove ſerviceable to him in his future practice. His principal merit, however, was his knowledge of natural hiſtory; and it was this part of his character which introduced him early to the acquaintance of Mr Boyle and Mr Ray, two of the moſt eminent naturaliſts of that age. His intimacy with theſe diſtinguiſhed characters continued as long as they lived; and as he was careful to communicate to them every object of curioſity that attracted his attention, the obſervations which he occaſionally made often excited their admiration and obtained their applauſe.

After ſtudying four years at London with unremitting ſeverity, Mr Sloane determined to viſit foreign countries for farther improvement. In this view he ſet out for France in the company of two other ſtudents, and having croſſed to Dieppe, proceeded to Paris. In the way thither they were elegantly entertained by the famous M. Lemery the elder; and in return Mr Sloane preſented that eminent chemiſt with a ſpecimen of four different kinds of phoſphorus, of which, upon the credit of other writers, M. Lemery had treated in his book of chemiſtry, though he had never ſeen any of them.

At Paris Mr Sloane lived as he had done in London. He attended the hoſpitals, heard the lectures of Tournefort, De Verney, and other eminent maſters; viſited all the literati, who received him with particular marks of eſteem, and employed himſelf wholly in ſtudy.

From Paris Mr Sloane went to Montpelier; and, being furniſhed with letters of recommendation from M. Tournefort to M. Chirac, then chancellor of that univerſity, he found eaſy acceſs, through his means, to all the learned men of the province, particularly to M. Magnol, whom he always accompanied in his botanical excurſions in the environs of that city, where he beheld with pleaſure and admiration the ſpontaneous productions of nature, and learned under his inſtructions to claſs them in a proper manner.

Having here found an ample field for contemplation, which was entirely ſuited to his taſte, he took leave of his two companions, whom a curioſity of a different kind led into Italy.

After ſpending a whole year in collecting plants, he travelled through Languedoc with the ſame deſign; and paſſing through Thoulouſe and Bourdeaux, returned to Paris, where he made a ſhort ſtay. About the end of the year 1684 he ſet out for England, with an intention of ſettling there as a phyſician. On his arrival in London, he made it his firſt buſineſs to viſit his two illuſtrious friends Mr Ray and Mr Boyle, in order to communicate to them the diſcoveries he had made in his travels. The latter he found at home, but the former had retired to Eſſex; to which place Mr Sloane tranſmitted a great variety of plants and ſeeds, which Mr Ray has deſcribed in his Hiſtory of Plants, and for which he makes a proper acknowledgement.

About the year 1706 our author became acquainted with the celebrated Sydenham; who ſoon contracted ſo warm an affection for him that he took him into his houſe, and recommended him in the ſtrongeſt manner to his patients. He had not been long in London before he was propoſed by Dr Martin Liſter as a candidate to be admitted a member of the Royal Society, on the 26th of November 1684; and being approved, he was elected on the 21ſt of January following.

In 1685 he communicated ſome curioſities to the Society; and in July the ſame year he was a candidate for the office of their aſſiſtant ſecretary, but without ſucceſs, as he was obliged to give way to the ſuperior intereſt of his competitor Dr Halley. On the 12th of April 1687, he was choſen a fellow of the college of phyſicians in London; and the ſame year his friend and fellow traveller Dr Tancred Robinſon, having mentioned to the Society the plant called the *ſtar of the earth*, as a remedy newly diſcovered for the bite of a mad dog, Dr Sloane acquainted them that this virtue of the plant was to be found in a book called *De Grey's Farriery*; and that he knew a man who had cured with it twenty couple of dogs. This obſervation he made on the 13th of July, and on the 12th of September following he embarked at Portſmouth for Jamaica with the duke of Albemarle, who had been appointed governor of that iſland. The doctor attended his grace in quality of phyſician, and arrived at Jamaica on the 19th of December following.

Here a new field was opened for freſh diſcoveries in natural productions; but the world would have been deprived of the fruits of them, had not our author, by incredible application, converted, as we may ſay, his minutes into hours. The duke of Albemarle died ſoon after he landed, and the ducheſs determined to return to England whenever an anſwer ſhould be received to the letter ſhe had ſent to court on that melancholy occaſion. As Dr Sloane could not think of leaving her grace in her diſtreſs, whilſt the reſt of her retinue were preparing for their departure, he improved it in making collections of natural curioſities; ſo that, though his whole ſtay at Jamaica was not above fifteen months, he brought together ſuch a prodigious number of plants, that on his return to England, Mr Ray was aſtoniſhed that one man could procure in one iſland, and in ſo ſhort a ſpace, ſo vaſt a variety.

On his arrival in London, he applied himſelf to the practice of his profeſſion; and ſoon became ſo eminent, that he was choſen phyſician to Chriſt's hoſpital on the 17th October 1694: and this office he held till the year 1730, when, on account of his great age and infirmities, he found it neceſſary to reſign. It is ſomewhat ſingular, and redounds much to the doctor's honour, that though he received the emoluments of his office punctually, becauſe he would not lay down a precedent which might hurt his ſucceſſors, yet he conſtantly applied the money to the relief of thoſe who were the greateſt objects of compaſſion in the hoſpital, that it might never be ſaid he enriched himſelf by giving health to the poor. He had been elected ſecretary to the Royal Society on the 30th of November 1693; and upon this occaſion he revived the publication of the Philoſophical Tranſactions, which had been omitted for ſome time. He continued to be the editor of this work till the year 1712; and the volumes which appeared during that period are monuments of his induſtry and ingenuity, many of the pieces contained in them being written by himſelf.

In the mean time he publiſhed *Catalogus Plantarum quæ in Inſula Jamaica ſponte proveniunt*, &c.; *ſeu Prodromi Hiſtoriæ Naturalis pars prima*; which he dedicated to the Royal Society and College of Phyſicians. About the ſame time he formed the plan of a diſpenſary, where the poor might be furniſhed at prime coſt with ſuch medicines as their ſeveral maladies might require; which he afterwards carried into execution, with the aſſiſtance of the preſident and other members of the college of phyſicians.

Our author's thirſt for natural knowledge ſeems to have been born with him, ſo that his cabinet of curioſities may be ſaid to have commenced with his being. He was continually enriching and enlarging it; and the fame which, in the courſe of a few years, it had acquired, brought every thing that was curious in art or nature to be firſt offered to him for purchaſe. Theſe acquiſitions, however, increaſed it but very ſlowly in compariſon of the augmentation it received in 1701 by the death of William Courten, Eſq. a gentleman who had employed all his time, and the greater part of his fortune, in collecting rarities, and who bequeathed the whole to Dr Sloane, on condition of his paying certain debts and legacies with which he had charged it. Theſe terms our author accepted, and he executed the will of the donor with the moſt ſcrupulous exactneſs; on which account ſome people have ſaid, that he purchaſed Mr Courten's curioſities at a dear rate.

In 1707 the firſt volume of Dr Sloane's Natural Hiſtory of Jamaica appeared in folio, though the publication of the ſecond was delayed till 1725. By this very uſeful as well as magnificent work, the materia medica was enriched with a great number of excellent drugs not before known. In 1708 the Doctor was elected a foreign member of the Royal Academy of Sciences at Paris, in the room of Mr Tſchirnaus; an honour ſo much the greater, as we were then at war with France, and the queen's expreſs conſent was neceſſary before he could accept it. In proportion as his credit roſe among the learned, his practice increaſed among the people of rank: Queen Anne herſelf frequently conſulted him, and in her laſt illneſs was blooded by him.

On the advancement of George I. to the throne, that prince, on the 3d of April 1716, created the Doctor a baronet, an hereditary title of honour to which no Engliſh phyſician had before attained; and at the ſame time made him phyſician general to the army, in which ſtation he continued till 1727, when he was appointed phyſician in ordinary to George II. He attended the royal family till his death; and was particularly favoured by Queen Caroline, who placed the greateſt confidence in his preſcriptions. In the mean time he had been unanimouſly choſen one of the elects of the college of phyſicians June 1. 1716, and he was elected preſident of the ſame body on September 30. 1719, an office which he held for ſixteen years. During that period he not only gave the higheſt proofs of his zeal and aſſiduity in the diſcharge of his duty, but in 1721 made a preſent to that ſociety of 100l.; and ſo far remitted a very conſiderable debt, which the corporation owed him, as to accept it in ſuch ſmall ſums as were leaſt inconvenient to the ſtate of their affairs. Sir Hans was no leſs liberal to other learned bodies. He had no ſooner purchaſed the manor of Chelſea, than he gave the company of apothecaries the entire freehold of their botanical garden there, upon condition only that they ſhould preſent yearly to the Royal Society fifty new plants, till the number ſhould amount to 2000 (A). He gave beſides ſeveral other conſiderable donations for the improvement of this garden; the ſituation of which, on the banks of the Thames, and in the neighbourhood of the capital, was ſuch as to render it uſeful in two reſpects: Firſt, by producing the moſt rare medicinal plants; and, ſecondly, by ſerving as an excellent ſchool for young botaniſts; an advantage which he himſelf had derived from it in the early part of his life.

The death of Sir Iſaac Newton, which happened in 1727, made way for the advancement of Sir Hans to the preſidency of the Royal Society. He had been vice-preſident, and frequently ſat in the chair for that great man; and by his long connection with this learned body he had contracted ſo ſtrong an affection for it, that he made them a preſent of an hundred guineas, cauſed a curious buſt of King Charles II. its founder, to be erected in the great hall where it met, and, as is ſaid, was very inſtrumental in procuring Sir Godfrey Copley's benefaction of a medal of the value of five guineas, to be annually given as an honorary mark of diſtinction to the perſon who communicates the beſt experiments to the Society.

On his being raiſed to the chair, Sir Hans laid aſide all thoughts of further promotion, and applied himſelf wholly to the faithful diſcharge of the duties of the offices which he enjoyed. In this laudable occupation he employed his time from 1727 to 1740, when, at the age of fourſcore, he formed a reſolution of quitting the ſervice of the public, and of living for himſelf. With this view he reſigned the preſidency of the Royal Society much againſt the inclination of that reſpectable body, who choſe Martin Folkes, Eſq: to ſucceed him, and in a public aſſembly thanked him for the great and eminent ſervices he had rendered them. In the month of January 1741, he began to remove his library, and his cabinet of rarities, from his houſe in Bloomſbury to that at Chelſea; and on the 12th of March following, having ſettled all his affairs, he retired thither himſelf, to enjoy in peaceful tranquillity the remains of a well-ſpent life. He did not, however, bury himſelf in that ſolitude which excludes men from ſociety. He received in Chelſea, as he had done in London, the viſits of people of diſtinction, of all learned foreigners, and of the royal family, who ſometimes did him the honour to wait on him; but, what was ſtill more to his praiſe, he never refuſed admittance or advice to rich or poor who came to conſult him concerning their health. Not contented with this contracted method of doing good, he now, during his retreat, preſented to the public ſuch uſeful remedies as ſucceſs had warranted, during the courſe of a long continued practice. Among theſe is the efficacious receipt for diſtempers in the eyes, and his remedy for the bite of a mad dog.

During the whole courſe of his life, Sir Hans had lived with ſo much temperance, as had preſerved him from feeling the infirmities of old age; but in his 90th year he began to complain of pains, and to be ſenſible of an univerſal decay. He was often heard to ſay, that the approach of death brought no terrors along with it; that he had long expected the ſtroke; and that he was prepared to receive it whenever the great Author of his being ſhould think fit. After a ſhort illneſs of three days, he died on the 11th of January 1752, and was interred on the 18th at Chelſea, in the ſame vault with his lady, the ſolemnity being attended with the greateſt concourſe of people, of all ranks and conditions, that had ever been ſeen before on the like occaſion.

Sir Hans being extremely ſolicitous leſt his cabinet of curioſities, which he had taken ſo much pains to collect, ſhould be again diſſipated at his death, and being at the ſame time unwilling that ſo large a portion of his fortune ſhould be loſt to his children, he bequeathed it to the public, on condition that 20,000l. ſhould be made good by parliament to his family. This ſum, though large in appearance, was ſcarcely more than the intrinſic value of the gold and ſilver medals, the ores and precious ſtones that were found in it; for in his laſt will he declares, that the firſt coſt of the whole amounted at leaſt to 50,000l. Beſides his library, conſiſting

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(A) This garden was firſt eſtabliſhed by the company in 1673; and having after that period been ſtocked by them with a great variety of plants, for the improvement of botany, Sir Hans, in order to encourage ſo ſerviceable an undertaking, granted to the company the inheritance of it, being part of his eſtate and manor of Chelſea, on condition that it ſhould be for ever preſerved as a phyſic garden. As a proof of its being ſo maintained, he obliged the company, in conſideration of the ſaid grant, to preſent yearly to the Royal Society, in one of their weekly meetings, fifty ſpecimens of plants that had grown in the garden the preceding year, and which were all to be ſpecifically diſtinct from each other, until the number of two thouſand ſhould be completed. This number was completed in the year 1761. In 1733 the company erected a marble ſtatue of Sir Hans, executed by Ryſbrac, which is placed upon a pedeſtal in the centre of the garden, with a Latin inſcription, expreſſing his donation, and the deſign and advantages of it.

ſiſting of more than 50,000 volumes, 347 of which were illuſtrated with cuts finely engraven and coloured from nature, there were 3560 manuſcripts, and an infinite number of rare and curious works of every kind. The parliament accepted the legacy, and fulfilled the conditions.

SLOANEA, a genus of plants belonging to the claſs of polyandria, and order of monogynia; and in the natural ſyſtem ranging under the 50th order, *Amentaceæ*. See Botany *Index*.

SLOE. See Prunus, Botany *Index*.

SLOOP, a ſmall veſſel furniſhed with one maſt, the mainſail of which is attached to a gaff above, or to the maſt on its foremoſt edge, and to a long boom below, by which it is occaſionally ſhifted to either quarter. See Ship.

Sloop of War, a name given to the ſmalleſt veſſels of war except cutters. They are either rigged as ſhips or ſnows.

SLOT, in the ſportſman's language, a term uſed to expreſs the mark of the foot of a ſtag or other animal proper for the chace in the clay or earth, by which they are able to gueſs when the animal paſſed, and which way he went. The ſlot, or treading of the ſtag, is very nicely ſtudied on this occaſion; if the ſlot be large, deep printed in the ground, and with an open cleft, and, added to theſe marks, there is a large ſpace between mark and mark, it is certain that the ſtag is an old one. If there be obſerved the ſlots or treadings of two, the one long and the other round, and both of one ſize, the long ſlot is always that of the larger animal. There is alſo another way of knowing the old ones from the young ones by the treading; which is, that the hinder feet of the old ones never reach to their fore feet, whereas thoſe of the young ones do.

SLOTH. See Bradypus, Mammalia *Index*.

SLOUGH, a deep muddy place. The caſt ſkin of a ſnake, the damp of a coal-pit, and the ſcar of a wound, are alſo called by the ſame appellation. The ſlough of a wild boar is the bed, ſoil, or mire, wherein he wallows, or in which he lies in the day-time.

SLUCZK, a large and populous town in Poland, in Lithuania, and capital of a duchy of the ſame name; famous for three battles gained here by Conſtantine duke of Oſtrog over the Tartars, in the reign of Sigiſmund I. It is ſeated on the river Sluczk, 72 miles ſouth-eaſt of Minſki, and 70 ſouth of Novogrodeck. E. Long. 27. 44. N. Lat. 53. 2.

SLUG. See Limax, Helminthology *Index*.

SLUICE, a frame of timber, ſtone, or other matter, ſerving to retain and raiſe the water of a river, &c. and on occaſion to let it paſs.

Such is the ſluice of a mill, which ſtops and collects the water of a rivulet, &c. to let it fall at length in the greater plenty upon the mill-wheel; ſuch alſo are thoſe uſed as vents or drains to diſcharge water off land. And ſuch are the ſluices of Flanders, &c. which ſerve to prevent the waters of the ſea from overflowing the lower lands.

Sometimes there is a kind of canal incloſed between two gates or ſluices, in artificial navigations. to ſave the water, and render the paſſage of boats equally eaſy and ſafe, upwards and downwards; as in the ſluices of Briare in France, which are a kind of maſſive walls built parallel to each other, at the diſtance of 20 or 24 feet, cloſed with ſtrong gates at each end, between which is a kind of canal or chamber, conſiderably longer than broad; wherein a veſſel being incloſed, the water is let out at the firſt gate, by which the veſſel is raiſed 15 or 16 feet, and paſſed out of this canal into another much higher. By ſuch means a boat is conveyed out of the Loire into the Seine, though the ground between them riſe above 150 feet higher than either of thoſe rivers*.

Sluices are made different ways, according to the uſe for which they are intended: when they ſerve for navigation, they are ſhut with two gates, preſenting an angle towards the ſtream; when they are made near the ſea, two pair of gates are made, the one to keep the water out and the other in, as occaſion requires: in this caſe, the gates towards the ſea preſent an angle that way, and the others the contrary way; and the ſpace incloſed by thoſe gates is called the *chamber*. When ſluices are made in the ditches of a fortreſs, to keep up the water in ſome parts, inſtead of gates, ſhutters are made ſo as to ſlide up and down in grooves; and when they are made to raiſe an inundation, they are then ſhut by means of ſquare timbers let down in culliſes, ſo as to lie cloſe and firm.

The word *ſluice* is formed of the French *eſcluſe*, which Menage derives from the Latin *excluſa*, found in the Salic law in the ſame ſenſe. But this is to be reſtrained to the ſluices of mills, &c. for as to thoſe ſerving to raiſe veſſels, they were wholly unknown to the ancients.

SLUR, in *Muſic*, a mark like the arch of a circle, drawn from one note to another, comprehending two or more notes in the ſame or different degrees. If the notes are in different degrees, it ſignifies that they are all to be ſung to one ſyllable; for wind inſtruments, that they are to be made in one continued breath; and for ſtringed inſtruments that are ſtruck with a bow, as a violin, &c. that they are made with one ſtroke. If the notes are in the ſame degree, it ſignifies that it is all one note, to be made as long as the whole notes ſo connected; and this happens moſt frequently betwixt the laſt note of one line and the firſt of the next; which is particularly called *ſyncopation*.

SLUYS, a town of Dutch Flanders, oppoſite the iſland of Cadſand, with a good harbour, 10 miles north of Bruges, containing 14,000 inhabitants. E. Long. 3. 25. N. Lat. 51. 19.

SMACK, a ſmall veſſel, commonly rigged as a ſloop or hoy, uſed in the coaſting or fiſhing trade, or as a tender in the king's ſervice.

SMALAND, or East Gothland, a province of Sweden, which makes part of Gothland; and is bounded on the north by Oſtrogothia or Eaſt Gothland, on the eaſt by the Baltic ſea, on the ſouth by Schonen and Bleckingia, and on the weſt by Weſtrogothia or Weſt Gothland. It is about 112 miles in length, and 62 in breadth. Calmar is the capital town.

SMALKALD, a town of Germany, in Franconia, and in the county of Henneberg: famous for the confederacy entered into by the German Proteſtants againſt the emperor, commonly called the *league of Smalkald*. The deſign of it was to defend their religion and liberties. It is ſeated on the river Werra, 25 miles ſouth-weſt of Erford, and 50 north-weſt of Bamberg. E. Long. 10. 53. N Lat. 50. 49. It is ſubject to the prince of Heſſe-Caſſel.

SMALLAGE. See Apium, Botany *Index*.

SMALT,

* See Canal.

SMALT, a kind of glaſs of a dark blue colour, which when levigated appears of a moſt beautiful colour; and if it could be made ſufficiently fine, would be an excellent ſuccedaneum for ultramarine, as not only reſiſting all kinds of weather, but even the moſt violent fires. It is prepared by melting one part of calcined cobalt with two of flint powder, and one of potaſh. At the bottoms of the crucibles in which the ſmalt is manufactured, we generally find a regulus of a whitiſh colour inclined to red, and extremely brittle. This is melted afreſh, and when cold ſeparates into two parts; that at the bottom is the cobaltic regulus, which is employed to make more of the ſmalt; the other is biſmuth.

SMARAGDITE, a ſpecies of mineral belonging to the magneſian genus. See MINERALOGY, p. 197.

SMARAGDUS, an old name for the emerald. See EMERALD, MINERALOGY, p. 159.

SMEATON, JOHN, an eminent civil engineer, was born the 28th of May 1724, O. S. at Auſthorpe, near Leeds, in a houſe built by his grandfather, and where his family have reſided ever ſince.

The ſtrength of his underſtanding and the originality of his genius appeared at an early age; his playthings were not the playthings of children, but the tools which men employ; and he appeared to have greater entertainment in ſeeing the men in the neighbourhood work, and aſking them queſtions, than in any thing elſe. One day he was ſeen (to the diſtreſs of his family) on the top of his father's barn, fixing up ſomething like a windmill; another time, he attended ſome men fixing a pump at a neighbouring village, and obſerving them cut off a piece of bored pipe, he was ſo lucky as to procure it, and he actually made with it a working pump that raiſed water. Theſe anecdotes refer to circumſtances that happened while he was in petticoats, and moſt likely before he attained his ſixth year.

About his 14th and 15th year, he made for himſelf an engine for turning, and made ſeveral preſents to his friends of boxes in ivory or wood very neatly turned. He forged his iron and ſteel, and melted his metal; he had tools of every ſort for working in wood, ivory, and metals. He made a lathe, by which he cut a perpetual ſcrew in braſs, a thing little known at that day, which was the invention of Mr Henry Hindley of York; with whom Mr Smeaton ſoon became acquainted, and they ſpent many a night at Mr Hindley's houſe till day-light, converſing on thoſe ſubjects.

Thus had Mr Smeaton, by the ſtrength of his genius and indefatigable induſtry, acquired, at the age of 18, an extenſive ſet of tools, and the art of working in moſt of the mechanical trades, without the aſſiſtance of any maſter. A part of every day was generally occupied in forming ſome ingenious piece of mechaniſm.

Mr Smeaton's father was an attorney, and deſirous of bringing him up to the ſame profeſſion; Mr Smeaton therefore came up to London in 1742, and attended the courts in Weſtminſter hall; but finding (as his common expreſſion was) that the law did not ſuit the bent of his genius, he wrote a ſtrong memorial to his father on that ſubject; whoſe good ſenſe from that moment left Mr Smeaton to purſue the bent of his genius in his own way.

In 1751, he began a courſe of experiments to try a machine of his invention to meaſure a ſhip's way at ſea, and alſo made two voyages in company with Dr Knight to try it, and a compaſs of his own invention and making, which was made magnetical by Dr Knight's artificial magnets: the ſecond voyage was made in the Fortune ſloop of war, commanded at that time by Captain Alexander Campbell.

In 1753 he was elected member of the Royal Society; the number of papers publiſhed in their Tranſactions will ſhow the univerſality of his genius and knowledge. In 1759 he was honoured by an unanimous vote with their gold medal for his paper intitled "An Experimental Inquiry concerning the Natural Powers of Water and Wind to turn Mills, and other Machines depending on a Circular Motion."

This paper, he ſays, was the reſult of experiments made on working models in the years 1752 and 1753, but not communicated to the Society till 1759; before which time he had an opportunity of putting the effect of theſe experiments into real practice, in a variety of caſes, and for various purpoſes, ſo as to aſſure the Society he had found them to anſwer.

In December 1755, the Eddyſtone lighthouſe was burnt down: Mr Weſton, the chief proprietor, and the others, being deſirous of rebuilding it in the moſt ſubſtantial manner, inquired of the earl of Macclesfield (then preſident of the Royal Society) whom he thought the moſt proper to rebuild it; his lordſhip recommended Mr Smeaton.

Mr Smeaton undertook the work, and completed it in the ſummer of 1759. Of the preparation for this extrardinary work, of its commencement and progreſs, Mr Smeaton has given an ample and intereſting deſcription in a ſplendid folio volume which was firſt publiſhed in 1791. The ſame volume contains the hiſtory of the different buildings which have been erected on the Eddyſtone rock. See EDDYSTONE.

Though Mr Smeaton completed the building of the Eddyſtone lighthouſe in 1759 (a work that does him ſo much credit) yet it appears he did not ſoon get into full buſineſs as a civil engineer; but in 1764, while in Yorkſhire, he offered himſelf a candidate for one of the receivers of the Derwentwater eſtate, and on the 31ſt of December in that year, he was appointed at a full board of Greenwich hoſpital, in a manner highly flattering to himſelf; when two other perſons ſtrongly recommended and powerfully ſupported were candidates for the employment. In this appointment he was very happy, by the aſſiſtance and abilities of his partner Mr Walton one of the receivers, who taking upon himſelf the management and accounts, left Mr Smeaton leiſure and opportunity to exert his abilities on public works, as well as to make many improvements in the mills and in the eſtates of Greenwich hoſpital. By the year 1775 he had ſo much buſineſs as a civil engineer, that he wiſhed to reſign this appointment; and would have done it then, had not his friend the late Mr Stuart the hoſpital ſurveyor, and Mr Ibbetſon their ſecretary, prevailed upon him to continue in the office about two years longer.

Mr Smeaton having now got into full buſineſs as a civil engineer, performed many works of general utility. He made the river Calder navigable; a work that required great ſkill and judgment, owing to the very impetuous floods in that river: He planned and attended the execution of the great canal in Scotland for conveying the trade of the country either to the Atlantic or German ocean; and having brought it to the place originally intended, he declined a handſome yearly ſalary, in order that he might attend to the multiplicity of his other buſineſs.

On the opening of the great arch at London bridge, the excavation around and under the ſterlings was ſo conſiderable, that the bridge was thought to be in great danger of falling. He was then in Yorkſhire, and was ſent for by expreſs, and arrived with the utmoſt diſpatch: "I think (ſays Mr Holmes, the author of his life) it was on a Saturday morning, when the apprehenſion of the bridge falling was ſo general that few would paſs over or under it. He applied himſelf immediately to examine it, and to ſound about the ſterlings as minutely as he could; and the committee being called together, adopted his advice, which was to repurchaſe the ſtones that had been taken from the middle pier, then lying in Moorfields, and to throw them into the river to guard the ſterlings." Nothing ſhows the apprehenſions concerning the falling of the bridge more than the alacrity with which this advice was purſued; the ſtones were repurchaſed that day, horſes, carts, and barges were got ready, and they began the work on Sunday morning. Thus Mr Smeaton, in all human probability, ſaved London bridge from falling, and ſecured it till more effectual methods could be taken.

The vaſt variety of mills which Mr Smeaton conſtructed, ſo greatly to the ſatisfaction and advantage of the owners, will ſhow the great uſe which he made of his experiments in 1752 and 1753; for he never truſted to theory in any caſe where he could have an opportunity to inveſtigate it by experiment. He built a ſteam engine at Auſthorpe, and made experiments thereon, purpoſely to aſcertain the power of Newcomen's ſteam-engine, which he improved and brought to a greater degree of perfection, both in its conſtruction and powers, than it was before.

Mr Smeaton during many years of his life was a frequent attendant on parliament, his opinion being continually called for; and here his ſtrength of judgment and perſpicuity of expreſſion had its full diſplay: it was his conſtant cuſtom, when applied to, to plan or ſupport any meaſure, to make himſelf fully acquainted with it, to ſee its merits before he would engage in it: by this caution, added to the clearneſs of his deſcription and the integrity of his heart, he ſeldom failed to obtain for the bill which he ſupported an act of parliament. No one was heard with more attention, nor had any one ever more confidence placed in his teſtimony. In the courts of law he had ſeveral compliments paid him from the bench by Lord Mansfield and others, for the new light which he threw on difficult ſubjects.

About the year 1785 Mr Smeaton's health began to decline; and he then took the reſolution to endeavour to avoid all the buſineſs he could, ſo that he might have leiſure to publiſh an account of his inventions and works, which was certainly the firſt wiſh of his heart; for he has often been heard to ſay, that "he thought he could not render ſo much ſervice to his country as by doing that." He got only his account of the Edyſtone lighthouſe completed, and ſome preparations to his intended Treatiſe on Mills; for he could not reſiſt the ſolicitations of his friends in various works: and Mr Aubert, whom he greatly loved and reſpected, being choſen chairman of Ramſgate harbour, prevailed upon him to accept the place of engineer to that harbour; and to their joint efforts the public is chiefly indebted for the improvements that have been made there within theſe few years, which fully appears in a report that Mr Smeaton gave in to the board of truſtees in 1791, which they immediately publiſhed.

Mr Smeaton being at Auſthorpe, walking in his garden on the 16th of September 1792, was ſtruck with the palſy, and died the 28th of October. "In his illneſs (ſays Mr Holmes) I had ſeveral letters from him, ſigned with his name, but written and ſigned by another's pen; the diction of them ſhowed that the ſtrength his mind had not left him. In one written the 26th of September, after minutely deſcribing his health and feelings, he ſays, "in conſequence of the foregoing, I conclude myſelf nine-tenths dead; and the greateſt favour the Almighty can do me (as I think), will be to complete the other part; but as it is likely to be a lingering illneſs, it is only in His power to ſay when that is likely to happen."

Mr Smeaton had a warmth of expreſſion that might appear to thoſe who did not know him well to border on harſhneſs; but thoſe more intimately acquainted with him, knew it aroſe from the intenſe application of his mind, which was always in the purſuit of truth, or engaged in inveſtigating difficult ſubjects. He would ſometimes break out haſtily, when any thing was ſaid that did not tally with his ideas; and he would not give up any thing he argued for, till his mind was convinced by ſound reaſoning.

In all the ſocial duties of life he was exemplary; he was a moſt affectionate huſband, a good father, a warm, zealous, and ſincere friend, always ready to aſſiſt thoſe whom he reſpected, and often before it was pointed out to him in what way he could ſerve them. He was a lover and encourager of merit wherever he found it; and many men are in a great meaſure indebted to his aſſiſtance and advice for their preſent ſituation. As a companion, he was always entertaining and inſtructive; and none could ſpend any time in his company without improvement.

SMELL; this word has in moſt languages two meanings, ſignifying either that ſenſation of mind of which we are conſcious, in conſequence of certain impreſſions made on the noſtrils, and conveyed to the brain by the olfactory nerves; or that unknown virtue, or quality in bodies, which is the cauſe of our ſenſations of ſmell.

SMELLING is the act by which we perceive ſmells, or become ſenſible of the preſence of odorous bodies. The ſenſations of ſmell are excited by certain effluvia, which, in the open air, are always iſſuing from the ſurfaces of moſt bodies, and ſtriking on the extremities of the olfactory nerves, give them a peculiar ſort of impreſſion, which is communicated to the brain. The particles which iſſue thus from bodies are extremely volatile, and produce ſenſation by a degree of contact, which, though inſenſible, is ſtill more efficient than if it were more groſs and palpable. It is by a ſimilar ſpecies of inſenſible contact that the eyes and ears are affected by external objects; whilſt, in the excitation of the ſenſations of touch and of taſte, an actual and ſenſible contact of the object with the organ is neceſſary.

ſary. The organs of ſmelling are the noſtrils and olfactory nerves; the minute ramifications of the latter being diſtributed throughout the whole concavity of the former. For a deſcription of theſe, ſee Anatomy.

The effluvia from odorous bodies are conſtantly floating about in the atmoſphere, and muſt of courſe be drawn into the noſtrils along with the air in inſpiration; "ſo that there is," as Dr Reid obſerves, "a manifeſt appearance of deſign in placing the organ of ſmell in the inſide of that canal, through which the air is continually paſſing in inſpiration and expiration." It has been affirmed by Boerhaave, that the matter in animals, vegetables, foſſils, &c. which chiefly affects the ſenſe of ſmelling, is that attenuated ſubſtance, inherent in their oily parts, called *ſpirits;* becauſe, when this is taken away from the moſt fragrant bodies, what remains has ſcarcely any ſmell at all; but this, he ſays, if poured on the moſt inodorous bodies, gives them a fragrancy*. We cannot, however, enter at preſent upon this inquiry.

The ſenſe of ſmell has a cloſe alliance with that of taſte; and it ſeems probable from the proximity in the ſituation of their organs in all animals, that both are principally intended to guide them in the choice of their food; ſo that from this cloſe connection, they are better enabled to chooſe what is good for them, and to reject what would be injurious. This is the opinion of Dr Reid, as it was, in a very early period of the hiſtory of philoſophy, that of Socrates and of Cicero (A). Dr Reid alſo remarks, that the ſenſe of ſmell probably ſerves the ſame purpoſe in the natural ſtate of man; but it is not always a ſure guide for this purpoſe. The organs of ſmell differ, like thoſe of the other ſenſes, according to the deſtination of the animals to which they belong; and we know, that this ſenſe is in man much leſs acute, than it is in many other animals. We ſee, that in the choice of their food, they are guided by the ſenſes of ſmell and of taſte, except when man has brought them into a ſort of unnatural ſtate by domeſtication. And this circumſtance renders it probable, that both theſe ſenſes were intended to ſerve the ſame purpoſe in the natural ſtate of our ſpecies, although leſs calculated for this end than they are in the brutes, on account of the great ſuperiority of their ſmelling organs. Beſides, ſince it is probable that man, in the natural ſtate, acts more by inſtinct than when civilized in ſociety, ſo alſo it is reaſonable to think, that he may poſſeſs ſome of the ſenſes, (this of ſmell for inſtance), in greater acuteneſs than we do. This indeed, we are aſſured to be a fact; for we are told, in the *Hiſtoire des Antilles*, that there are negroes who, by the ſmell alone, can diſtinguiſh the footſteps of a Frenchman from thoſe of a negro.

The ſenſe of ſmell is much more obtuſe in man than in ſome of the lower animals. Dogs we know poſſeſs a power of ſmelling, of which we can ſcarcely form a conception, and which, it is happy for us we do not poſſeſs (B); and birds of prey are ſaid to poſſeſs this ſenſe in ſtill greater acuteneſs. But although this be more perfect, ſtill the ſenſe of ſmelling in man, who has other means of judging of his food, &c. is ſuch as to fit him for deriving enjoyment from a diverſity of ſcents, particularly thoſe of flowers and perfumes, to which dogs and other animals ſeem perfectly inſenſible. It has been ſaid, we are aware, that ſome animals, the elephant for inſtance, are capable of this enjoyment (C); but of this fact we cannot help being very doubtful.

There is a very great ſympathy between the organs of ſmell and of taſte; for any defect or diſeaſe of one is generally attended with ſome correſponding defect or diſeaſe of the other. There is alſo a greater ſimilarity between the ſenſations of both theſe, than between thoſe of any other two ſenſes: and hence it is, that we can ſometimes tell the taſte of an object from its ſmell, and *vice verſa.* Hence alſo the reaſon why we apply the ſame epithets to the names of both theſe claſſes of ſenſations; as a ſweet ſmell or taſte, &c.

It deſerves alſo to be remarked, that both theſe ſenſes ſeem ſubſervient to the preſervation of the animal exiſtence, rather than to any other purpoſe. They accordingly conſtitute an object of the natural hiſtory of man, rather than of intellectual or of moral philoſophy. The other three ſenſes, on the contrary, ſeem rather intended for (as they certainly are eſſential to) our intellectual improvement, and become, of courſe, a proper object of inveſtigation in the ſciences of moral philoſophy, or metaphyſics.

The advantages derived by man and the other animals from the ſenſe of ſmelling are not confined to the aſſiſtance which it affords them in the choice of their food. Moſt bodies in nature, when expoſed to the open air, are conſtantly ſending forth emanations or effluvia of ſuch extreme minuteneſs as to be perfectly inviſible. Theſe diffuſe themſelves through the air, and however noxious or ſalutary, would not be perceived without the ſenſe of ſmelling, which if not vitiated by unnatural habits, is not only a faithful monitor when danger is at hand, but conveys to us likewiſe the moſt exquiſite

* See alſo *um- nd's A- lemical eſtions,* i. k i. p. 9.

(A) "Ut guſtus (ſays a learned phyſiologiſt) cibi itineri, ſic olfactus oſtio viarum, quas aër ſubire debet, cuſtos præponitur, moniturus ne quid noxii, via quæ ſemper patet, in corpus admittatur. Porro, ut guſtus, ſic quoque olfactus ad ſalutarem cibum invitat, à noxio aut corrupto, putrido imprimis vel rancido, deterret."

"When thou ſeeſt the mouth, through which animals take in whatever they deſire, always placed near the noſe and eyes, thinkeſt thou not, ſays Socrates to Ariſtodemus, that this is the work of a providence." Xenophon's Memorables, book i. chap. 4.

(B) "The exceſſive eagerneſs which dogs expreſs on ſmelling their game, ſeems to be but little connected with the appetite for food, and wholly independent of any preconceived ideas of the objects of their purſuit being fit for it. Hence ſeveral kinds of them will not eat the game which they purſue with ſuch wild impetuoſity; and of which the ſcent ſeems to animate them to a degree of ecſtaſy far beyond what the deſire of food can produce." Knight on Taſte.

(C) There is an animal to which, naturaliſts ſay, perfume is ſo agreeable and ſo neceſſary, that nature has provided it with a little bag ſtored with an exquiſite odour. "On pretend, (ſays Buffon), que la mangouſte ouvre cette poche, pour ſe refraichir lorſqu' elle a trop chaud."

pleaſures. The fragrance of a roſe, and of many other flowers, is not only pleaſant, but gives a refreſhing and delightful ſtimulus to the whole ſyſtem, whilſt the odours proceeding from hemlock, or any noxious vegetable, or other ſubſtance, are highly offenſive to our noſtrils. Hence we are naturally led to ſeek the one claſs of ſenſations, and to avoid the other.

In ſome ſpecies of animals the ſenſe of ſmell ſeems to be connected with certain mental ſympathies, as thoſe of hearing and ſight are in all that poſſeſs them in any high degree: for not only their ſexual deſires appear to be excited by means of it, but other inſtinctive paſſions, which, according to the uſual ſyſtem of nature, ſhould be ſtill more remote from its influence. Dogs, although wholly unacquainted with lions, will ſhudder at their roar; and an elephant that has never ſeen a tiger, will in the ſame manner ſhow the ſtrongeſt ſymptoms of horror and affright at the ſmell of it. "The late Lord Clive (ſays an ingenious writer), exhibited a combat between two of theſe animals at Calcutta; but the ſcent of the tiger had ſuch an effect upon the elephant, that nothing could either force or allure him to go along the road, where the cage in which the tiger was incloſed, had paſſed, until a gallon of arack was given him. Upon this, his horror ſuddenly turning into fury, he broke down the paling to get at his enemy, and killed him without difficulty."

If riding along a road, near which a dead horſe, or part of its carcaſs, happens to be lying, we know, that our horſe, although he ſees it not, cannot be made to paſs the place but with difficulty. Where blood has been ſhed, particularly that of their own ſpecies, oxen will aſſemble, and upon ſmelling it, roar and bellow, and ſhow the moſt manifeſt ſigns of horror and diſtreſs. And yet theſe ſymptoms could not ariſe from any aſſociated notions of danger or death, ſince they appear in ſuch as never had any opportunities of acquiring them. They muſt therefore be inſtinctive, like other inſtinctive antipathies and propenſities. But although in their mutual intercourſe, animals make much uſe of the ſenſe of ſmell, ſtill it does not ſeem to be further concerned in exciting their ſexual deſires, than in indicating their object.

Some of thoſe ſplenetic philoſophers. who are ready upon all occaſions to quarrel with the conſtitution of nature, have taken the liberty of condemning their Maker, becauſe it has pleaſed his unfathomable wiſdom to beſtow in ſome inſtances upon the brutes ſenſes and inſtincts more perfect than he has given to man, without reflecting that he has given to man an ample equivalent; for it may be aſked with the poet,

> "Is not his reaſon all theſe powers in one?
> "Is Heaven unkind to man and man alone?
> "Shall he alone, whom rational we call,
> "Be pleaſed with nothing if not bleſſed with all."

With reſpect to that unknown peculiarity of bodies, which is the cauſe of our ſenſations of ſmell, the opinions of philoſophers have been very various. Until of late, the doctrine of Deſcartes and Locke on this ſubject was pretty generally received; but, ſince the publication of Doctor Reid's works, his opinion, which we deem the moſt correct and ſatisfactory, has become very popular. We will endeavour to abridge his account of this matter. For this purpoſe, let us ſuppoſe a perſon, who has grown up without the ſenſe of ſmell, to be immediately endowed with the uſe of this organ, and placed near ſome flowers of an exquiſite ſavour. When he examines what he feels in ſuch a ſituation, he can find no reſemblance between this new ſenſation, and any thing with which he is already acquainted. He finds himſelf unable to explain its nature, and cannot aſcribe to it figure, extenſion, or any known property of matter. It is a ſimple affection, or feeling, of mind, and, conſidered abſtractedly, can have no neceſſary connection with the nerves, the noſtrils, or effluvia, or with any thing material whatever. By the nature of his conſtitution he is, however, led to refer this peculiar ſenſation to the noſtrils, as its organ; and when, from experience, and by means of touch, he learns that external objects have the power of exciting this ſenſation, he concludes, that there muſt exiſt in bodies ſome unknown cauſe by which it is excited. In the firſt part of this proceſs he conſiders the feeling, or ſenſation, abſtractedly. As ſuch it exiſts in the mind only; and cannot exiſt there but when the mind is conſcious of it. His conſciouſneſs ſoon enables him to diſtinguiſh different ſorts of ſmells, all of them very diſtinct from one another; but, conformably to the nature of all ſenſation, extremely ſimple. He concludes, that each of theſe muſt have a diſtinct cauſe; and finding, by experience, that this cauſe is an unknown ſomething in bodies, he concludes, that it muſt be a property of matter, and, for want of another, gives it the name of ſmell. When he removes an odorous body from the organ, the ſenſation vaniſhes: when the body is again applied, the ſenſation is excited: and hence it is, that he is led naturally to connect the ſenſation with this unknown peculiarity of bodies by which it is produced. But ſince we ſee, that the ſenſation is, in a great degree, related to other objects beſides its unknown cauſe, to the mind in which it exiſts, for inſtance, and to the organ which is its inſtrument, it may be aſked why it becomes aſſociated in the mind with its cauſe only? The reaſon ſeems pretty obvious. No ſingle ſenſation or claſs of ſenſations, is more connected with the mind, than any others of which it is ſuſceptible. Nor is the connection ſubſiſting between the organ and any of the ſenſations peculiar to it greater than that which ſubſiſts between it and every other ſenſation of which it is the inlet. Hence the connection between the ſmell of an orange and the mind, or between it and the noſtrils, is very general, and cannot, in the former inſtance, diſtinguiſh it from any other ſenſation of whatever kind, nor, in the latter from any other particular ſmell. But the connexion between this ſenſation and the orange is peculiar and permanent; and we accordingly find them always aſſociated in the mind, juſt as we aſſociate the notion of fire with the ſenſation of burning. The relation which a ſenſation of ſmell, or any ſenſation, bears to the mind, to an organ, or to the memory and conception of itſelf, is common to all ſenſations. The relation which any ſenſation bears to its own cauſe, ſuppoſe of the ſenſation of ſmell to a particular virtue or quality of bodies, is common to it with every other ſenſation, when conſidered with reſpect to its peculiar cauſe. And finally, a ſenſation of any kind bears the ſame ſort of relation to the memory and conception of itſelf, that any other feeling or operation of mind bears to the conception and memory of that particular feeling or operation.

Whatever then be the nature of the minute particles of of bodies by which our ſenſations of ſmell are excited, we cannot help conſidering their unknown cauſe as a virtue or quality of matter. Like all other modifications of material ſubſtance, it muſt be confeſſed, that this can have no reſemblance to the ſenſations of mind. But we are not therefore, to conclude with the followers of Des Cartes and Locke, that this ſecondary quality is a mere ſenſation; eſpecially as we can readily conceive it exiſting where it is not ſmelled, or even after ſuppoſing the annihilation of every ſentient being throughout the univerſe. The exiſtence of the ſenſation we know to be momentary and fugitive; but in the exiſtence of its cauſe we can, without difficulty, or inconſiſtency, conceive a permanency independent of mind and of its ſenſations.

The doctrine we have been illuſtrating has of late been called in queſtion by a ſceptical writer, who, it appears to us, has upon this occaſion been entirely deficient in his accuſtomed acuteneſs. Dr Reid's account of this affair ſeems ſo full, ſo clear and convincing, that we are at a loſs to conceive how his meaning can be miſunderſtood; and yet the arguments and objections of the writer to whom we allude, derive all their plauſibility from a miſinterpretation of Dr Reid's meaning, and from a deviation from the eſtabliſhed uſe of language. "An eminent metaphyſician [*] (ſays this author) has declared that he has not the leaſt difficulty in conceiving the air perfumed with aromatic odours in the deſerts of Arabia; and he has decided, that the man who maintains ſmells to exiſt only in the mind, muſt be mad, or muſt abuſe language and diſgrace philoſophy. There are ſome authors, nevertheleſs, who differ widely on this ſubject from the learned metaphyſician. It is poſſible for a ſenſation to exiſt where there is no ſentient? The authors to whom I allude think it impoſſible." And ſo, we may tell this learned author, does Dr Reid, if he will take his word for it. Of the ſenſation of ſmell he remarks: "It is indeed impoſſible, that it can be in any body: it is a ſenſation; and a ſenſation can be in a ſentient thing only [†]." Again, "I can think of the ſmell of a roſe when I do not ſmell it; and it is poſſible that when I think of it there is no roſe anywhere exiſting; but, when I ſmell it, I am neceſſarily determined to believe that the ſenſation really exiſts. This is common to all ſenſations, that, *as they cannot exiſt but in being perceived*, ſo they cannot be perceived but they muſt exiſt [‡]." But continues this acute metaphyſician, "a ſmell is nothing elſe than a ſenſation. It is a feeling, which may be agreeable or diſagreeable; which may, as ſome think, be excited by various combinations of elements; but which, ſince it is a feeling, cannot be thoſe elements which are ſaid to cauſe it, and cannot exiſt where there is no creature to perceive it. What is to be underſtood, in philoſophical ſtrictneſs, by the perfumes of the deſert? We can excuſe the poet when he makes the ocean ſmile [*], the winds dance [†], and the flowers reſpire [‡]; or even were he to perfume the deſert. But the philoſopher is no ſuch magician, and had better not wander through the regions of fancy in ſearch of ſenſations where there is no ſentient." And is it then true that the word ſmell means only a ſenſation? A ſenſation is no more than an effect; it is a tranſient modification of the mind, which the mind itſelf can never produce. It muſt then have ſome cauſe which is external to the mind. Now, it is to this cauſe, and not to the ſenſation, that the name *ſmell* is moſt frequently applied in all languages; and it is this cauſe which Dr Reid ſuppoſes capable of exiſting in the deſerts of Arabia, where there is no ſentient being to perceive it. But let us hear himſelf: "We have conſidered ſmell as ſignifying a ſenſation, feeling, or impreſſion upon the mind; and in this ſenſe it can only be in a mind or ſentient being: but it is evident that mankind give the name of *ſmell* much more frequently to ſomething which they conceive to be external, and to be a quality of body; they underſtand by it ſomething which does not at all infer a mind, and have not the leaſt difficulty in conceiving the air perfumed with aromatic odours in the deſerts of Arabia, or ſome uninhabited iſland where the human foot never trod [*]." "The faculty of ſmelling is ſomething very different from the actual ſenſation of ſmelling; for the faculty may remain when we have no ſenſation. And the mind is no leſs different from the faculty, for it continues the ſame individual being when the faculty is loſt. What is ſmell in the roſe? It is a quality or virtue of the roſe, or of ſomething proceeding from it, which we perceive by the ſenſe of ſmelling; and this is all we know of the matter. But what is ſmelling? It is an act of the mind, but is never imagined to be a quality of the mind. Again, the ſenſation of ſmelling is conceived to infer neceſſarily a mind or ſentient being; but ſmell in the roſe infers no ſuch thing. We ſay, this body ſmells ſweet and that ſtinks; but we do not ſay, this mind ſmells ſweet and that ſtinks; therefore, ſmell in the roſe, and the ſenſation which it cauſes, are not conceived, even by the vulgar, to be things of the ſame kind, although they have the ſame name [†]."

There are ſome other remarks on Dr Reid's opinion in the work upon which we have been commenting, which we ſhall paſs by; we may, however, notice the author's concluding argument: after mentioning ſome examples, he obſerves, "Now in theſe inſtances we ſee men and animals that muſt have perception of ſmell, if I may be permitted to ſay ſo, altogether different from each other. Is not ſmell ſenſation when the ſpaniel finds ſport in the field for his maſter; when the ſhark purſues through the ocean its expected victim; and when the camel conducts the thirſty wanderer to a fountain of freſh water acroſs the burning ſands of the Arabian deſert? If no animal had the ſenſation of ſmell, there would be no odour; for *aroma* and oils may be thought to be material compoſitions, but are neither agreeable nor diſagreeable feelings." If men and animals differ in their perceptions of ſmell, (and no doubt, difference of organization will cauſe them to do ſo) the concluſion ſhould not be, we think, that ſmell is merely ſenſation, but that there is actually ſomething external which is the cauſe of their ſenſations, and about which they differ. A roſe put to the noſtrils of a man and then to thoſe of a dog, may excite very different ſenſations; but we cannot think that the peculiarity of the roſe, which excites thoſe different ſenſations, varies by thus changing the poſition of the roſe. If at table one perſon miſtakes mutton for beef, and another thinks that it is veniſon, the concluſion may be, that it is neither veniſon nor beef; but no man in his ſenſes can conclude that there is no meat at the table. But, "is not ſmell ſenſation when the ſpaniel finds ſport for his maſter in the field?" There is ſenſation no doubt; but we may be permitted to aſk, what would become of the ſpaniel's ſenſation of ſmell and of his maſter's ſport, were there no game in the

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r Reid.

[†] id's Inry, ch. ect. 2.

[‡] id. ch. ect. 3.

[*] lilton.

[†] owley.

[‡] omſon.

[*] Inquiry, &c. ch. ii. ſect. 8.

[†] Ibid. ſect. ix.

the field? What of the ſhark's ſenſation of ſmell and purſuit, were there no victim in the ocean? and what of the camel and the thirſty wanderer, were there no fountain of freſh water in the Arabian deſerts? "The *ſmell of a roſe* ſignifies two things, ſays Dr Reid; *Firſt*, A ſenſation which can have no exiſtence but when it is perceived, and can only be in a ſentient being or mind. *Secondly*, It ſignifies ſome power, quality, or virtue, in the roſe, or in effluvia proceeding from it, which hath a permanent exiſtence independent of the mind; and which, by the conſtitution of nature, produces the ſenſation in us. By the original conſtitution of our nature we are both led to believe that there is a permanent cauſe of the ſenſation, and prompted to ſeek after it; and experience determines us to place it in the roſe. The names of all ſmells, taſtes, ſounds, as well as heat and cold, have a like ambiguity in all languages; but it deſerves our attention, that theſe names are but rarely, in common language, uſed to ſignify the ſenſations; for the moſt part, they ſignify the external qualities which are indicated by the ſenſations*. We have been induced thus to diſcuſs this topic at ſome length, becauſe we regretted to ſee Dr Reid's opinion and reaſoning miſrepreſented; and we ſhall now conclude, not as this modern Berkleian does, "that, if no animal had the ſenſation of ſmell, there would be no odour;" but, that if there were no odour or external cauſe of ſmell, no animal would have this ſenſation.

The ſenſe of ſmell becomes ſometimes too acute, either in conſequence of ſome defect or diſeaſe of the organ, or from too great a ſenſibility of the whole nervous ſyſtem, ſuch as we ſometimes obſerve in fevers, in phrenitis, and in hyſterical diſeaſes. It is however more frequently blunted in conſequence of affections of the brain and nerves, ariſing from blows on the head, or from internal cauſes; or this may happen on account of too great a dryneſs of the organ, owing to a ſuppreſſion of the accuſtomed humours, or to their being conveyed off by ſome other channel: or it may ariſe from too great a quantity of tears and of mucus choking up the noſtrils. We have inſtances of both in caſes of common cold, in which, at the beginning of the diſeaſe, the noſtrils are dry, but as it advances, begin to diſcharge a great deal of humour, or become obſtructed by a thick mucus. Whatever hinders the free entrance of the air into the noſtrils or its paſſage through them, muſt alſo injure the ſenſe of ſmell. It is alſo ſometimes ſo depraved as to perceive ſmells when there is no odorous body preſent, or to perceive ſmells different from thoſe that are really preſent. Some of the particles of the odorous effluvia, after having remained for ſome time in the caverns of the noſtrils, iſſuing forth again and affecting the organ, will ſometimes cauſe this ſpecies of falſe perception, even in the moſt healthy perſons.

The ſenſe of ſmelling may be diminiſhed or deſtroyed by diſeaſes; as by the moiſture, dryneſs, inflammation, or ſuppuration of the olfactory membrane, the compreſſion of the nerves which ſupply it, or ſome fault in the brain itſelf at their origin. A defect, or too great a degree of ſolidity of the ſmall ſpongy bones of the upper jaw, the caverns of the forehead, &c. may likewiſe impair this ſenſe; and it may be alſo injured by a collection of fetid matter in theſe caverns, which is continually exhaling from them, and alſo by immoderate uſe of ſnuff. When the noſe abounds with moiſture, after gentle evacuations, ſuch things as tend to take off irritation and coagulate the thin ſharp ſerum may be applied; as the oil of aniſe mixed with fine flour, camphor diſſolved in oil of almonds, &c. the vapours of amber, frankincenſe, gum-maſtic, and benjamin, may likewiſe be received into the noſe and mouth. For moiſtening the mucus when it is too dry, ſome recommend ſnuff made of the leaves of marjoram, mixed with oil of amber, marjoram, and aniſeed; or a ſternutatory of calcined white vitriol, twelve grains of which may be mixed with two ounces of marjoram water and filtrated. The ſteam of vinegar upon hot iron, and received up the noſtrils, is alſo of uſe for ſoftening the mucus, removing obſtructions, &c. If there be an ulcer in the noſe, it ought to be dreſſed with ſome emollient ointment, to which, if the pain be very great, a little laudanum may be added. If it be a venereal ulcer, 12 grains of corroſive ſublimate may be diſſolved in a pint and a half of brandy, a table ſpoonful of which may be taken twice a-day. The ulcer ought likewiſe to be waſhed with it, and the fumes of cinnabar may be received up the noſtrils.

If there be reaſon to ſuſpect that the nerves which ſupply the organs of ſmelling are inert, or want ſtimulating, volatile ſalts, or ſtrong ſnuffs, and other things which occaſion ſneezing, may be applied to the noſe; the forehead may likewiſe be anointed with balſam of Peru, to which may be added a little oil of amber.

SMELT. See SALMO, ICHTHYOLOGY *Index*.

SMELTING, in *Metallurgy*, the fuſion or melting of the ores of metals, in order to ſeparate the metalline part from the earthy, ſtony, and other parts. See ORES, *Reduction of*.

SMEW. See MERGUS, ORNITHOLOGY *Index*.

SMILAX, ROUGH BINDWEED, a genus of plants belonging to the claſs of *diœcia* and order of *hexandria*; and in the natural ſyſtem ranging under the 11th order, *Sarmentaceæ*. See BOTANY and MATERIA MEDICA *Index*.

SMITH, SIR THOMAS, was born at Walden in Eſſex in 1512. At 14 he was ſent to Queen's college Cambridge, where he diſtinguiſhed himſelf ſo much, that he was made Henry VIII.'s ſcholar, together with John Cheke. He was choſen a fellow of his college in 1531, and appointed two years after to read the public Greek lecture. The common mode of reading Greek at that time was very faulty; the ſame ſound being given to the letters and diphthongs, ι, η, υ, ει, οι, υι. Mr Smith and Mr Cheke had been for ſome time ſenſible that this pronunciation was wrong: and after a good deal of conſultation and reſearch, they agreed to introduce that mode of reading which prevails at preſent. Mr Smith was lecturing on *Ariſtotle de Republica* in Greek. At firſt he dropped a word or two at intervals in the new pronunciation, and ſometimes he would ſtop as if he had committed a miſtake, and correct himſelf. No notice was taken of this for two or three days; but as he repeated more frequently, his audience began to wonder at the unuſual ſounds, and at laſt ſome of his friends mentioned to him what they had remarked. He owned that ſomething was in agitation, but that it was not yet ſufficiently digeſted to be made public. They entreated him earneſtly to diſcover his project: he did ſo; and in a ſhort time great numbers reſorted to him for information. The new pronunciation was

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* *Inquiry*, chap. ii. ſect. 9.

was adopted with enthuſiaſm, and ſoon became univerſal at Cambridge. It was afterwards oppoſed by Biſhop Gardiner the chancellor; but its ſuperiority to the old mode was ſo viſible, that in a few years it ſpread over all England.

In 1539 he travelled into foreign countries, and ſtudied for ſome time in the univerſities of France and Italy. On his return he was made regius profeſſor of civil law at Cambridge. About this time he publiſhed a treatiſe on the mode of pronouncing Engliſh. He was uſeful likewiſe in promoting the reformation. Having gone into the family of the duke of Somerſet, the protector during the minority of Edward VI. he was employed by that nobleman in public affairs; and in 1548 was made ſecretary of ſtate, and received the honour of knighthood. While that nobleman continued in office, he was ſent ambaſſador, firſt to Bruſſels and afterwards to France.

Upon Mary's acceſſion he loſt all his places, but was fortunate enough to preſerve the friendſhip of Gardiner and Bonner. He was exempted from perſecution, and was allowed, probably by their influence, a penſion of 100l. During Elizabeth's reign he was employed in public affairs, and was ſent three times by that princeſs as her ambaſſador to France. He died in 1577. His abilities were excellent, and his attainments uncommonly great: He was a philoſopher, a phyſician, a chemiſt, mathematician, linguiſt, hiſtorian, and architect. He wrote, 1. A treatiſe called the *Engliſh Commonwealth*. 2. A letter *De Recta et Emendata Linguæ Græcæ Pronunciatione*. 3. *De Moribus Turcarum*. 4. *De Druidum Moribus*.

Smith, *Edmund*, an Engliſh poet, the only ſon of Mr Neale an eminent merchant, by a daughter of Baron Lechmere, was born in 1668. By his father's death he was left young to the care of Mr Smith, who had married his father's ſiſter, and who treated him with ſo much tenderneſs, that at the death of his generous guardian he aſſumed his name. His writings are not many, and thoſe are ſcattered about in miſcellanies and collections: his celebrated tragedy of Phædra and Hippolitus was acted in 1707; and being introduced at a time when the Italian opera ſo much engroſſed the polite world, gave Mr Addiſon, who wrote the prologue, an opportunity to rally the vitiated taſte of the public. However, notwithſtanding the eſteem it has always been held in, it is perhaps rather to be conſidered as a fine poem than as a good play. This tragedy, with a Poem to the memory of Mr John Philips, three or four Odes, with a Latin oration ſpoken at Oxford *in laudem Thomæ Bodleii*, were publiſhed as his works by his friend Mr Oldiſworth. Mr Smith died in 1710, ſunk into indolence and intemperance by poverty and diſappointments: the hard fate of many a man of genius.

Smith, *John*, an excellent mezzotinter, flouriſhed about 1700; but neither the time of his birth nor death is accurately known. He united ſoftneſs with ſtrength, and finiſhed with freedom. He ſerved his time with one Tillet a painter in Moorfields; and as ſoon as he became his own maſter, learned from Becket the ſecret of mezzotinto, and being farther inſtructed by Van der Vaart, was taken to work in Sir Godfrey Kneller's houſe; and as he was to be the publiſher of that maſter's works, doubtleſs received conſiderable hints from him, which he amply repaid. "To poſterity perhaps his prints (ſays Mr Walpole) will carry an idea of ſomething burleſque; perukes of an enormous length flowing over ſuits of armour, compoſe wonderful habits. It is equally ſtrange that faſhion could introduce the one, and eſtabliſh the practice of repreſenting the other when it was out of faſhion. Smith excelled in exhibiting both, as he found them in the portraits of Kneller, who was leſs happy in what he ſubſtituted to armour. In the Kit-cat club he has poured full bottoms chiefly over night-gowns. If thoſe ſtreams of hair were *incommode* in a battle, I know nothing (he adds) they were adapted to that can be done in a night-gown. Smith compoſed two large volumes, with proofs of his own plates, for which he aſked 50l. His fineſt works are Duke Schomberg on horſeback; that duke's ſon and ſucceſſor Maynhard: the earls of Pembroke, Dorſet, and Albemarle; three plates with two figures in each, of young perſons or children, in which he ſhone: William Cowper; Gibbons and his wife; Queen Anne; the duke of Glouceſter, a whole length, with a flower-pot; a very curious one of Queen Mary, in a high head, fan, and gloves; the earl of Godolphin; the ducheſs of Ormond, a whole length, with a black; Sir George Rooke, &c. There is a print by him of James II. with an anchor, but no inſcription; which not being finiſhed when the king went away, is ſo ſcarce that it is ſometimes ſold for above a guinea. Smith alſo performed many hiſtoric pieces: as the loves of the gods, from Titian, at Blenheim, in ten plates; Venus ſtanding in a ſhell, from a picture by Corregio, and many more, of which perhaps the moſt delicate is the holy family with angels, after Carlo Maratti."

Walpole's Catalogue of Engravers.

Smith, *Dr Adam*, the celebrated author of the Inquiry into the Nature and Cauſes of the Wealth of Nations, was the only ſon of Adam Smith comptroller of the cuſtoms at Kirkaldy, and of Margaret Douglas daughter of Mr Douglas of Strathenry. He was born at Kirkaldy on the 5th June 1723, a few months after the death of his father. His conſtitution during his infancy was infirm and ſickly, and required all the care of his ſurviving parent. When only three years old he was carried by his mother to Strathenry on a viſit to his uncle Mr Douglas; and happening one day to be amuſing himſelf alone at the door of the houſe, he was ſtolen by a party of thoſe vagrants who in Scotland are called *tinkers*. Luckily he was miſſed immediately, and the vagrants purſued and overtaken in Leſlie wood; and thus Dr Smith was preſerved to extend the bounds of ſcience, and reform the commercial policy of Europe.

Philoſophical Tranſactions of the Royal Society of Edinburgh, vol. iii.

He received the rudiments of his education in the ſchool of Kirkaldy under David Miller, a teacher of conſiderable eminence, and whoſe name deſerves to be recorded on account of the great number of eminent men which that ſeminary produced while under his direction. Dr Smith, even while at ſchool, attracted notice by his paſſionate attachment to books, and by the extraordinary powers of his memory; while his friendly and generous diſpoſition gained and ſecured the affection of his ſchoolfellows. Even then he was remarkable for thoſe habits which remained with him through life, of ſpeaking to himſelf when alone and of abſence in company. He was ſent in 1737 to the univerſity of Glaſgow, where he remained till 1740, when he went to to Baliol college Oxford, as an exhibitioner on Snell's foundation. His favourite purſuits while at the univerſity were mathematics and natural philoſophy. After his removal to England he frequently employed himſelf in tranſlating, particularly from the French, with a view to the improvement of his own ſtyle: a practice which he often recommended to all who wiſhed to cultivate the art of compoſition. It was probably then alſo that he applied himſelf with the greateſt care to the ſtudy of languages, of which, both ancient and modern, his knowledge was uncommonly extenſive and accurate.

After ſeven years reſidence at Oxford he returned to Kirkaldy, and lived two years with his mother without any fixed plan for his future life. He had been deſigned for the church of England; but diſliking the eccleſiaſtical profeſſion, he reſolved to abandon it altogether, and to limit his ambition to the proſpect of obtaining ſome of thoſe preferments to which literary attainments lead in Scotland. In 1748 he fixed his reſidence in Edinburgh, and for three years read a courſe of lectures on rhetoric and belles lettres under the patronage of Lord Kames. In 1751 he was elected profeſſor of logic in the univerſity of Glaſgow, and the year following was removed to the profeſſorſhip of moral philoſophy, vacant by the death of Mr Thomas Cragie, the immediate ſucceſſor of Dr Hutcheſon. In this ſituation he remained 13 years, a period he uſed frequently to look back to as the moſt uſeful part of his life. His lectures on moral philoſophy were divided into four parts: The firſt contained natural theology; in which he conſidered the proofs of the being and attributes of God, and thoſe truths on which religion is founded: the ſecond comprehended ethics, ſtrictly ſo called, and conſiſted chiefly of thoſe doctrines which he afterwards publiſhed in his theory of moral ſentiments: in the third part he treated more at length of that part of morality called *juſtice;* and which, being ſuſceptible of preciſe and accurate rules, is for that reaſon capable of a full and accurate explanation: in the laſt part of his lectures he examined thoſe political regulations which are founded, not upon the principle of juſtice, but of expediency; and which are calculated to increaſe the riches, the power, and the proſperity of a ſtate. Under this view he conſidered the political inſtitutions relating to commerce, to finances, to eccleſiaſtical and military governments: this contained the ſubſtance of his *Wealth of Nations*. In delivering his lectures he truſted almoſt entirely to extemporary elocution: his manner was plain and unaffected, and he never failed to intereſt his hearers. His reputation ſoon roſe very high, and many ſtudents reſorted to the univerſity merely upon his account.

When his acquaintance with Mr Hume firſt commenced is uncertain; but it had ripened into friendſhip before the year 1752.

In 1759 he publiſhed his Theory of Moral Sentiments; a work which deſervedly extended his reputation: for, though ſeveral of its concluſions be ill-founded, it muſt be allowed by all to be a ſingular effort of invention, ingenuity, and ſubtilty. Beſides, it contains a great mixture of important truth; and, though the author has ſometimes been miſled, he has had the merit of directing the attention of philoſophers to a view of human nature, which had formerly in a great meaſure eſcaped their notice. It abounds everywhere with the pureſt and moſt elevated maxims concerning the practical conduct of life; and when the ſubject of his work leads him to addreſs the imagination and the heart, the variety and felicity of his illuſtrations, the richneſs and fluency of his eloquence, and the ſkill with which he wins the attention and commands the paſſions of his readers, leave him among our Britiſh moraliſts without a rival.

Towards the end of 1763 Dr Smith received an invitation from Mr Charles Townſend to accompany the duke of Buccleugh on his travels; and the liberal terms in which this propoſal was made induced him to reſign his office at Glaſgow. He joined the duke of Buccleugh at London early in the year 1764, and ſet out with him for the continent in the month of March following. After a ſtay of about ten days at Paris, they proceeded to Thoulouſe, where they fixed their reſidence for about 18 months; thence they went by a pretty extenſive route through the ſouth of France to Geneva, where they paſſed two months. About Chriſtmas 1765 they returned to Paris, and remained there till October following. The ſociety in which Dr Smith paſſed theſe ten months may be conceived in conſequence of the recommendation of Mr Hume. Turgot, Queſnai, Necker, d'Alembert, Helvetius, Marmontel, Madame Riccoboni, were among the number of his acquaintances; and ſome of them he continued ever after to reckon among the number of his friends. In October 1766 the duke of Buccleugh returned to England.

Dr Smith ſpent the next ten years of his life with his mother at Kirkaldy, occupied habitually in intenſe ſtudy, but unbending his mind at times in the company of ſome of his old ſchoolfellows, who ſtill continued to reſide near the place of their birth. In 1776 he publiſhed his *Inquiry into the Nature and Cauſes of the Wealth of Nations;* a book ſo univerſally known, that any panegyric on it would be uſeleſs. The variety, importance, and (may we not add), novelty, of the information which it contains; the ſkill and comprehenſiveneſs of mind diſplayed in the arrangement; the admirable illuſtrations with which it abounds; together with a plainneſs and perſpicuity which makes it intelligible to all —render it unqueſtionably the moſt perfect work which has yet appeared on the general principles of any branch of legiſlation.

He ſpent the next two years of his life in London, where he enjoyed the ſociety of ſome of the moſt eminent men of the age: but he removed to Edinburgh in 1778, in conſequence of having been appointed, at the requeſt of the duke of Buccleugh, one of the commiſſioners of the cuſtoms in Scotland. Here he ſpent the laſt twelve years of his life in an affluence which was more than equal to all his wants. But his ſtudies ſeemed entirely ſuſpended till the infirmities of old age reminded him, when it was too late, of what he yet owed to the public and to his own fame. The principal materials of the works which he had announced had long ago been collected, and little probably was wanting but a few years of health and retirement to complete them. The death of his mother, who had accompanied him to Edinburgh in 1784, together with that of his couſin Miſs Douglas in 1788, contributed to fruſtrate theſe projects. They had been the objects of his affection for more than 60 years, and in their ſociety he had enjoyed from his infancy all that he ever knew of the endearments of a family. He was now alone and helpleſs; and though he bore his loſs with equanimity, and regained apparently his former cheerfulneſs, yet his health and ſtrength gradually declined till the period of his death, which happened in July 1790. Some days before his death he ordered all his papers to be burnt except a few eſſays, which have ſince been publiſhed.

Of the originality and comprehenſiveneſs of his views; the extent, the variety, and the correctneſs of his information; the inexhauſtible fertility of his invention—he has left behind him laſting monuments. To his private worth, the moſt certain of all teſtimonies may be found in that confidence, reſpect, and attachment, which followed him through all the various relations of life. He was habitually abſent in converſation, and was apt when he ſpoke to deliver his ideas in the form of a lecture. He was rarely known to ſtart a new topic himſelf, or to appear unprepared upon thoſe topics that were introduced by others. In his external form and appearance there was nothing uncommon. When perfectly at eaſe, and when warmed with converſation, his geſtures were animated and not ungraceful; and in the ſociety of thoſe he loved, his features were often brightened by a ſmile of inexpreſſible benignity. In the company of ſtrangers, his tendency to abſence, and perhaps ſtill more his conſciouſneſs of that tendency, rendered his manners ſomewhat embarraſſed; an effect which was probably not a little heightened by thoſe ſpeculative ideas of propriety which his recluſe habits tended at once to perfect in his conception, and to diminiſh his power of realizing.

SMITHIA, a genus of plants belonging to the diadelphia claſs; and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

SMITHERY, a ſmith's ſhop; alſo the art of a ſmith, by which iron is wrought into any ſhape by means of fire, hammering, filing, &c.

SMITING-LINE, in a ſhip, is a ſmall rope faſtened to the mizen-yard-arm, below at the deck, and is always furled up with the mizen-ſail, even to the upper end of the yard, and thence it comes down to the poop. Its uſe is to looſe the mizen-ſail without ſtriking down the yard, which is eaſily done, becauſe the mizen-ſail is furled up only with rope-yarns; and therefore when this rope is pulled hard, it breaks all the rope-yarns, and ſo the ſail falls down of itſelf. The ſailor's phraſe is, *ſmite the mizen* (whence this rope takes its name), that is, hale by this rope that the ſail may fall down.

SMOKE, a denſe elaſtic vapour, ariſing from burning bodies. As this vapour is extremely diſagreeable to the ſenſes, and often prejudicial to the health, mankind have fallen upon ſeveral contrivances to enjoy the benefit of fire, without being annoyed by ſmoke. The moſt univerſal of theſe contrivances is a tube leading from the chamber in which the fire is kindled to the top of the building, through which the ſmoke aſcends, and is diſperſed into the atmoſphere. Theſe tubes are called *chimneys*; which, when conſtructed in a proper manner, carry off the ſmoke entirely; but, when improperly conſtructed, they carry off the ſmoke imperfectly, to the great annoyance of the inhabitants. As our maſons at preſent ſeem to have a very imperfect knowledge of the manner in which chimneys ought to be built, we can hardly perform a more acceptable ſervice to the public than to point out the manner in which they ought to be conſtructed, ſo as to carry off the ſmoke entirely; as well as to explain the cauſes from which the defects ſo often complained of generally proceed, and the method of removing them.

Tranſactions of the American Philoſophical Society.

Thoſe who would be acquainted with this ſubject, ſhould begin by conſidering on what principle ſmoke aſcends in any chimney. At firſt many are apt to think that ſmoke is in its nature, and of itſelf, ſpecifically lighter than air, and riſes in it for the ſame reaſon that cork riſes in water. Theſe ſee no cauſe why ſmoke ſhould not riſe in the chimney though the room be ever ſo cloſe. Others think there is a power in chimneys to *draw* up the ſmoke, and that there are different forms of chimneys which afford more or leſs of this power. Theſe amuſe themſelves with ſearching for the beſt form. The equal dimenſions of a funnel in its whole length is not thought artificial enough, and it is made, for fancied reaſons, ſometimes tapering and narrowing from below upwards, and ſometimes the contrary, &c. &c. A ſimple experiment or two may ſerve to give more correct ideas. Having lighted a pipe of tobacco, plunge the ſtem to the bottom of a decanter half filled with cold water; then putting a rag over the bowl, blow through it, and make the ſmoke deſcend in the ſtem of the pipe, from the end of which it will riſe in bubbles through the water; and being thus cooled, will not afterwards riſe to go out through the neck of the decanter, but remain ſpreading itſelf and reſting on the ſurface of the water. This ſhows that ſmoke is really heavier than air, and that it is carried upwards only when attached to or acted upon by air that is heated, and thereby rarefied and rendered ſpecifically lighter than the air in its neighbourhood.

Smoke being rarely ſeen but in company with heated air, and its upward motion being viſible, though that of the rarefied air that drives it is not ſo, has naturally given riſe to the error. It is now well known that air is a fluid which has weight as well as others, though about 800 times lighter than water; that heat makes the particles of air recede from each other, and take up more ſpace, ſo that the ſame weight of air heated will have more bulk than equal weights of cold air which may ſurround it, and in that caſe muſt riſe, being forced upwards by ſuch colder and heavier air, which preſſes to get under it and take its place. That air is ſo rarefied or expanded by heat, may be proved to their comprehenſion by a lank blown bladder, which laid before a fire, will ſoon ſwell, grow tight, and burſt.

Plate ccccxcvii.

Another experiment may be to take a glaſs tube about an inch in diameter, and 12 inches long, open at both ends, and fixed upright on legs ſo that it need not be handled, for the hands might warm it. At the end of a quill faſten five or ſix inches of the fineſt light filament of ſilk, ſo that it may be held either above the upper end of the tube or under the lower end, your warm hand being at a diſtance by the length of the quill. If there were any motion of air through the tube, it would manifeſt itſelf by its effect on the ſilk; but if the tube and the air in it are of the ſame temperature with the ſurrounding air, there will be no ſuch motion, whatever may be the form of the tube, whether crooked or ſtraight, narrow below and widening upwards, or the contrary, the air in it will be quieſcent. Warm the tube, and you will find as long as it continues warm, a conſtant current of air entering below and paſſing up through it till diſcharged at the top; becauſe the warmth of the tube being communicated to the air it contains, rarefies that air, and makes it lighter than the air without; which therefore preſſes in below, forces it upwards, follows and takes its place, and is rarefied in its turn. And, without warming the tube, if you hold under it a knob of hot iron, the air thereby heated will riſe and fill the tube, going out at its top; and this motion in the tube will continue as long as the knob remains hot, becauſe the air entering the tube below, is heated and rarefied by paſſing near and over that knob.

That this motion is produced merely by the difference of ſpecific gravity between the fluid within and that without the tube, and not by any fancied form of the tube itſelf, may appear by plunging it into water contained in a glaſs jar a foot deep, through which ſuch motion might be ſeen. The water within and without the tube being of the ſame ſpecific gravity, balance each other, and both remain at reſt. But take out the tube, ſtop its bottom with a finger, and fill it with olive oil, which is lighter than water; then ſtopping the top, place it as before, its lower end under water, its top a very little above. As long as you keep the bottom ſtopped the fluids remain at reſt; but the moment it is unſtopt, the heavier enters below, forces up the lighter, and takes its place: and the motion then ceaſes, merely becauſe the new fluid cannot be ſucceſſively made lighter, as air may be by a warm tube.

In fact, no form of the funnel of a chimney has any ſhare in its operation or effect reſpecting ſmoke except its height. The longer the funnel, if erect, the greater its force when filled with heated and rarefied air to draw in below and drive up the ſmoke, if one may, in compliance with cuſtom, uſe the expreſſion *draw*, when in fact it is the ſuperior weight of the ſurrounding atmoſphere that preſſed to enter the funnel below, and ſo drives up before it the ſmoke and warm air it meets with in its paſſage.

What is it then which makes a ſmoky chimney, that is, a chimney which, inſtead of conveying up all the ſmoke, diſcharges a part of it into the room, offending the eyes and damaging the furniture?

The cauſes of this effect may be reduced to *nine*, differing from each other, and therefore requiring different remedies.

1. *Smoky chimneys in a new houſe are ſuch frequently from mere want of air.* The workmanſhip of the rooms being all good, and juſt out of the workman's hands, the joints of the boards of the flooring, and of the pannels of wainſcotting, are all true and tight; the more ſo as the walls, perhaps not yet thoroughly dry, preſerve a dampneſs in the air of the room which keeps the woodwork ſwelled and cloſe. The doors and the ſaſhes too, being worked with truth, ſhut with exactneſs, ſo that the room is as tight as a ſnuff-box, no paſſage being left open for air to enter except the key-hole, and even that is ſometimes covered by a little dropping ſhutter. Now if ſmoke cannot riſe but as connected with rarefied air, and a column of ſuch air, ſuppoſe it filling the funnel, cannot riſe unleſs other air be admitted to ſupply its place; and if therefore no current of air enter the opening of the chimney—there is nothing to prevent the ſmoke from coming out into the room. If the motion upwards of the air in a chimney that is freely ſupplied be obſerved by the riſing of the ſmoke or a feather in it, and it be conſidered that in the time ſuch feather takes in riſing from the fire to the top of the chimney, a column of air equal to the content of the funnel muſt be diſcharged, and an equal quantity ſupplied from the room below, it will appear abſolutely impoſſible that this operation ſhould go on if the tight room is kept ſhut; for were there any force capable of drawing conſtantly ſo much air out of it, it muſt ſoon be exhauſted like the receiver of an air-pump, and no animal could live in it. Thoſe therefore who ſtop every crevice in a room to prevent the admiſſion of freſh air, and yet would have their chimney carry up the ſmoke, require inconſiſtencies, and expect impoſſibilities. Yet under this ſituation it is not uncommon to ſee the owner of a new houſe in deſpair, and ready to ſell it for much leſs than it coſt; conceiving it uninhabitable becauſe not a chimney in any one of its rooms will carry off the ſmoke unleſs a door or window be left open. Much expence has alſo been made to alter and amend new chimneys which had really no fault: in one houſe particularly which Dr Franklin knew that belonged to a nobleman in Weſtminſter, that expence amounted to no leſs than 300l. after his houſe had been, as he thought, finiſhed and all charges paid. And after all, ſeveral of the alterations were ineffectual, for want of underſtanding the true principles.

Remedies. When you find on trial that opening the door or a window enables the chimney to carry up all the ſmoke, you may be ſure that want of air from without is the cauſe of its ſmoking. "I ſay from *without*, (adds Dr Franklin), to guard you againſt a common miſtake of thoſe who may tell you the room is large, contains abundance of air ſufficient to ſupply any chimney, and therefore it cannot be that the chimney wants air. Theſe reaſoners are ignorant that the largeneſs of a room, if tight, is in this caſe of ſmall importance, ſince it cannot part with a chimneyful of its air without occaſioning ſo much vacuum; which it requires a great force to effect, and could not be borne if effected."

It appearing plainly then, that ſome of the outward air muſt be admitted, the queſtion will be, how much is abſolutely neceſſary? for you would avoid admitting more, as being contrary to one of your intentions in having a fire, viz. that of warming your room. To diſcover this quantity, ſhut the door gradually while a middling fire is burning, till you find that before it is quite ſhut the ſmoke begins to come out into the room; then open it a little till you perceive the ſmoke comes out no longer. There hold the door, and obſerve the width of the open crevice between the edge of the door and the rabbet it ſhould ſhut into. Suppoſe the diſtance to be half an inch, and the door eight feet high; you find thence that your room requires an entrance for air equal in area to 96 half inches, or 48 ſquare inches, or a paſſage of 6 inches by 8. This, however, is a large ſuppoſition; there being few chimneys that, having a moderate opening and a tolerable height of funnel, will not be ſatisfied with ſuch a crevice of a quarter of an inch: Dr Franklin found a ſquare of 6 by 6, or 36 ſquare inches, to be pretty good medium that

that will ſerve for moſt chimneys. High funnels with ſmall and low openings may indeed be ſupplied through a leſs ſpace; becauſe, for reaſons that will appear hereafter, the force of levity, if one may ſo ſpeak, being greater in ſuch funnels, the cool air enters the room with greater velocity, and conſequently more enters in the ſame time. This, however, has its limits; for experience ſhows, that no increaſed velocity ſo occaſioned has made the admiſſion of air through the key-hole equal in quantity to that through an open door, though through the door the current moves ſlowly, and through the key-hole with great rapidity.

It remains then to be conſidered, how and where this neceſſary quantity of air from without is to be admitted ſo as to be leaſt inconvenient: for if at the door, left ſo much open, the air thence proceeds directly to the chimney, and in its way comes cold to your back and heels as you ſit before your fire. If you keep the door ſhut, and raiſe a little the ſaſh of your window, you feel the ſame inconvenience. Various have been the contrivances to avoid this; ſuch as bringing in freſh air through pipes in the jams of the chimney, which pointing upwards ſhould blow the ſmoke up the funnel; opening paſſages into the funnel above, to let in air for the ſame purpoſe. But theſe produce an effect contrary to that intended: for as it is the conſtant current of air paſſing from the room through the opening of the chimney into the funnel which prevents the ſmoke from coming out into the room, if you ſupply the funnel by other means or in other ways with the air which it wants, and eſpecially if that air be cold, you diminiſh the force of that current, and the ſmoke in its efforts to enter the room finds leſs reſiſtance.

The wanted air muſt then indiſpenſably be admitted into the room, to ſupply what goes off through the opening of the chimney. M. Gauger, a very ingenious and intelligent French writer on the ſubject, propoſes with judgment to admit it above the opening of the chimney; and to prevent inconvenience from its coldneſs, he directs that it may be ſo made, that it ſhall paſs in its entrance through winding cavities made behind the iron back and ſides of the fire-place, and under the iron hearth-plate; in which cavities it will be warmed, and even heated, ſo as to contribute much, inſtead of cooling, to the warming of the room. This invention is excellent in itſelf, and may be uſed with advantage in building new houſes; becauſe the chimneys may then be ſo diſpoſed as to admit conveniently the cold air to enter ſuch paſſages: but in houſes built without ſuch views, the chimneys are often ſo ſituated as not to afford that convenience without great and expenſive alterations. Eaſy and cheap methods, though not quite ſo perfect in themſelves, are of more general utility; and ſuch are the following.

In all rooms where there is a fire, the body of air warmed and rarefied before the chimney is continually changing place, and making room for other air that is to be warmed in its turn. Part of it enters and goes up the chimney, and the reſt riſes and takes place near the ceiling. If the room be lofty, that warm air remains above our heads as long as it continues warm, and we are little benefited by it, becauſe it does not deſcend till it is cooler. Few can imagine the difference of climate between the upper and lower parts of ſuch a room, who have not tried it by the thermometer, or by going up a ladder till their heads are near the ceiling. It is then among this warm air that the wanted quantity of outward air is beſt admitted, with which being mixed, its coldneſs is abated, and its inconvenience diminiſhed ſo as to become ſcarce obſervable. This may be eaſily done by drawing down about an inch the upper ſaſh of a window; or, if not moveable, by cutting ſuch a crevice through its frame; in both which caſes it will be well to place a thin ſhelf of the length to conceal the opening, and ſloping upwards, to direct the entering air horizontally along and under the ceiling. In ſome houſes the air may be admitted by ſuch a crevice made in the wainſcot, cornice, or plaſtering, near the ceiling and over the opening of the chimney. This, if practicable, is to be choſen, becauſe the entering cold air will there meet with the warmeſt riſing air from before the fire, and be ſooneſt tempered by the mixture. The ſame kind of ſhelf ſhould alſo be placed here. Another way, and not a very difficult one, is to take out an upper pane of glaſs in one of your ſaſhes, ſet it in a tin frame, giving it two ſpringing angular ſides, and then replacing it, with hinges below on which it may be turned to open more or leſs above. It will then have the appearance of an internal ſky-light. By drawing this pane in, more or leſs, you may admit what air you find neceſſary. Its poſition will naturally throw that air up and along the ceiling. This is what is called in France a *Was iſt das?* As this is a German queſtion, the invention is probably of that nation, and takes its name from the frequent aſking of that queſtion when it firſt appeared. In England ſome have of late years cut a round hole about five inches diameter in a pane of the ſaſh, and placed againſt it a circular plate of tin hung on an axis, and cut into vanes; which, being ſeparately bent a little obliquely, are acted upon by the entering air, ſo as to force the plate continually round like the vanes of a windmill. This admits the outward air, and by the continual whirling of the vanes, does in ſome degree diſperſe it. The noiſe only is a little inconvenient.

Fig. 2.

2. A ſecond cauſe of the ſmoking of chimneys is, *their openings in the room being too large;* that is, too wide, too high, or both. Architects in general have no other ideas of proportion in the opening of a chimney than what relate to ſymmetry and beauty reſpecting the dimenſions of the room; while its true proportion reſpecting its function and utility depends on quite other principles; and they might as properly proportion the ſtep in a ſtaircaſe to the height of the ſtory, inſtead of the natural elevation of men's legs in mounting. The proportion then to be regarded, is what relates to the height of the funnel. For as the funnels in the different ſtories of a houſe are neceſſarily of different heights or lengths, that from the loweſt floor being the higheſt or longeſt, and thoſe of the other floors ſhorter and ſhorter, till we come to thoſe in the garrets, which are of courſe the ſhorteſt; and the force of draft being, as already ſaid, in proportion to the height of funnel filled with rarefied air, and a current of air from the room into the chimney, ſufficient to fill the opening, being neceſſary to oppoſe and prevent the ſmoke from coming out into the room; it follows, that the openings of the longeſt funnels may be larger, and that thoſe of the ſhorter funnels ſhould be ſmaller. For if there be a large opening to a chimney that does not draw ſtrongly, the funnel

may happen to be furniſhed with the air which it demands by a partial current entering on one ſide of the opening, and leaving the other ſide free of any oppoſing current, may permit the ſmoke to iſſue there into the room. Much too of the force of draft in a funnel depends on the degree of rarefaction in the air it contains, and that depends on the nearneſs to the fire of its paſſage in entering the funnel. If it can enter far from the fire on each ſide, or far above the fire, in a wide or high opening, it receives little heat in paſſing by the fire, and the contents of the funnel are by thoſe means leſs different in levity from the ſurrounding atmoſphere, and its force in drawing conſequently weaker. Hence if too large an opening be given to chimneys in upper rooms, thoſe rooms will be ſmoky: On the other hand, if too ſmall openings be given to chimneys in the lower rooms, the entering air operating too directly and violently on the fire, and afterwards ſtrengthening the draft as it aſcends the funnel, will conſume the fuel too rapidly.

Remedy. As different circumſtances frequently mix themſelves in theſe matters, it is difficult to give preciſe dimenſions for the openings of all chimneys. Our fathers made them generally much too large: we have leſſened them; but they are often ſtill of greater dimenſions than they ſhould be, the human eye not being eaſily reconciled to ſudden and great changes. If you ſuſpect that your chimney ſmokes from the too great dimenſion of its opening, contract it by placing moveable boards ſo as to lower and narrow it gradually till you find the ſmoke no longer iſſues into the room. The proportion ſo found will be that which is proper for that chimney, and you may employ the bricklayer or maſon to reduce it accordingly. However, as in building new houſes ſomething muſt be ſometimes hazarded, Dr Franklin propoſes to make the openings in the lower rooms about 30 inches ſquare and 18 deep, and thoſe in the upper only 18 inches ſquare and not quite ſo deep; the intermediate ones diminiſhing in proportion as the height of the funnel is diminiſhed. In the larger openings, billets of two feet long, or half the common length of cordwood, may be burnt conveniently; and for the ſmaller, ſuch wood may be ſawed into thirds. Where coals are the fuel, the grates will be proportioned to the openings. The ſame depth is nearly neceſſary to all, the funnels being all made of a ſize proper to admit a chimney-ſweeper. If in large and elegant rooms cuſtom or fancy ſhould require the appearance of a larger chimney, it may be formed of expenſive marginal decorations, in marble, &c. But in time perhaps, that which is fitteſt in the nature of things may come to be thought handſomeſt.

3. Another cauſe of ſmoky chimneys is *too ſhort a funnel*. This happens neceſſarily in ſome caſes, as where a chimney is required in a low building; for, if the funnel be raiſed high above the roof, in order to ſtrengthen its draft, it is then in danger of being blown down, and cruſhing the roof in its fall.

Remedies. Contract the opening of the chimney, ſo as to oblige all the entering air to paſs through or very near the fire; whereby it will be more heated and rarefied, the funnel itſelf be more warmed, and its contents have more of what may be called the force of levity, ſo as to riſe ſtrongly and maintain a good draft at the opening.

Or you may in ſome caſes, to advantage, build additional ſtories over the low building, which will ſupport a high funnel.

If the low building be uſed as a kitchen, and a contraction of the opening therefore inconvenient, a large one being neceſſary, at leaſt when there are great dinners, for the free management of ſo many cooking utenſils; in ſuch caſe the beſt expedient perhaps would be to build two more funnels joining to the firſt, and having three moderate openings, one to each funnel, inſtead of one large one. When there is occaſion to uſe but one, the other two may be kept ſhut by ſliding plates, hereafter to be deſcribed; and two or all of them may be uſed together when wanted. This will indeed be an expence, but not an uſeleſs one, ſince your cooks will work with more comfort, ſee better than in a ſmoky kitchen what they are about, your victuals will be cleaner dreſſed and not taſte of ſmoke, as is often the caſe; and to render the effect more certain, a ſtack of three funnels may be ſafely built higher above the roof than a ſingle funnel.

The caſe of too ſhort a funnel is more general than would be imagined, and often found where one would not expect it. For it is not uncommon, in ill-contrived buildings, inſtead of having a funnel for each room or fire place, to bend and turn the funnel of an upper room ſo as to make it enter the ſide of another funnel that comes from below. By theſe means the upper room funnel is made ſhort of courſe, ſince its length can only be reckoned from the place where it enters the lower room funnel; and that funnel is alſo ſhortened by all the diſtance between the entrance of the ſecond funnel and the top of the ſtack: for all that part being readily ſupplied with air through the ſecond funnel, adds no ſtrength to the draft, eſpecially as that air is cold when there is no fire in the ſecond chimney. The only eaſy remedy here is, to keep the opening of that funnel ſhut in which there is no fire.

4. Another very common cauſe of the ſmoking of chimneys is, *their overpowering one another*. For inſtance, if there be two chimneys in one large room, and you make fires in both of them, the doors and windows cloſe ſhut, you will find that the greater and ſtronger fire ſhall overpower the weaker, from the funnel of which it will draw air down to ſupply its own demand; which air deſcending in the weaker funnel, will drive down its ſmoke, and force it into the room. If, inſtead of being in one room, the two chimneys are in two different rooms, communicating by a door, the caſe is the ſame whenever that door is open. In a very tight houſe, a kitchen chimney on the loweſt floor, when it had a great fire in it, has been known to overpower any other chimney in the houſe, and draw air and ſmoke into its room as often as the door communicating with the ſtaircaſe was opened.

Remedy. Take care that every room have the means of ſupplying itſelf from without with the air which its chimney may require, ſo that no one of them may be obliged to borrow from another, nor under the neceſſity of lending. A variety of theſe means have been already deſcribed.

5. Another cauſe of ſmoking is, *when the tops of chimneys are commanded by higher buildings, or by a hill*, ſo that the wind blowing over ſuch eminences falls like water over a dam, ſometimes almoſt perpendicularly on

the tops of the chimneys that lie in its way, and beats down the ſmoke contained in them.

Fig. 3. To illuſtrate this, let A (fig. 3.) repreſent a ſmall building at the ſide of a great rock B, and the wind coming in the direction CD; when the current of air comes to the point D, being hurried forward with great velocity, it goes a little forward, but ſoon deſcends downward, and gradually is reflected more and more inward, as repreſented by the dotted lines EE, &c. ſo that, deſcending downwards upon the top of the chimney A, the ſmoke is beat back again into the apartments.

It is evident that houſes ſituated near high hills or thick woods will be in ſome meaſure expoſed to the ſame inconvenience; but it is likewiſe plain, that if a houſe be ſituated upon the ſlope of a hill (as at F, fig. 3.), it will not be in any danger of ſmoke when the wind blows towards that ſide of the hill upon which it is ſituated; for the current of air coming over the houſe-top in the direction GH, is immediately changed by the ſlope of the hill to the direction HC, which powerfully draws the ſmoke upward from the top of the chimney. But it is alſo evident, that a houſe in this ſituation will be liable to ſmoke when the wind blows from the hill; for the current of air coming downward in the direction CH, will beat downward on the chimney F, and prevent the ſmoke from aſcending with freedom. The effect will be much heightened if the doors and windows are chiefly in the lowermoſt ſide of the houſe.

Remedy. That commonly applied in this caſe is a turncap made of tin or plate iron, covering the chimney above and on three ſides, open on one ſide, turning on a ſpindle; and which being guided or governed by a vane always preſents its back to the current. This may be generally effectual, though not certain, as there may be caſes in which it will not ſucceed. Raiſing your funnels if practicable, ſo as their tops may be higher, or at leaſt equal, with the commanding eminence, is more to be depended on. But the turning cap, being eaſier and cheaper ſhould firſt be tried. "If obliged to build in ſuch a ſituation, I would chooſe (ſays Dr Franklin) to place my doors on the ſide next the hill, and the backs of my chimneys on the fartheſt ſide; for then the column of air falling over the eminence, and of courſe preſſing on that below, and forcing it to enter the doors or *was-iſt-das*es on that ſide, would tend to balance the preſſure down the chimneys, and leave the funnels more free in the exerciſe of their functions."

6. There is another caſe which is the reverſe of that laſt mentioned. It is where the commanding eminence is farther from the wind than the chimney commanded. To explain this a figure may be neceſſary. Suppoſe then a building whoſe ſide AB happens to be expoſed to the wind, and forms a kind of dam againſt its progreſs. Suppoſe the wind blowing in the direction FE. The air obſtructed by this dam or building AB will like water preſs and ſearch for paſſages through it; but finding none, it is beat back with violence, and ſpreads itſelf on every ſide, as is repreſented by the curved lines *e*, *e*, *e*, *e*, *e*, *e*. It will therefore force itſelf down the ſmall chimney C, in order to get through by ſome door or window open on the other ſide of the building. And if there be a fire in ſuch chimney, its ſmoke is of courſe beat down, and fills the room.

Remedy. There is but one remedy, which is to raiſe ſuch a funnel higher than the roof, ſupporting it if neceſſary by iron bars. For a turncap in this caſe has no effect, the dammed-up air preſſing down through it in whatever poſition the wind may have placed its opening.

Dr Franklin mentions a city in which many houſes are rendered ſmoky by this operation. For their kitchens being built behind, and connected by a paſſage with the houſes, and the tops of the kitchen chimneys lower than the tops of the houſes, the whole ſide of a ſtreet when the wind blows againſt its back forms ſuch a dam as above deſcribed; and the wind ſo obſtructed forces down thoſe kitchen-chimneys (eſpecially when they have but weak fires in them) to paſs through the paſſage and houſe into the ſtreet. Kitchen-chimneys ſo formed and ſituated have another inconvenience. In ſummer, if you open your upper room windows for air, a light breeze blowing over your kitchen-chimney towards the houſe, though not ſtrong enough to force down its ſmoke as aforeſaid, is ſufficient to waft it into your windows, and fill the rooms with it; which, beſides the diſagreeableneſs, damages your furniture.

7. Chimneys, otherwiſe drawing well, are ſometimes made to ſmoke by *the improper and inconvenient ſituation of a door*. When the door and chimney are on the ſame ſide of the room, if the door being in the corner is made to open againſt the wall, which is common, as being there, when open, more out of the way, it follows, that when the door is only opened in part, a current of air ruſhing in paſſes along the wall into and acroſs the opening of the chimney, and flirts ſome of the ſmoke out into the room. This happens more certainly when the door is ſhutting, for then the force of the current is augmented, and becomes very inconvenient to thoſe who, warming themſelves by the fire, happen to ſit in its way.

The *remedies* are obvious and eaſy. Either put an intervening ſcreen from the wall round great part of the fireplace; or, which is perhaps preferable, ſhift the hinges of your door, ſo as it may open the other way, and when open throw the air along the other wall.

8. A room that has no fire in its chimney is ſometimes filled with *ſmoke which is received at the top of its funnel, and deſcends into the room.* Funnels without fires have an effect according to their degree of coldneſs or warmth on the air that happens to be contained in them. The ſurrounding atmoſphere is frequently changing its temperature; but ſtacks of funnels covered from winds and ſun by the houſe that contains them, retain a more equal temperature. If, after a warm ſeaſon, the outward air ſuddenly grows cold, the empty warm funnels begin to draw ſtrongly upward; that is, they rarefy the air contained in them, which of courſe riſes, cooler air enters below to ſupply its place, is rarefied in its turn, and riſes; and this operation continues till the funnel grows cooler, or the outward air warmer, or both, when the motion ceaſes. On the other hand, if after a cold ſeaſon the outward air ſuddenly grows warm and of courſe lighter, the air contained in the cool funnels being heavier deſcends into the room; and the warmer air which enters their tops being cooled in its turn, and made heavier, continues to deſcend; and this operation goes on till the funnels are warmed by the paſſing of warm air through them, or the air itſelf grows cooler.

cooler. When the temperature of the air and of the funnels is nearly equal, the difference of warmth in the air between day and night is ſufficient to produce theſe currents: the air will begin to aſcend the funnels as the cool of the evening comes on, and this current will continue till perhaps nine or ten o'clock the next morning, when it begins to heſitate; and as the heat of the day approaches, it ſets downwards, and continues ſo till towards evening, when it again heſitates for ſome time, and then goes upwards conſtantly during the night, as before mentioned. Now when ſmoke iſſuing from the tops of neighbouring funnels paſſes over the tops of funnels which are at the time drawing downwards, as they often are in the middle part of the day, ſuch ſmoke is of neceſſity drawn into theſe funnels, and deſcends with the air into the chamber.

The remedy is to have a ſliding plate that will ſhut perfectly the offending funnel. Dr Franklin has thus deſcribed it: "The opening of the chimney is contracted by brick-work faced with marble ſlabs to about two feet between the jams, and the breaſt brought down to within about three feet of the hearth. An iron frame is placed juſt under the breaſt, and extending quite to the back of the chimney, ſo that a plate of the ſame metal may ſlide horizontally backwards and forwards in the grooves on each ſide of the frame. This plate is juſt ſo large as to fill the whole ſpace, and ſhut the chimney entirely when thruſt quite in, which is convenient when there is no fire. Draw it out, ſo as to leave between its further edge and the back a ſpace of about two inches; this ſpace is ſufficient for the ſmoke to paſs; and ſo large a part of the funnel being ſtopt by the reſt of the plate, the paſſage of warm air out of the room, up the chimney, is obſtructed and retarded; and by thoſe means much cold air is prevented from coming in through crevices, to ſupply its place. This effect is made manifeſt three ways. 1. When the fire burns briſkly in cold weather, the howling or whiſtling noiſe made by the wind, as it enters the room through the crevices, when the chimney is open as uſual, ceaſes as ſoon as the plate is ſlid in to its proper diſtance. 2. Opening the door of the room about half an inch, and holding your hand againſt the opening, near the top of the door, you feel the cold air coming in againſt your hand, but weakly, if the plate be in. Let another perſon ſuddenly draw it out, ſo as to let the air of the room go up the chimney, with its uſual freedom where chimneys are open, and you immediately feel the cold air ruſhing in ſtrongly. 3. If ſomething be ſet againſt the door, juſt ſufficient, when the plate is in, to keep the door nearly ſhut, by reſiſting the preſſure of the air that would force it open: then, when the plate is drawn out, the door will be forced open by the increaſed preſſure of the outward cold air endeavouring to get in to ſupply the place of the warm air that now paſſes out of the room to go up the chimney. In our common open chimneys, half the fuel is waſted, and its effect loſt; the air it has warmed being immediately drawn off."

9. Chimneys which generally draw well, do nevertheleſs ſometimes give ſmoke into the rooms, *it being driven down by ſtrong winds paſſing over the tops of their funnels*, though not deſcending from any commanding eminence. This caſe is moſt frequent where the funnel is ſhort and the opening turned from the wind. It is the more grievous, when it happens to be a cold wind that produces the effect, becauſe when you moſt want your fire you are ſometimes obliged to extinguiſh it. To underſtand this, it may be conſidered that the riſing light air, to obtain a free iſſue from the funnel, muſt puſh out of its way or oblige the air that is over it to riſe. In a time of calm or of little wind this is done viſibly; for we ſee the ſmoke that is brought up by that air riſe in a column above the chimney: but when a violent current of air, that is, a ſtrong wind, paſſes over the top of a chimney, its particles have received ſo much force, which keeps them in a horizontal direction and follow each other ſo rapidly, that the riſing light air has not ſtrength ſufficient to oblige them to quit that direction and move upwards to permit its iſſue.

Remedies. In Venice, the cuſtom is to open or widen the top of the flue, rounding it in the true form of a funnel. In other places the contrary is practiſed; the tops of the flues being narrowed inwards, ſo as to form a ſlit for the iſſue of the ſmoke, long as the breadth of the funnel, and only four inches wide. This ſeems to have been contrived on a ſuppoſition that the entry of the wind would thereby be obſtructed; and perhaps it might have been imagined, that the whole force of the riſing warm air being condenſed, as it were, in the narrow opening, would thereby be ſtrengthened, ſo as to overcome the reſiſtance of wind. This, however, did not always ſucceed; for when the wind was at north-eaſt and blew freſh, the ſmoke was forced down by fits into the room where Dr Franklin commonly ſat, ſo as to oblige him to ſhift the fire into another. The poſition of the ſlit of this funnel was indeed north-eaſt and ſouth-weſt. Perhaps if it had lain acroſs the wind, the effect might have been different. But on this we can give no certainty. It ſeems a matter proper to be referred to experiment. Poſſibly a turncap might have been ſerviceable, but it was not tried.

With all the ſcience, however, that a man ſhall ſuppoſe himſelf poſſeſſed of in this article, he may ſometimes meet with caſes that ſhall puzzle him. "I once lodged (ſays Dr Franklin) in a houſe at London, which in a little room had a ſingle chimney and funnel. The opening was very ſmall, yet it did not keep in the ſmoke, and all attempts to have a fire in this room were fruitleſs. I could not imagine the reaſon, till at length obſerving that the chamber over it, which had no fireplace in it, was always filled with ſmoke when a fire was kindled below, and that the ſmoke came through the cracks and crevices of the wainſcot; I had the wainſcot taken down, and diſcovered that the funnel which went up behind it had a crack many feet in length, and wide enough to admit my arm; a breach very dangerous with regard to fire, and occaſioned probably by an apparent irregular ſettling of one ſide of the houſe. The air entering this breach freely, deſtroyed the drawing force of the funnel. The remedy would have been, filling up the breach, or rather rebuilding the funnel: but the landlord rather choſe to ſtop up the chimney.

"Another puzzling caſe I met with at a friend's country houſe near London. His beſt room had a chimney in which, he told me, he never could have a fire, for all the ſmoke came out into the room. I flattered myſelf I could eaſily find the cauſe and preſcribe the cure. I opened the door, and perceived it was not want of air. I made a temporary contraction of the opening of the chimney, and found that it was not its being

being too large that cauſed the ſmoke to iſſue. I went out and looked up at the top of the chimney: Its funnel was joined in the ſame ſtack with others; ſome of them ſhorter, that drew very well, and I ſaw nothing to prevent its doing the ſame. In fine, after every other examination I could think of, I was obliged to own the inſufficiency of my ſkill. But my friend, who made no pretenſion to ſuch kind of knowledge, afterwards diſcovered the cauſe himſelf. He got to the top of the funnel by a ladder, and looking down found it filled with twigs and ſtraw cemented by earth and lined with feathers. It ſeems the houſe after being built, had ſtood empty ſome years before he occupied it; and he concluded that ſome large birds had taken the advantage of its retired ſituation to make their neſt there. The rubbiſh, conſiderable in quantity, being removed, and the funnel cleared, the chimney drew well, and gave ſatisfaction."

Chimneys whoſe funnels go up in the north wall of a houſe, and are expoſed to the north winds, are not ſo apt to draw well as thoſe in a ſouth wall; becauſe when rendered cold by thoſe winds, they draw downwards.

Chimneys incloſed in the body of a houſe are better than thoſe whoſe funnels are expoſed in cold walls.

Chimneys in ſtacks are apt to draw better than ſeparate funnels, becauſe the funnels that have conſtant fires in them warm the others in ſome degree that have none.

SMOKE-Jack. This ingenious machine is of German origin, and Meſſinger, in his *Collection of Mechanical Performances*, ſays it is very ancient, being repreſented in a painting at Nurenbergh, which is known to be older than the year 1350.

Plate CXCVII. ig. 5.

Its conſtruction is abundantly ſimple. An upright iron ſpindle GA (fig. 5.), placed in the narrow part of the kitchen chimney, turns round on two points H and I. The upper one H paſſes through an iron bar, which is built in acroſs the chimney; and the lower pivot I is of tempered ſteel, and is conical or pointed, reſting in a conical bell-metal ſocket fixed on another croſs bar. On the upper end of the ſpindle is a circular fly G, conſiſting of 4, 6, 8, or more thin iron plates, ſet obliquely on the ſpindle like the ſails of a windmill, as we ſhall deſcribe more particularly by and by. Near the lower end of the ſpindle is a pinion A, which works in the teeth of a contrate or face wheel B, turning on a horizontal axis BC. One pivot of this axis turns in a cock fixed on the croſs bar, which ſupports the lower end of the upright ſpindle HI, and the other pivot turns in a cock fixed on the ſide wall of the chimney; ſo that this axle is parallel to the front of the chimney. On the remote end of this horizontal axle there is a ſmall pulley C, having a deep angular groove. Over this pulley there paſſes a chain CDE, in the lower bight of which hangs the large pulley E of the ſpit. This end of the ſpit turns looſely between the branches of the fork of the rack or raxe F, but without reſting on it. This is on the top of a moveable ſtand, which can be ſhifted nearer to or farther from the fire. The other end turns in one of the notches of another rack. The number of teeth in the pinion A and wheel B, and the diameters of the pulleys C and E, are ſo proportioned that the fly G makes from 12 to 20 turns for one turn of the ſpit.

The manner of operation of this uſeful machine is eaſily underſtood. The air which contributes to the burning of the fuel, and paſſes through the midſt of it, is greatly heated, and expanding prodigiouſly in bulk, becomes lighter than the neighbouring air, and is therefore puſhed by it up the chimney. In like manner, all the air which comes near the fire is heated, expanded, becomes lighter, and is driven up the chimney. This is called the *draught* or *ſuction*, but would with greater propriety be termed the *drift* of the chimney. As the chimney gradually contracts in its dimenſions, and as the ſame quantity of heated air paſſes through every ſection of it, it is plain that the rapidity of its aſcent muſt be greateſt in the narroweſt place. There the fly G ſhould be placed, becauſe it will there be expoſed to the ſtrongeſt current. The air, ſtriking the fly vanes obliquely, puſhes them aſide, and thus turns them round with a conſiderable force. If the joint of meat is exactly balanced on the ſpit, it is plain that the only reſiſtance to the motion of the fly is what ariſes from the friction of the pivots of the upright ſpindle, the friction of the pinion and wheel, the friction of the pivots of the horizontal axis, the friction of the ſmall end of the ſpit, and the friction of the chain in the top pulleys. The whole of this is but a mere trifle. But there is frequently a conſiderable inequality in the weight of the meat on different ſides of the ſpit: there muſt therefore be a ſufficient overplus of force in the impulſe of the aſcending air on the vanes of the fly, to overcome this want of equilibrium occaſioned by the unſkilfulneſs or negligence of the cook. There is, however, commonly enough of power when the machine is properly conſtructed. The utility of this machine will, we hope, procure us the indulgence of ſome of our readers, while we point out the circumſtances on which its performance depends, and the maxims which ſhould be followed in its conſtruction.

The upward current of air is the moving power, and ſhould be increaſed as much as poſſible, and applied in the moſt advantageous manner. Every thing will increaſe the current which improves the draught of the chimney, and ſecures it from ſmoking. A ſmoky chimney muſt always have a weak current. For this particular, therefore, we refer to what has been delivered in the article PNEUMATICS, N° 359; and the article SMOKE.

With reſpect to the manner of applying this force, it is evident that the beſt conſtruction of a windmill ſails will be nearly the beſt conſtruction for the fly. According to the uſual theory of the impulſe of fluids, the greateſt effective impulſe (that is, in the direction of the fly's motion) will be produced if the plane of the vane be inclined to the axis in an angle of 54 degrees 46 minutes. But, ſince we have pronounced this theory to be ſo very defective, we had better take a determination founded on the experiments on the impulſe of fluids made by the academy of Paris. Theſe authoriſe us to ſay, that 49½ or 50 degrees will be the beſt angle to give the vane: but this muſt be underſtood only of that part of it which is cloſe adjoining to the axis. The vane itſelf muſt be twiſted, or *weathered* as the millwrights term it, and muſt be much more oblique at its outer extremity. The exact poſition cannot be determined with any preciſion; becauſe this depends on the

proportion

proportion of the velocity of the vane to that of the current of heated air. This is ſubject to no rule, being changed according to the load of the jack. We imagine that an obliquity of 65 degrees for the outer ends of the vanes will be a good poſition for the generality of caſes. Meſſinger deſcribes an ingenious contrivance for changing this angle at pleaſure, in order to vary the velocity of the motion. Each vane is made to turn round a midrib, which ſtands out like a radius from the ſpindle, and the vane is moved by a ſtiff wire attached to one of the corners adjoining to the axle. Theſe wires are attached to a ring which ſlides on the ſpindle like the ſpreader of an umbrella; and it is ſtopped on any part of the ſpindle by a pin thruſt through a hole in the ſpindle and ring. We mention this briefly, it being eaſily underſtood by any mechanic, and but of little conſequence, becauſe the machine is not ſuſceptible of much preciſion.

It is eaſy to ſee that an increaſe of the ſurface of the vanes will increaſe the power: therefore they ſhould occupy the whole ſpace of the circle, and not conſiſt of four narrow arms like the ſails of a windmill. It is better to make many narrow vanes than a few broad ones; as will appear plain to one well acquainted with the mode of impulſe of fluids acting obliquely. We recommend eight or twelve at leaſt; and each vane ſhould be ſo broad, that when the whole is held perpendicular between the eye and the light, no light ſhall come through the fly, the vanes overlapping each other *a very ſmall matter*. We alſo recommend the making them of ſtiff plate. Their weight contributes to the ſteady motion, and enables the fly, which has acquired a conſiderable velocity during a favourable poſition of things, to retain a momentum ſufficient to pull round the ſpit while the heavy ſide of the meat is riſing from its loweſt poſition. In ſuch a ſituation a light fly ſoon loſes its momentum, and the jack ſtaggers under its load.

It is plain, from what has been ſaid, that the fly ſhould occupy the whole of that ſection of the vent where it is placed. The vent muſt therefore be brought to a round form in that place, that none of the current may paſs uſeleſsly by it.

It is an important queſtion where the fly ſhould be placed. If in a wide part of the vent, it will have a great ſurface, and act by a long lever; but the current in that place is ſlow, and its impulſe weak. This is a fit ſubject of calculation. Suppoſe that we have it in our choice to place it either as it is drawn in the figure, or farther up at *g*, where its diameter muſt be one half of what it is at G. Since the ſame quantity of heated air paſſes through both ſections, and the ſection *g* has only one-fourth of the area of the ſection G, it is plain that the air muſt be moving four times faſter, and that its impulſe is 16 times greater. But the ſurface on which it is acting is the fourth part of that of the fly G; the actual impulſe therefore is only four times greater, ſuppoſing both flies to be moving with the ſame relative velocity in reſpect of the current; that is, the rim of each moving with the ſame portion of the velocity of the current. This will be the caſe when the ſmall fly turns eight times as often in a minute as the large fly: for the air is moving four times as quick at *g*, and the diameter of *g* is one half of that of G. Therefore, when the ſmall fly is turning eight times as quick as the great one, there is a quadruple impulſe acting at half the diſtance from the axis. The momentum or energy therefore of the current is double. Therefore, ſuppoſing the pinion, wheel, and pulleys of both jacks to be the ſame, the jack with the ſmall fly, placed in the narrow part of the vent, will be 16 times more powerful.

By this example, more eaſily underſtood than a general proceſs, it appears that it is of particular importance to place the fly in an elevated part of the vent, where the area may be much contracted. In order ſtill farther to increaſe the power of the machine, it would be very proper to lengthen the ſpindle ſtill more, and to put another fly on it at a conſiderable diſtance above the firſt, and a third above this, &c.

As the velocity of the current changes by every change of the fire, the motion of this jack muſt be very unſteady. To render it as adjuſtable as may be to the particular purpoſe of the cook, the pulley E has ſeveral grooves of different diameters, and the ſpit turns more or leſs ſlowly, by the ſame motion of the fly, according as it hangs in the chain by a larger or ſmaller pulley or groove.

Such is the conſtruction of the ſmoke-jack in its moſt ſimple form. Some are more artificial and complicated, having, in place of the pulleys and connecting chain, a ſpindle coming down from the horizontal axis BC. On the upper end of this ſpindle is a horizontal contrate wheel, driven by a pinion in place of the pulley C. On the lower end is a pinion, driving a contrate wheel in place of the pulley E. This conſtruction is repreſented in fig. 6. Others are conſtructed more ſimply, in the manner repreſented in fig. 7. But our firſt conſtruction has great advantage in point of ſimplicity, and allows a more eaſy adjuſtment of the ſpit, which may be brought nearer to the fire or removed farther from it without any trouble; whereas, in the others, with a train of wheels and pinions, this cannot be done without ſeveral changes of pins and ſcrews. The only imperfection of the pulley is, that by long uſe the grooves become ſlippery, and an ill-balanced joint is apt to hold back the ſpit, while the chain ſlides in the grooves. This may be completely prevented by making the grooves flat inſtead of angular (which greatly diminiſhes the friction), and furniſhing them with ſhort ſtuds or pins which take into every third or fourth link of the chain. If the chain be made of the ſimpleſt form, with flat links, and each link be made of an exact length (making them all on a mould), the motion will be as eaſy as with any wheelwork, and without the leaſt chance of ſlipping.

Fig. 6.
Fig. 7.

It is always of importance to avoid this ſlipping of the chain by balancing the loaded ſpit. For this purpoſe it will be extremely convenient to have what is called a *balance-ſkewer*. Let a part of the ſpit, immediately adjoining to the pulley, be made round, and let an arm be made to turn on it ſtiffly, ſo that it may be made faſt in any poſition by a ſcrew. Let a leaden ball be made to ſlide along this arm, with a ſcrew to faſten it at any diſtance from the ſpit. When the meat is ſpitted, lay it on the racks, and the heavieſt ſide will immediately place itſelf undermoſt. Now turn round the balance-ſkewer, ſo that it may point ſtraight upwards, and make it faſt in that poſition by the ſcrew. Put the leaden ball on it, and ſlide it inwards or out-

PLATE CCCCXCVII.

Fig. 1.

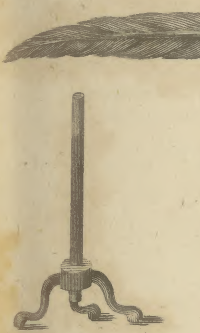


Fig. 3.

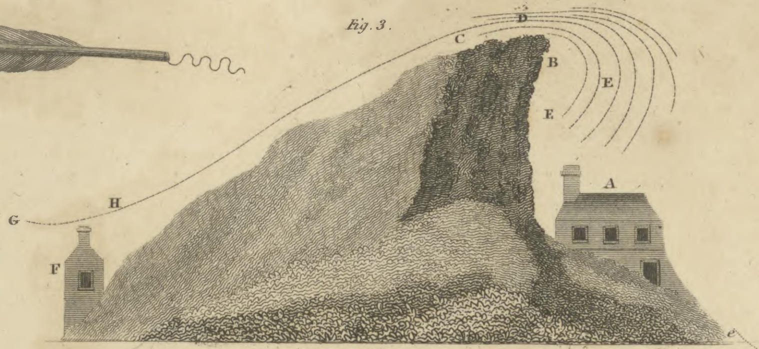


Fig. 2.

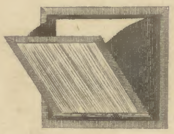


Fig. 4.

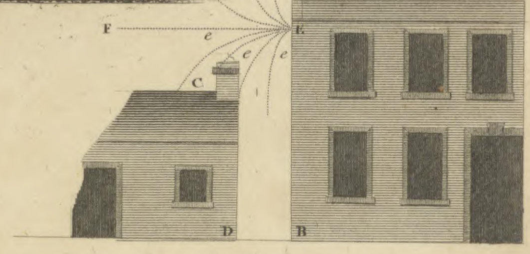
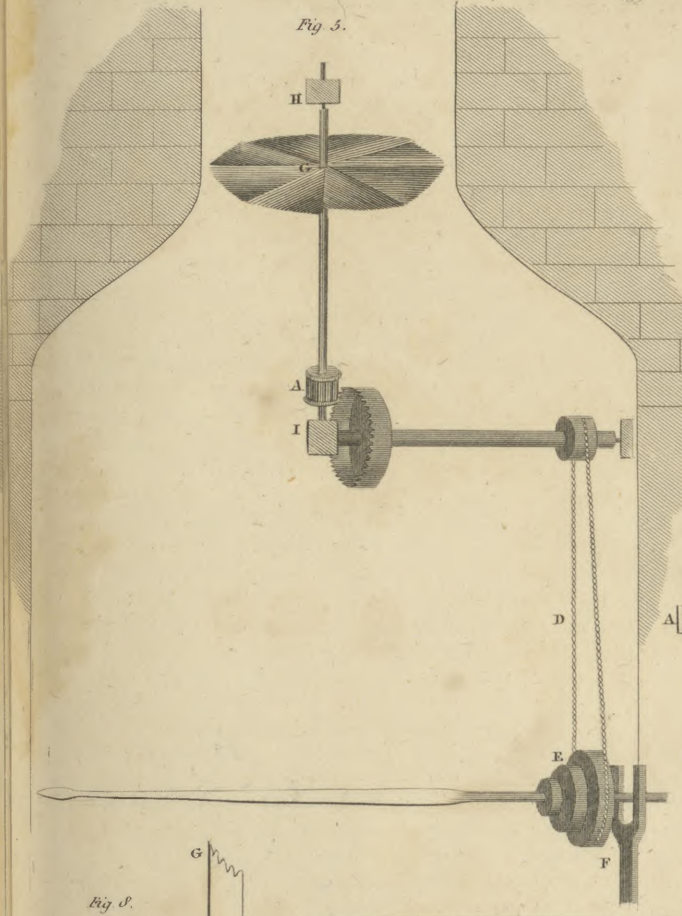


Fig. 5.



SOUNDING MACHINE

Fig. 1.

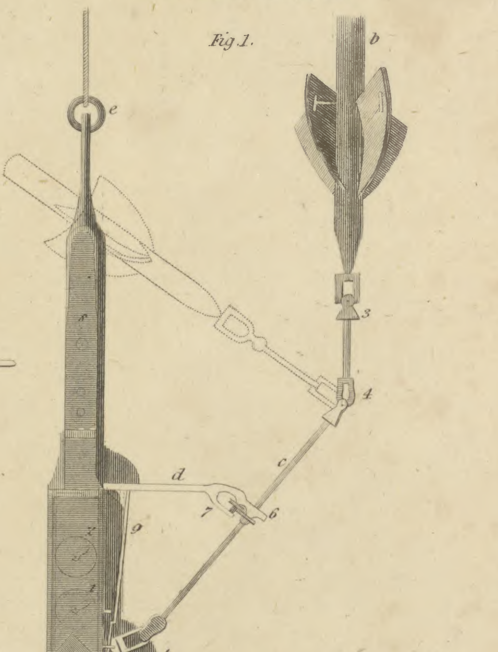


Fig. 7.

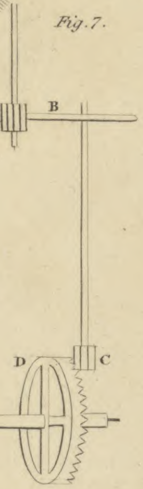


Fig. 2.

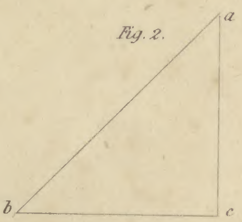


Fig. 8.

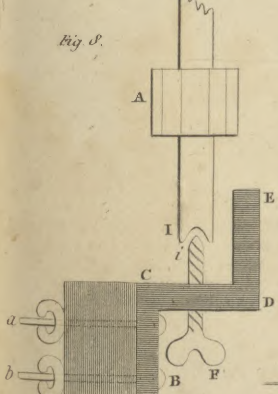
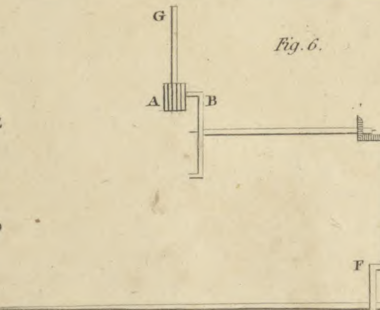


Fig. 6.



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wards till it exactly balances the heavy ſide, which will appear by the ſpit's remaining in any poſition in which it is put.

The greateſt difficulty is to keep the machine in repair. The eſſential part of it, the firſt mover, the fly, and the pinion and wheel, by which its motion is tranſmitted to the reſt of the machine, are ſituated in a place of difficult acceſs, and where they are expoſed to violent heat and to the ſmoke and ſoot. The whole weight of the fly, reſting on the lower pivot I, muſt exert a great preſſure there, and occaſion great friction, even when this pinion is reduced to the ſmalleſt ſize that is compatible with the neceſſary ſtrength. The pivot muſt be of hardened ſteel, tapered like an obtuſe cone, and muſt turn in a conical ſocket, alſo of hardened ſteel or of bell-metal; and this ſeat of preſſure and friction muſt be continually ſupplied with oil, which it conſumes very quickly. It is not ſufficient that it be from time to time ſmeared with an oiled feather; there muſt be an iron cup formed round the ſocket, and kept filled with oil. It is ſurpriſing how quickly it diſappears; it ſoon becomes clammy by evaporation, and by the ſoot which gathers about it. The continued rubbing of the pivot and ſocket wears them both very faſt; and this is increaſed by hard powders, ſuch as ſandy duſt, that are hurried up by the rapid current every time that the cook ſtirs the fire. Theſe, getting between the rubbing parts, cauſe them to grind and wear each other prodigiouſly. It is a great improvement to invert theſe rubbing parts. Let the lower end of the ſpindle be of a conſiderable thickneſs, and have a conical hollow nicely drilled in its extremity. Let a blunt-pointed conical pin riſe up in the middle of the oil cup, on which the conical hollow of the ſpindle may reſt. Here will be the ſame ſteady ſupport, and the ſame friction as in the other way; but no grinding duſt can now lodge between the pivot and its ſocket: and if this upright pin be ſcrewed up through the bottom of the cup, it may be ſcrewed farther up in proportion as it wears; and thus the upper pivot *g* will never deſert its hole, a thing which ſoon happens in the common way. We can ſay from experience, that a jack conſtructed in this way will not require the fifth part of the repairs of one done in the other way.

It is of importance that the whole be ſo put together as to be eaſily taken down, in order to ſweep the vent, or to be repaired, &c. For this purpoſe, let the croſs bar which carries the lower end of the upright ſpindle be placed a little on one ſide of the perpendicular line from the upper pivot hole. Let the cock which carries the oil cup and the pivot of the horizontal axis BC be ſcrewed to one ſide of this croſs bar, ſo that the centre of the cup may be exactly under the upper pivot hole. By this conſtruction we have only to unſcrew this cock, and then both axles come out of their places at once, and may be replaced without any trouble. We
8. have ſketched in fig. 8. the manner in which this may be done, where M repreſents a ſection of the lower croſs bar. BCDE is the cock, fixed to the bar by the pins which go through both, with finger nuts *a* and *b* on the oppoſite ſide. F *i* is the hard ſteel pin with the conical top *i*, on which the lower end I of the upright ſpindle AG reſts, in the manner recommended as the beſt and moſt durable. The pivot of the horizontal axis turns in a hole at E the top of the cock.

After all, we muſt acknowledge that the ſmoke-jack is inferior to the common jack that is moved by a weight. It is more expenſive at firſt, and requires more frequent repairs; its motion is not ſo much under command; it occaſions ſoot to be thrown about the fire, to the great annoyance of the cook; and it is a great encumbrance when we would clean the vent.

SMOKE-Farthings. The pentecoſtals or cuſtomary oblations offered by the diſperſed inhabitants within a dioceſe when they made their proceſſion to the mother or cathedral church, came by degrees into a ſtanding annual rent called *ſmoke farthings*.

SMOKE-Silver. Lands were holden in ſome places by the payment of the ſum of 6d. yearly to the ſheriff, called *ſmoke-ſilver* (Par. 4. Edw. VI.). Smoke-ſilver and ſmoke-penny are to be paid to the miniſters of divers pariſhes as a *modus* in lieu of tithe-wood: and in ſome manors formerly belonging to religious houſes, there is ſtill paid, as appendant to the ſaid manors, the ancient Peter-pence, by the name of *ſmoke-money* (*Twiſd. Hiſt. Vindicat.* 77.).—The biſhop of London *anno* 1444, iſſued out his commiſſion, *Ad levandum le* ſmoke-farthings, &c.

SMOLENSKO, a large and ſtrong city of Ruſſia, and capital of a palatinate of the ſame name, with a caſtle ſeated on a mountain, and a biſhop's ſee. It is ſtrong by its ſituation, being in the middle of a wood, and ſurrounded by almoſt inacceſſible mountains. It has been taken and retaken ſeveral times by the Poles and Ruſſians; but theſe laſt have had poſſeſſion of it ever ſince the year 1687. It is ſeated on the river Nieper, near the frontiers of Lithuania, 188 miles ſouth-weſt of Moſcow. E. Long. 31. 22. N. Lat. 54. 50.

SMOLENSKO, a duchy and palatinate of Ruſſia, bounded on the north by Biela, on the eaſt by the duchy of Moſcow, on the ſouth by that of Severia and the paltinate of Meiſlaw, and on the weſt by the ſame palatinate and by that of Witepſk. It is full of foreſts and mountains: and the capital is of the ſame name.

SMOLLET, Dr TOBIAS, an author whoſe writings will tranſmit his name with honour to poſterity, was born in the year 1720 at a ſmall village within two miles of Cameron, on the banks of the river Leven. He appears to have received a claſſical education, and was bred to the practice of phyſic and ſurgery; and in the early part of his life ſerved as a ſurgeon's mate in the navy.

The incidents that befel him during his continuance in this capacity ſerved as a foundation for Roderic Random, one of the moſt entertaining novels in the Engliſh tongue. He was preſent at the ſiege of Carthagena; and in the before-mentioned novel he has given a faithful, though not very pleaſing, account of the management of that ill-conducted expedition, which he cenſures in the warmeſt terms, and from circumſtances which fell under his own particular obſervation.

His connection with the ſea ſeems not to have been of long continuance; and it is probable that he wrote ſeveral pieces before he became known to the public by his capital productions. The firſt piece we know of with certainty is a Satire in two parts, printed firſt in the years 1746 and 1747, and reprinted in a Collection of his Plays and Poems in 1777. About this period, or ſome time before, he wrote for Mr Rich an opera intitled Alceſte, which has never been performed nor printed.

At the age of 18 he wrote a tragedy intitled The Regicide, founded on the ſtory of the aſſaſſination of James I. of Scotland. In the preface to this piece, publiſhed by ſubſcription in the year 1749, he bitterly exclaimed againſt falſe patrons, and the duplicity of theatrical managers. The warmth and impetuoſity of his temper hurried him, on this occaſion, into unjuſt reflections againſt the late George Lord Lyttleton and Mr Garrick: the character of the former he characteriſed in the novel of Peregrine Pickle, and he added a burleſque of the Monody written by that nobleman on the death of his lady. Againſt Mr Garrick he made illiberal ill-founded criticiſms; and in his novel of Roderick Random gave a very unfair repreſentation of his treatment of him reſpecting this tragedy. Of this conduct he afterwards repented, and acknowledged his errors; though in the ſubſequent editions of the novel the paſſages which were the haſty effuſions of diſappointment were not omitted.

However, in giving a ſketch of the liberal arts in his Hiſtory of England, he afterwards remarked, "the exhibitions of the ſtage were improved to the moſt exquiſite entertainment by the talents and management of Garrick, who greatly ſurpaſſed all his predeceſſors of this and perhaps every other nation, in his genius for acting, in the ſweetneſs and variety of his tones, the irreſiſtible magic of his eye, the fire and vivacity of his action, the eloquence of attitude, and the whole pathos of expreſſion.

Not ſatisfied with this public declaration, he wrote an apology to Mr Garrick in ſtill ſtronger terms. With theſe ample conceſſions, Mr Garrick was completely ſatisfied; ſo that in 1757, when Dr Smollet's comedy of the Repriſals, an afterpiece of two acts, was performed at Drury Lane theatre, the latter acknowledged himſelf highly obliged for the friendly care of Mr Garrick exerted in preparing it for the ſtage; and ſtill more for his acting the part of Luſignan in Zara for his benefit, on the ſixth inſtead of the ninth night, to which he was only intitled by the cuſtom of the theatre.

The Adventures of Roderic Random, publiſhed in 1748, 2 vols 12mo, a book which ſtill continues to have a moſt extenſive ſale, firſt eſtabliſhed the Doctor's reputation. All the firſt volume and the beginning of the ſecond appear to conſiſt of real incident and character, though certainly a good deal heightened and diſguiſed. The Judge his grandfather, Crab and Potion the two apothecaries, and 'Squire Gawky, were characters well known in that part of the kingdom where the ſcene was laid. Captains Oakhum and Whiffle, Doctors Mackſhane and Morgan, were alſo ſaid to be real perſonages; but their names we have either never learned or have now forgotten. A bookbinder and barber long eagerly contended for being ſhadowed under the name of *Strap*. The Doctor ſeems to have enjoyed a peculiar felicity in deſcribing ſea characters, particularly the officers and ſailors of the navy. His Trunnion, Hatchway, and Pipes, are highly finiſhed originals; but what exceeds them all, and perhaps equals any character that has yet been painted by the happieſt genius of ancient or modern times, is his Lieutenant Bowling. This is indeed nature itſelf; original, *unique*, and *ſui generis*.

By the publication of this work the Doctor had acquired ſo great a reputation, that henceforth a certain degree of ſucceſs was inſured to every thing known or ſuſpected to proceed from his hand. In the courſe of a few years, the Adventures of Peregrine Pickle appeared; a work of great ingenuity and contrivance in the compoſition, and in which an uncommon degree of erudition is diſplayed, particularly in the deſcription of the entertainment given by the Republican Doctor, after the manner of the ancients. Under this perſonage the late Dr Akenſide, author of The Pleaſures of Imagination, is ſuppoſed to be typified; and it would be difficult to determine whether profound learning or genuine humour predominate moſt in this epiſode. Another epiſode of the Adventures of a Lady of Quality, likewiſe inſerted in this work, contributed greatly to its ſucceſs, and is indeed admirably executed; the materials, it is ſaid, the lady herſelf (the celebrated Lady *Vane*) furniſhed.

Theſe were not the only original compoſitions of this ſtamp with which the Doctor has favoured the public. Ferdinand Count Fathom, and Sir Launcelot Greaves, are ſtill in the liſt of what may be called *reading novels*, and have gone through ſeveral editions; but there is no injuſtice in placing them in a rank far below the former. No doubt invention, character, compoſition, and contrivance, are to be found in both; but then ſituations are deſcribed which are hardly poſſible, and characters are painted which, if not altogether unexampled, are at leaſt incompatible with modern manners; and which ought not to be, as the ſcenes are laid in modern times.

The laſt work which we believe the Doctor publiſhed was of much the ſame ſpecies, but caſt into a different form—The Expedition of Humphrey Clinker. It conſiſts of a ſeries of letters, written by different perſons to their reſpective correſpondents. He has here carefully avoided the faults which may be juſtly charged to his two former productions. Here are no extravagant characters nor unnatural ſituations. On the contrary, an admirable knowledge of life and manners is diſplayed; and moſt uſeful leſſons are given applicable to intereſting but to very common ſituations.

We know not whether the remark has been made, but there is certainly a very obvious ſimilitude between the characters of the three heroes of the Doctor's chief productions. Roderic Random, Peregrine Pickle, and Matthew Bramble, are all brothers of the ſame family. The ſame ſatirical, cynical diſpoſition, the ſame generoſity and benevolence, are the diſtinguiſhing and characteriſtical features of all three: but they are far from being ſervile copies or imitations of each other. They differ as much as the Ajax, Diomed, and Achilles of Homer. This was undoubtedly a great effort of genius; and the Doctor ſeems to have deſcribed his own character at the different ſtages and ſituations of his life.

Before he took a houſe at Chelſea, he attempted to ſettle as practitioner of phyſic at Bath; and with that view wrote a treatiſe on the waters; but was unſucceſsful, chiefly becauſe he could not render himſelf agreeable to the women, whoſe favour is certainly of great conſequence to all candidates for eminence, whether in medicine or divinity. This, however, was a little extraordinary; for thoſe who remembered Dr Smollet at that time, cannot but acknowledge that he was as graceful and handſome a man as any of the age he lived in; beſides,

beſides, there was a certain dignity in his air and manner which could not but inſpire reſpect wherever he appeared. Perhaps he was too ſoon diſcouraged; in all probability, had he perſevered, a man of his great learning, profound ſagacity, and intenſe application, beſides being endued with every other external as well as internal accompliſhment, muſt have at laſt ſucceeded, and, had he attained to common old age, been at the head of his profeſſion.

Abandoning phyſic altogether as a profeſſion, he fixed his reſidence at Chelſea, and turned his thoughts entirely to writing. Yet, as an author, he was not near ſo ſucceſsful as his happy genius and acknowledged merit certainly deſerved. He never acquired a patron among the great, who by his favour or beneficence relieved him from the neceſſity of writing for a ſubſiſtence. The truth is, Dr Smollet poſſeſſed a loftineſs and elevation of ſentiment and character which appear to have diſqualified him for paying court to thoſe who were capable of conferring favours. It would be wrong to call this diſpoſition pride or haughtineſs; for to his equals and inferiors he was ever polite, friendly, and generous. Bookſellers may therefore be ſaid to have been his only patrons; and from them he had conſtant employment in tranſlating, compiling, and reviewing, He tranſlated Gil Blas and Don Quixote, both ſo happily, that all the former tranſlations of theſe excellent productions of genius have been almoſt ſuperſeded by his. His name likewiſe appears to a tranſlation of Voltaire's Proſe Works; but little of it was done by his own hand; he only reviſed it, and added a few notes. He was concerned in a great variety of compilations. His Hiſtory of England was the principal work of that kind. It had a moſt extenſive ſale; and the Doctor is ſaid to have received 2000l. for writing it and the continuation.

In 1755 he ſet on foot the Critical Review, and continued the principal manager of it till he went abroad for the firſt time in the year 1763, He was perhaps too acrimonious ſometimes in the conduct of that work; and at the ſame time diſplayed too much ſenſibility when any of the unfortunate authors attempted to retaliate whoſe works he had perhaps juſtly cenſured.

Among other controverſies in which his engagements in this publication involved him, the moſt material in its conſequences was that occaſioned by his remarks on a pamphlet publiſhed by Admiral Knowles. That gentleman, in defence of his conduct on the expedition to Rochfort, publiſhed a vindication of himſelf; which falling under the Doctor's examination, produced ſome very ſevere ſtrictures both on the performance and on the character of the writer. The admiral immediately commenced a proſecution againſt the printer; declaring at the ſame time that he deſired only to be informed who the writer was, that if he proved to be a gentleman he might obtain the ſatisfaction of one from him. In this affair the Doctor behaved both with prudence and with ſpirit. Deſirous of compromiſing the diſpute with the admiral in an amicable manner, he applied to his friend Mr Wilkes to interpoſe his good offices with his opponent. The admiral, however, was inflexible; and juſt as ſentence was going to be pronounced againſt the printer, the Doctor came into court, avowed himſelf the author of the Strictures, and declared himſelf ready to give Mr Knowles any ſatisfaction he choſe. The admiral immediately commenced a freſh action againſt the Doctor, who was found guilty, fined 100l. and condemned to three months impriſonment in the King's Bench. It is there he is ſaid to have written the Adventures of Sir Launcelot Greaves, in which he has deſcribed ſome remarkable characters, then his fellow-priſoners.

When Lord Bute was called to the chief adminiſtration of affairs, he was prevailed upon to write in defence of that nobleman's meaſures; which he did in a weekly paper called the *Briton*. This gave riſe to the famous North Briton; wherein, according to the opinion of the public, he was rather baffled. The truth is the Doctor did not ſeem to poſſeſs the talents neceſſary for political altercation. He wanted temper and coolneſs; and his friends accuſed his patron of having denied him the neceſſary information, and even neglected the fulfilling of ſome of his other engagements with him. Be that as it will, the Doctor is ſaid not to have forgotten him in his ſubſequent performances.

Beſides the Briton, Dr Smollet is ſuppoſed to have written other pieces in ſupport of the cauſe he eſpouſed. The Adventures of an Atom, in two volumes, are known to be his production.

His conſtitution being at laſt greatly impaired by a ſedentary life and aſſiduous application to ſtudy, he went abroad for his health in June 1763, and continued in France and Italy two years. He wrote an account of his travels in a ſeries of letters to ſome friends, which were afterwards publiſhed in two volumes octavo, 1766. During all that time he appears to have laboured under a conſtant fit of chagrin. A very ſlight peruſal of theſe letters will ſufficiently evince that this obſervation is founded in fact, and is indeed a melancholy inſtance of the influence of bodily diſtemper over the beſt diſpoſition.

His relation of his travels is actually cynical; for which Sterne, in his Sentimental Journey, has animadverted on him under the character of Smelfungus. The Doctor lived to return to his native country: but his health continuing to decline, and meeting with freſh mortifications and diſappointments, he went back to Italy, where he died October 21. 1771. He was employed, during the laſt years of his life, in abridging the Modern Univerſal Hiſtory, great part of which he had originally written himſelf, particularly the hiſtories of France, Italy, and Germany.

He certainly met with many mortifications and diſappointments; which, in a letter to Mr Garrick, he thus feelingly expreſſes: "I am old enough to have ſeen and obſerved, that we are all playthings of Fortune; and that it depends upon ſomething as inſignificant and precarious as the toſſing up of a halfpenny, whether a man riſes to affluence and honours, or continues to his dying day ſtruggling with the difficulties and diſgraces of life."

It would be needleſs to expatiate on the character of a man ſo well known as Dr Smollet, who has, beſides, given ſo many ſtrictures of his own character and manner of living in his writings, particularly in Humphrey Clinker; where he appears under the appellation of *Mr Serle*, and has an interview with Mr Bramble; and his manner of living is deſcribed in another letter, where young Melford is ſuppoſed to dine with him at his houſe in Chelſea. No doubt he made money by his connec-

tions

tions with the bookſellers; and had he been a rigid economiſt, or endued with the gift of retention (an expreſſion of his own), he might have lived and died very independent. However, to do juſtice to his memory, his difficulties, whatever they were, proceeded not from extravagance or want of economy. He was hoſpitable, but not oſtentatiouſly ſo; and his table was plentiful, but not extravagant. No doubt he had his failings; but ſtill it would be difficult to name a man who was ſo reſpectable for the qualities of his head, or more amiable for the virtues of his heart.

Since his death a monument has been erected to his memory near Leghorn, on which is inſcribed an epitaph written in Latin by his friend Dr Armſtrong, author of The Art of Preſerving Health, and many other excellent pieces. An inſcription written in Latin was likewiſe inſcribed on a pillar erected to his memory on the banks of the Leven, by one of his relations.

To theſe memoirs we are extremely ſorry to add, that ſo late as 1785 the widow of Dr Smollet was reſiding in indigent circumſtances at Leghorn. On this account the tragedy of Venice Preſerved was acted for her benefit at Edinburgh on the 5th of March, and an excellent prologue ſpoken on that occaſion.

The pieces inſerted in the poſthumous collection of Dr Smollet's plays and poems are, The Regicide, a tragedy: The Repriſal, a comedy; Advice and Reproof, two ſatires; The Tears of Scotland; Verſes on a Young Lady; a Love Elegy, in imitation of Tibullus; two Songs; a Burleſque Ode; Odes to Mirth, to Sleep, to Leven Water, to Blue-ey'd Ann, and to Independence.

SMUGGLERS, perſons who import or export prohibited goods without paying the duties appointed by the law.

The duties of cuſtoms, it is ſaid, were originally inſtituted, in order to enable the king to afford protection to trade againſt pirates: they have ſince been continued as a branch of the public revenue. As duties impoſed upon the importation of goods neceſſarily raiſe their price above what they might otherwiſe have been ſold for, a temptation is preſented to import the commodity clandeſtinely and to evade the duty. Many perſons, prompted by the hopes of gain, and conſidering the violation of a poſitive law of this nature as in no reſpect criminal (an idea in which they have been encouraged by a great part of the community, who make no ſcruple to purchaſe ſmuggled goods), have engaged in this illicit trade. It was impoſſible that government could permit this practice, which is highly injurious to the fair trader, as the ſmuggler is enabled to underſell him, while at the ſame time he impairs the national revenue, and thus wholly deſtroys the end for which theſe duties were appointed. Such penalties are therefore inflicted as it was thought would prevent ſmuggling.

Burn's Law Dictionary, vol. ii.

Many laws have been made with this view. If any goods be ſhipped or landed without warrant and preſence of an officer, the veſſel ſhall be forfeited, and the wharfinger ſhall forfeit 100l. and the maſter or mariner of any ſhip inward bound ſhall forfeit the value of the goods: and any carman, porter, or other aſſiſting, ſhall be committed to gaol, till he find ſurety of his good behaviour, or until he ſhall be diſcharged by the court of exchequer (13 and 14 C. II. c. 11.). If goods be relanded after drawback, the veſſel and goods ſhall be forfeited; and every perſon concerned therein ſhall forfeit double the value of the drawback (8 An. c. 13.). Goods taken in at ſea ſhall be forfeited, and alſo the veſſel into which they are taken; and every perſon concerned therein ſhall forfeit treble value (9 G. II. c. 35.). A veſſel hovering near the coaſt ſhall be forfeited, if under 50 tons burden; and the goods ſhall alſo be forfeited, or the value thereof (5 G. III. c. 43.). Perſons receiving or buying run goods ſhall forfeit 20l. (8 G. c. 18.). A concealer of run goods ſhall forfeit treble value (8 G. c. 18.). Offering run goods to ſale, the ſame ſhall be forfeited, and the perſon to whom they are offered may ſeize them; and the perſon offering them to ſale ſhall forfeit treble value (11 G. c. 30.). A porter or other perſon carrying run goods ſhall forfeit treble value (9 G. II. c. 35.). Perſons armed or diſguiſed carrying run goods ſhall be guilty of felony, and tranſported for ſeven years (8 G. c. 18. 9 G. II. c. 35.).

But the laſt ſtatute, 19 G. II. c. 34. is for this purpoſe *inſtar omnium*; for it makes all forcible acts of ſmuggling, carried on in defiance of the laws, or even in diſguiſe to evade them, felony without benefit of clergy: enacting, that if three or more perſons ſhall aſſemble, with fire-arms or other offenſive weapons, to aſſiſt in the illegal exportation or importation of goods, or in reſcuing the ſame after ſeizure, or in reſcuing offenders in cuſtody for ſuch offences; or ſhall paſs with ſuch goods in diſguiſe; or ſhall wound, ſhoot at, or aſſault, any officers of the revenue when in the execution of their duty; ſuch perſons ſhall be felons, without the benefit of clergy.

When we conſider the nature, and ſtill more the hiſtory of mankind, we muſt allow that the enacting of ſevere penal laws is not the way to prevent crimes. It were indeed much to be wiſhed that there were no ſuch thing as a political crime; for the generality of men, but eſpecially the lower orders, not diſcerning the propriety or utility of ſuch laws, conſider them as oppreſſive and tyrannical, and never heſitate to violate them when they can do it with impunity. Inſtead therefore of puniſhing ſmugglers, it would be much better to remove the temptation. But the high duties which have been impoſed upon the importation of many different ſorts of foreign goods, in order to diſcourage their conſumption in Great Britain, have in many caſes ſerved only to encourage ſmuggling; and in all caſes have reduced the revenue of the cuſtoms below what more moderate duties would have afforded. The ſaying of Dr Swift, that in the arithmetic of the cuſtoms two and two, inſtead of making four, make ſometimes only one, holds perfectly true with regard to ſuch heavy duties, which never could have been impoſed, had not the mercantile ſyſtem taught us, in many caſes, to employ taxation as an inſtrument, not of revenue, but of monopoly.

Smith's Wealth of Nations, vol. iii.

The bounties which are ſometimes given upon the exportation of home produce and manufactures, and the drawbacks which are paid upon the re-exportation of the greater part of foreign goods, have given occaſion to many frauds, and to a ſpecies of ſmuggling more deſtructive of the public revenue than any other. In order to obtain the bounty or drawback, the goods, it is well known, are ſometimes ſhipped and ſent to ſea, but ſoon

ſoon afterwards clandeſtinely relanded in ſome other part of the country.

Heavy duties being impoſed upon almoſt all goods imported, our merchant importers ſmuggle as much, and make entry of as little as they can. Our merchant exporters, on the contrary, make entry of more than they export; ſometimes out of vanity, and to paſs for great dealers in goods which pay no duty; and ſometimes to gain a bounty or a drawback. Our exports, in conſequence of theſe different frauds, appear upon the cuſtomhouſe books greatly to overbalance our imports; to the unſpeakable comfort of thoſe politicians who meaſure the national proſperity by what they call the balance of trade.

SMUT, in *Huſbandry*, a diſeaſe in corn, when the grains, inſtead of being filled with flour, are full of a ſtinking black powder. See Wheat.

SMYRNA, or Ismir, at preſent the largeſt and richeſt city of Aſia Minor, is ſituated in north latitude 38° 28′, and in E. Long. 27° 25′ from Greenwich, and about 183 miles weſt by ſouth of Conſtantinople. The town extends along the ſhore about half a mile on a gentle declivity. The houſes of the Engliſh, French, and Dutch conſuls, are handſome ſtructures; theſe, with moſt of thoſe occupied by the Chriſtian merchants, are waſhed on one ſide by the ſea, forming a ſtreet named *Frank-ſtreet*, from its being ſolely inhabited by European Chriſtians. In the year 1763 the whole of this quarter was conſumed by fire: the loſs ſuſtained by this calamity in merchandiſe was eſtimated at a million and a half of Turkiſh dollars, or near 200,000l. ſterling. The port is one of the fineſt of the Levant, it being able to contain the largeſt fleet; and indeed there are ſeldom in it fewer than 100 ſhips of different nations.

A caſtle ſtands at its entrance, and commands all the ſhipping which ſail in or out. There is likewiſe an old ruinous caſtle, near a mile in circumference, which ſtands in the upper part of the city, and, according to tradition, was built by the empreſs Helena: and near it is an ancient ſtructure, ſaid to be the remains of a palace where the Greek council was held when Smyrna was the metropolis of Aſia Minor. They alſo ſhow the ruins of an amphitheatre, where it is ſaid St Polycarp, the firſt biſhop, fought with lions.

This city is about four miles in circumference, and nearly of a triangular form; but the ſide next the mountain is much longer than the other ſides. The houſes are low, and moſtly built with clay walls, on account of the earthquakes to which the country is ſubject; but the caravanſeras and ſome other of the public buildings have an air of magnificence. The ſtreets are wide, and almoſt a continued bazar, in which a great part of the merchandiſe of Europe and Aſia is expoſed to ſale, with plenty of proviſions; though theſe are not ſo cheap as in many other parts of Turkey, on account of the populouſneſs of the place, and the great reſort of foreigners. It is ſaid to contain 15,000 Turks, 10,000 Greeks, 1800 Jews, 200 Armenians, and 200 Franks: but the whole population is computed at 120,000. The Turks have 19 moſques; two churches belong to the Greeks; one to the Armenians; and the Jews have eight ſynagogues. The Romaniſts have three convents. There is alſo one of the fathers Della Terra Santa. Here reſides an archbiſhop of the Greek church; a Latin biſhop who has a ſalary from Rome, with the title of biſhop of Smyrna *in partibus infidelium*; and the Engliſh and Dutch factories have each their chaplain.

The walks about the town are extremely pleaſant, particularly on the weſt ſide of Frank ſtreet, where there are ſeveral little groves of orange and lemon trees, which being always clothed with leaves, bloſſoms, and fruit, regale ſeveral of the ſenſes at the ſame time. The vines which cover the little hills about Smyrna afford both a delightful proſpect and plenty of grapes, of which good wine is made. Theſe hills are agreeably interſperſed with fertile plains, little foreſts of olives and other fruit-trees, and many pleaſure-houſes, to which the Franks uſually retire during the ſummer. In the neighbourhood of Smyrna is great plenty of game and wild-fowl, and particularly deer and wild-hogs. The ſea alſo abounds with a variety of good fiſh. The European Chriſtians are here allowed all imaginable liberties, and uſually clothe themſelves after the European manner.

The chief commerce of this city conſiſts in raw ſilk, ſilk-ſtuffs, grograms, and cotton yarn.

However, the unhealthfulneſs of the ſituation, and more eſpecially the frequent earthquakes, from which, it is ſaid, they are ſcarcely ever free for two years together, and which have been felt 40 days ſucceſſively, are an abatement of the pleaſure that might otherwiſe be enjoyed here. A very dreadful one happened in June 1688, which overthrew a great number of the houſes; and the rock opening where the caſtle ſtood, ſwallowed it up, and no leſs than 5000 perſons periſhed on this occaſion.

In the year 1758, ſo deſolating a plague raged here, that ſcarcely a ſufficient number of the inhabitants ſurvived to gather in the fruits of the earth. In the year 1772, three-fourth parts of the city were conſumed by fire; and ſix years after it was viſited by the moſt dreadful earthquakes, which continued from the 25th of June to the 5th of July; by which ſucceſſive calamities the city has been ſo much reduced, that its former conſequence is never likely to be reſtored.

The ladies here wear the oriental dreſs, conſiſting of large trowſers or breeches, which reach to the ancle; long veſts of rich ſilk or velvet, lined in winter with coſtly furs; and round their waiſt an embroidered zone with claſps of ſilver or gold. Their hair is plaited, and deſcends down the back often in great profuſion. The girls have ſometimes above twenty thick treſſes, beſides two or three encircling the head as a coronet, and ſet off with flowers and plumes of feathers, pearls, or other jewels. They commonly ſtain it of a cheſnut colour, which is the moſt deſired. Their apparel and carriage are alike antique. It is remarkable that the trowſers are mentioned in a fragment of Sappho as part of the female dreſs.

SMYRNIUM, Alexanders; a genus of plants belonging to the claſs of pentandria, and to the order of digynia; and in the natural ſyſtem ranging under the 45th order, *Umbellatæ*. See Botany *Index*.

SNAFFLE, in the manege, is a very ſlender bitmouth without any branches, much uſed in England; the true bridles being reſerved for war.

SNAIL, in *Zoology*. See Helix, Conchology *Index*, and Limax, Helminthology *Index*.

SNAKE, in *Zoology*. See ANGUIS and SERPENS, OPHIOLOGY *Index*.

SNAKE-*Stones*, *Ammonitæ*, in *Natural Hiſtory*, the name of a large genus of foſſil ſhells, very few if any of which are yet known in their recent ſtate, or living either on our own or any other ſhores; ſo that it ſeems wonderful whence ſo vaſt a number and variety of them ſhould be brought into our ſubterranean regions. They ſeem indeed diſperſed in great plenty throughout the world, but nowhere are found in greater numbers, beauty, and variety, than in our iſland.

Mr Harenberg found prodigious numbers of them on the banks of a river in Germany. He traced this river through its ſeveral windings for many miles; and among a great variety of belemnitæ, cornua ammonis, and cochlitæ, of various kinds, he found alſo great quantities of wood of recent petrifaction, which ſtill preſerved plain marks of the axe by which it had been cut from the trees then growing on the ſhore. The water of this river he found in dry ſeaſons, when its natural ſprings were not diluted with rains, to be conſiderably heavier than common water; and many experiments ſhowed him that it contained ferruginous, as well as ſtony particles, in great quantity, whence the petrifactions in it appeared the leſs wonderful, though many of them of recent date.

Of the cornua ammonis, or ſerpent-ſtones, he there obſerved more than 30 different ſpecies. They lie immerſed in a bluiſh foſſil ſtone, of a ſoft texture and fatty appearance, in prodigious numbers, and of a great variety of ſizes, from the larger known ſorts down to ſuch as could not be ſeen without very accurate inſpection or the aſſiſtance of a microſcope. Such as lie in the ſofteſt of theſe ſtones are ſoft like their matrix, and eaſily crumble to pieces; others are harder. In a piece of this ſtone, of the bigneſs of a finger, it is common to find 30 or more of theſe foſſils; and often they are ſeen only in form of white ſpecks, ſo minute that their figure cannot be diſtinguiſhed till examined by the microſcope.

They all conſiſt of ſeveral volutæ, which are different in number in the different ſpecies, and their ſtriæ alſo are extremely various; ſome very deep with very high ridges between them, others very ſlight; ſome ſtraight, others crooked; others undulated, and ſome terminating in dots, tubercles, or cavities, towards the back, and others having tubercles in two or three places. They are all compoſed of a great number of chambers or cells, in the manner of the *nautilus Græcorum*, each having a communication with the others, by means of a pipe or ſiphunculus. There is a ſmall white ſhell fiſh of Barbadoes, which ſeems truly a recent animal of this genus; and in the Eaſt Indies there is another alſo, ſmall and grayiſh; but the large and beautifully marked ones are found only foſſil.

They are compoſed of various foſſil bodies, often of quarry ſtone, ſometimes of the matter of the common pyrites, and of a great variety of other ſubſtances; and though they appear uſually mere ſtones, yet in ſome the pearly part of the original ſhell is preſerved in all its beauty. Sometimes alſo, while the outer ſubſtance is of the matter of the pyrites, or other coarſe, ſtony, or mineral matter, the inner cavity is filled with a pure white ſpar of the common plated texture. This gives a great beauty to the ſpecimen. The cornua ammonis, or ſnake-ſtones, are found in many parts of England, particularly in Yorkſhire, where they are very plentiful in the alum rocks of ſeveral ſizes.

SNAKE-*Root*. See POLYGALA, BOTANY *Index*.

SNAKE-*Weed*. See POLYGONUM, BOTANY *Index*.

SNAPEDRAGON. See ANTIRRHINUM, BOTANY *Index*.

SNEEZING, a convulſive motion of the muſcles of the breaſt, whereby the air is expelled from the noſe with much vehemence and noiſe. It is cauſed by the irritation of the upper membrane of the noſe, occaſioned by acrid ſubſtances floating in the air, or by medicines called *ſternutatory*.

This irritation is performed either externally, by ſtrong ſmells, as marjoram, roſes, &c. or by duſt floating in the air, and taken in by inſpiration; or by ſharp pungent medicines, as creſſes and other ſternutatories, which vellicate the membrane of the noſe; or internally, by the acrimony of the lympha or mucus, which naturally moiſtens that membrane. The matters caſt forth in ſneezing come primarily from the noſe and throat; the pituitary membrane continually exuding a mucus thither; and, ſecondarily, from the breaſt, the trachea, and the bronchia of the lungs.

The practice of ſaluting the perſon who ſneezed exiſted in Africa, among nations unknown to the Greeks and Romans. The accounts we have of Monomotapa inform us *, that when the prince ſneezes, all his ſubjects in the capital are advertiſed of it, that they may offer up prayers for his ſafety. The author of the conqueſt of Peru aſſures us, that the cacique of Guachoia having ſneezed in preſence of the Spaniards, the Indians of his train fell proſtrate before him, ſtretched forth their hands, and diſplayed to him the accuſtomed marks of reſpect, while they invoked the ſun to enlighten him, to defend him, and to be his conſtant guard.

Every body knows that the Romans ſaluted each other on theſe occaſions: and Pliny relates †, that Tiberius exacted theſe ſigns of homage when drawn in his chariot. Superſtition, whoſe influence can debaſe every thing, had degraded this cuſtom for ſeveral ages, by attaching favourable or unfavourable omens to ſneezing according to the hour of the day or night, according to the ſigns of the zodiac, according as a work was more or leſs advanced, or according as one had ſneezed to the right or to the left ‡. If a man ſneezed at riſing from table or from his bed, it was neceſſary for him to ſit or lie down again. You are ſtruck with aſtoniſhment, ſaid Timotheus to the Athenians, who wiſhed to return into the harbour with their fleet §, becauſe he had ſneezed; you are ſtruck with aſtoniſhment, becauſe among 10,000 there is one man whoſe brain is moiſt.

Polydore Virgil pretends, that in the time of Gregory the Great, there reigned in Italy an epidemic diſtemper, which carried off by ſneezing all thoſe who were ſeized by it; and that this pontiff ordered prayers to be made againſt it, accompanied by certain ſigns of the croſs. But beſides that, there are very few caſes in which ſneezing can be conſidered as dangerous, and that it is frequently a favourable ſymptom ||: it is evident, that we ought not to date from the ſixth century the origin of a cuſtom which loſes itſelf in the obſcurity of antiquity. Avicenna and Cardan ſay, it is a ſort of convulſion, which gives occaſion to dread an epilepſy, and that

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* Strada, Prol. Ac

† Plin. H Nat. lib. cap. 2.

‡ Spond. Homeri Comment

§ Frontin lib. i. ca 11.

|| Hippocrat. Hal leri Phyſ

that this diſeaſe is endeavoured to be warded off by prayers. Clement of Alexandria conſiders it as a mark of intemperance and effeminacy, which ought to be proſcribed. And he inveighs bitterly againſt thoſe who endeavour to procure ſneezing by external aid. Montaigne, on the contrary, explains this fact in a tone rather cynical. It is ſingular enough, that ſo many ridiculous, contradictory, and ſuperſtitious opinions, have not aboliſhed thoſe cuſtomary civilities which are ſtill preſerved equally among high and low; and which only the Anabaptiſts and Quakers have rejected, becauſe they have renounced ſalutations in every caſe.

Among the Greeks ſneezing was almoſt always a good omen. It excited marks of tenderneſs, of reſpect, and attachment. The genius of Socrates informed him by ſneezing, when it was neceſſary to perform any action[*]. The young Parthenis, hurried on by her paſſion, reſolved to write to Sarpedon an avowal of her love[†]; ſhe ſneezes in the moſt tender and impaſſioned part of her letter: This is ſufficient for her; this incident ſupplies the place of an anſwer, and perſuades her that Sarpedon is her lover. Penelope, haraſſed by the vexatious courtſhip of her ſuitors, begins to curſe them all, and to pour forth vows for the return of Ulyſſes[‡]. Her ſon Telemachus interrupts her by a loud ſneeze. She inſtantly exults with joy, and regards this ſign as an aſſurance of the approaching return of her huſband. Xenophon was haranguing his troops; a ſoldier ſneezed in the moment when he was exhorting them to embrace a dangerous but neceſſary reſolution. The whole army, moved by this preſage, determine to purſue the project of their general; and Xenophon orders ſacrifices to Jupiter the preſerver[§].

This religious reverence for ſneezing, ſo ancient and ſo univerſal even in the times of Homer, always excited the curioſity of the Greek philoſophers and of the rabbins. Theſe laſt have ſpread a tradition, that, after the creation of the world, God made a general law to this purport, that every living man ſhould ſneeze but once in his life, and that at the ſame inſtant he ſhould render up his ſoul into the hand of his Creator[||], without any preceding indiſpoſition. Jacob obtained an exemption from the common law, and the favour of being informed of his laſt hour: He ſneezed and did not die; and this ſign of death was changed into a ſign of life. Notice of this was ſent to all the princes of the earth; and they ordained that in future ſneezing ſhould be accompanied with forms of bleſſing, and vows for the perſons who ſneezed.

Ariſtotle remounts likewiſe to the ſources of natural religion. He obſerves, that the brain is the origin of the nerves, of our ſentiments, our ſenſations, the ſeat of the ſoul, the image of the Divinity[*]; that upon all theſe accounts, the ſubſtance of the brain has ever been held in honour; that the firſt men ſwore by their head; that they durſt not touch nor eat the brains of any animal; that it was even a ſacred word which they dared not to pronounce. Filled with theſe ideas, it is not wonderful that they extended their reverence even to ſneezing. Such is the opinion of the moſt ancient and ſagacious philoſophers of Greece.

According to mythology, the firſt ſign of life Prometheus's artificial man gave was by ſternutation. This ſuppoſed creator is ſaid to have ſtolen a portion of the ſolar rays; and filling with them a phial, which he had made on purpoſe, ſealed it up hermetically. He inſtantly flies back to his favourite automaton, and opening the phial holds it cloſe to the ſtatue; the rays ſtill retaining all their activity, inſinuate themſelves through the pores, and ſet the fictitious man a ſneezing. Prometheus, tranſported with the ſucceſs of his machine, offers up a fervent prayer, with wiſhes for the preſervation of ſo ſingular a being. His automaton obſerved him, remembering his ejaculations, was very careful, on the like occaſions, to offer theſe wiſhes in behalf of his deſcendants, who perpetuated it from father to ſon in all their colonies.

SNIGGLING, a method of fiſhing for eels, chiefly uſed in the daytime, when they are found to hide themſelves near wears, mills, or flood-gates. It is performed thus: Take a ſtrong line and hook, baited with a garden worm, and obſerving the holes where the eels lie hid, thruſt your bait into them by the help of a ſtick; and if there be any, you ſhall be ſure to have a bite; and may, if your tackling hold, get the largeſt eels.

SNIPE, in *Ornithology*. See SCOLOPAX and SHOOTING.

SNORING, in *Medicine*, otherwiſe called *ſtertor*, is a ſound like that of the cerchnon, but greater and more manifeſt.

Many confound thoſe affections, and make them to differ only in place and magnitude, calling by the name of *ſtertor* that ſound or noiſe which is heard or ſuppoſed to be made in the paſſage between the palate and the noſtrils, as in thoſe who ſleep; that boiling or bubbling noiſe, which in reſpiration proceeds from the larynx or head, or orifice of the aſpera arteria, they call *cerchnon*; but if the ſound comes from the aſpera arteria itſelf, it is called *cerchnos*, that is, as ſome underſtand it, a rattling, or as others a ſtridulous or wheezing roughneſs of the aſpera arteria. In dying perſons this affection is called by the Greeks ῥεγχος, *rhenchos*, which is a ſnoring or rattling kind of noiſe, proceeding as it were from a conflict between the breath and the humours in the aſpera arteria.

This and ſuch like affections are owing to a weakneſs of nature, as when the lungs are full of pus or humours: to which purpoſe we read in the Prognoſtics of Hippocrates, "it is a bad ſign when there is no expectoration, and no diſcharge from the lungs, but a noiſe as from an ebullition is heard in the aſpera arteria from a plenitude of humour." Expectoration is ſuppreſſed either by the viſcidity of the humour, which requires to be diſcharged, and which adhering to the aſpera arteria, and being there agitated by the breath, excites that bubbling noiſe or ſtertor; or by an obſtruction of the bronchia; or, laſtly, by a compreſſion of the aſpera arteria and throat, whence the paſſage is ſtraitened, in which the humours being agitated, excite ſuch a kind of noiſe as before deſcribed. Hence Galen calls thoſe who are ſtrait-breaſted *ſtertorous*. That author aſſigns but two cauſes of this ſymptom, which are either the ſtraitneſs of the paſſage of reſpiration or redundance of humours, or both together; but it is neceſſary to add a third, to wit, the weakneſs of the faculty, which is the cauſe of the rhenchos in dying perſons, where nature is too weak to make diſcharges.

From what has been ſaid we conclude, that this ſymptom or this ſort of fervour or ebullition in the throat,

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Plutarch gen. So-at.

Ariſten-

Homeri Odyſſ. lib. i.

Xenoph. ab.

cad. des crip. iv.

Ariſtot. Prob.

throat, is not always mortal, but only when nature is oppreſſed with the redundance of humour, in ſuch a manner, that the lungs cannot diſcharge themſelves by ſpitting; or the paſſage appointed for the breath (being the aſpera arteria) is very much obſtructed, upon which account many dying perſons labour under a ſtertor with their mouths gaping.

SNOW, a well known meteor, formed by the freezing of the vapour of water in the atmoſphere. It differs from hail and hoar-froſt, in being as it were cryſtallized, which they are not. This appears in examining a flake of ſnow by a magnifying glaſs; when the whole of it will appear to be compoſed of fine ſhining ſpicula diverging like rays from a centre. As the flakes fall down through the atmoſphere, they are continually joined by more of theſe radiated ſpicula, and thus increaſe in bulk like the drops of rain or hailſtones. Dr Grew, in a diſcourſe of the nature of ſnow, obſerves, that many parts thereof are of a regular figure, for the moſt part ſtars of ſix points, and are as perfect and tranſparent ice as any we ſee on a pond, &c. Upon each of theſe points are other collateral points, ſet at the ſame angles as the main points themſelves: among which there are divers other irregular, which are chiefly broken points, and fragments of the regular ones. Others alſo, by various winds, ſeem to have been thawed and frozen again into irregular cluſters; ſo that it ſeems as if the whole body of ſnow were an infinite maſs of icicles irregularly figured. That is, a cloud of vapours being gathered into drops, the ſaid drops forthwith deſcend; upon which deſcent, meeting with a freezing air as they paſs through a colder region, each drop is immediately frozen into an icicle, ſhooting itſelf forth into ſeveral points; but theſe ſtill continuing their deſcent, and meeting with ſome intermitting gales of warmer air, or in their continual waftage to and fro touching upon each other, ſome of them are a little thawed, blunted, and again frozen into cluſters, or entangled ſo as to fall down in what we call *flakes*.

The lightneſs of ſnow, although it is firm ice, is owing to the exceſs of its ſurface, in compariſon to the matter contained under it; as gold itſelf may be extended in ſurface till it ride upon the leaſt breath of air.

The whiteneſs of ſnow is owing to the ſmall particles into which it is divided; for ice, when pounded, will become equally white. An artificial ſnow has been made by the following experiment. A tall phial of aquafortis being placed by the fire till it is warm, and filings of pure ſilver, a few at a time, being put into it; after a briſk ebullition, the ſilver will diſſolve ſlowly. The phial being then placed in a cold window, as it cools the ſilver particles will ſhoot into cryſtals, ſeveral of which running together will form a flake of ſnow, which will deſcend to the bottom of the phial. While they are deſcending, they repreſent perfectly a ſhower of ſilver ſnow, and the flakes will lie upon one another at the bottom, like real ſnow upon the ground.

According to Signior Beccaria, clouds of ſnow differ in nothing from clouds of rain, but in the circumſtance of cold that freezes them. Both the regular diffuſion of the ſnow, and the regularity of the ſtructure of its parts (particularly ſome figures of ſnow or hail which fall about Turin, and which he calls *roſette*) ſhow that clouds of ſnow are acted upon by ſome uniform cauſe like electricity; and he endeavours to ſhow how electricity is capable of forming theſe figures. He was confirmed in his conjectures by obſerving, that his apparatus for obſerving the electricity of the atmoſphere never failed to be electrified by ſnow as well as rain. Profeſſor Winthrop ſometimes found his apparatus electrified by ſnow when driven about by the wind, though it had not been affected by it when the ſnow itſelf was falling. A more intenſe electricity, according to Beccaria, unites the particles of hail more cloſely than the more moderate electricity does thoſe of ſnow, in the ſame manner as we ſee that the drops of rain which fall from thunder-clouds are larger than thoſe which fall from others, though the former deſcend through a leſs ſpace.

But we are not to conſider ſnow merely as a curious and beautiful phenomenon. The Great Diſpenſer of univerſal bounty has ſo ordered it, that it is eminently ſubſervient, as well as all the works of creation, to his benevolent deſigns. Were we to judge from appearances only, we might imagine, that ſo far from being uſeful to the earth, the cold humidity of ſnow would be detrimental to vegetation. But the experience of all ages aſſerts the contrary. Snow, particularly in thoſe northern regions where the ground is covered with it for ſeveral months, fructifies the earth, by guarding the corn or other vegetables from the intenſer cold of the air, and eſpecially from the cold piercing winds. It has been a vulgar opinion, very generally received, that ſnow fertilizes the lands on which it falls more than rain, in conſequence of the nitrous ſalts which it is ſuppoſed to acquire by freezing. But it appears from the experiments of Margraaf, in the year 1751, that the chemical difference between rain and ſnow water is exceedingly ſmall; that the latter contains a leſs proportion of earth than the former; but neither of them contain either earth or any kind of ſalt in any quantity which can be ſenſibly efficacious in promoting vegetation. Allowing, therefore, that nitre is a fertilizer of lands, which many are upon good grounds diſpoſed utterly to deny, yet ſo very ſmall is the quantity of it contained in ſnow, that it cannot be ſuppoſed to promote the vegetation of plants upon which the ſnow has fallen. The peculiar agency of ſnow, as a fertilizer in preference to rain, may admit of a very rational explanation, without recurring to nitrous ſalts ſuppoſed to be contained in it. It may be rationally aſcribed to its furniſhing a covering to the roots of vegetables, by which they are guarded from the influence of the atmoſpheric cold, and the internal heat of the earth is prevented from eſcaping.

The internal part of the earth, by ſome principle which we do not underſtand, is heated uniformly to the 48th degree of Fahrenheit's thermometer. This degree of heat is greater than that in which the watery juices of vegetables freeze, and it is propagated from the inward parts of the earth to the ſurface, on which the vegetables grow. The atmoſphere being variably heated by the action of the ſun in different climates, and in the ſame climate at different ſeaſons, communicates to the ſurface of the earth and to ſome diſtance below it the degree of heat or cold which prevails in itſelf. Different vegetables are able to preſerve life under different degrees of cold, but all of them periſh when the cold which reaches their roots is extreme. Providence has therefore, in the coldeſt climates, provided a covering of ſnow for the roots of vegetables, by which they are protected from the influence of the atmoſpherical cold. The ſnow keeps in the internal heat of the earth, which ſurrounds the roots of vegetables, and defends them from the cold of the atmoſphere.

Snow or ice water is always deprived of its fixed air, which eſcapes during the proceſs of congelation. Accordingly, as ſome of the inhabitants of the Alps who uſe it for their conſtant drink have enormous wens upon their throats, it has been aſcribed to this circumſtance. If this were the cauſe of theſe wens, it would be eaſy to remove it by expoſing the ſnow-water to the air for ſome time. But ſeveral eminent phyſicians have rejected the notion that ſnow-water is the cauſe of theſe wens; for in Greenland, where ſnow-water is commonly uſed, the inhabitants are not affected with ſuch ſwellings: on the other hand, they are common in Sumatra where ſnow is never ſeen.

Snow, in ſea-affairs, is generally the largeſt of all two-maſted veſſels employed by Europeans, and the moſt convenient for navigation.

The ſails and rigging on the mainmaſt and foremaſt of a ſnow are exactly ſimilar to thoſe on the ſame maſts in a ſhip; only that there is a ſmall maſt behind the mainmaſt of the former, which carries a ſail nearly reſembling the mizen of a ſhip. The root of the maſt is fixed on a block of wood on the quarter-deck abaft the mainmaſt; and the head of it is attached to the aftertop of the maintop. The ſail which is called the *tryſail* is extended from its maſt towards the ſtern of the veſſel.

When the ſloops of war are rigged as ſnows, they are furniſhed with a horſe, which anſwers the purpoſe of the tryſail-maſt, the fore-part of the ſail being attached by rings to the ſaid horſe, in different parts of its height.

Snow-Grotto, an excavation made by the waters on the ſide of Mount Etna, by making their way under the layers of lava, and by carrying away the bed of pozzolana below them. It occurred to the proprietor, that this place was very ſuitable for a magazine of ſnow: for in Sicily, at Naples, and particularly at Malta, they are obliged for want of ice to make uſe of ſnow for cooling their wine, ſherbet, and other liquors, and for making ſweetmeats.

This grotto was hired or bought by the knights of Malta, who having neither ice nor ſnow on the burning rock which they inhabit, have hired ſeveral caverns on Etna, into which people whom they employ collect and preſerve quantities of ſnow to be ſent to Malta when needed The grotto has therefore been repaired within at the expence of that order; flights of ſteps are cut into it, as well as two openings from above, by which they throw in the ſnow, and through which the grotto is enlightened. Above the grotto they have alſo levelled a piece of ground of conſiderable extent: this they have incloſed with thick and lofty walls, ſo that when the winds, which at this elevation blow with great violence, carry the ſnow from the higher parts of the mountains, and depoſit it in the incloſure, it is retained and amaſſed by the walls. The people then remove it into the grotto through the two openings; and it is there laid up, and preſerved in ſuch a manner as to reſiſt the force of the ſummer heats; as the layers of lava with which the grotto is arched above prevent them from making any impreſſion.

When the ſeaſon for exporting the ſnow comes on, it is put into large bags, into which it is preſſed as cloſely as poſſible; it is then carried by men out of the grotto, and laid upon mules, which convey it to the ſhore, where ſmall veſſels are waiting to carry it away.

But before thoſe lumps of ſnow are put into bags, they are wrapped in freſh leaves; ſo that while they are conveyed from the grotto to the ſhore, the leaves may prevent the rays of the ſun from making any impreſſion upon them.

The Sicilians carry on a conſiderable trade in ſnow, which affords employment to ſome thouſands of mules, horſes, and men. They have magazines of it on the ſummits of their loftieſt mountains, from which they diſtribute it through all their cities, towns, and houſes; for every perſon in the iſland makes uſe of ſnow. They conſider the practice of cooling their liquors as abſolutely neceſſary for the preſervation of health; and in a climate, the heat of which is conſtantly relaxing the fibres, cooling liquors, by communicating a proper tone to the fibres of the ſtomach, muſt greatly ſtrengthen them for the performance of their functions.

In this climate a ſcarcity of ſnow is no leſs dreaded than a ſcarcity of corn, wine, or oil. We are informed by a gentleman who was at Syracuſe in the year 1777, when there was a ſcarcity of ſnow, the people of the town learned that a ſmall veſſel loaded with that article was paſſing the coaſt: without a moment's deliberation they ran in a body to the ſhore, and demanded her cargo; which, when the crew refuſed to deliver up, the Syracuſans attacked and took, though with the loſs of ſeveral men.

Snow-Drop. See Chionanthus, Botany *Index*.

SNOWDON hill, the name of a mountain in Caernarvon-ſhire in Wales, generally thought to be the higheſt in Britain; though ſome have been of opinion that its height is equalled, or even exceeded, by mountains in the Highlands of Scotland. The mountain is ſurrounded by many others, called in the Welſh language *Crib Coch*, *Crib y Diſtill*, *Lliweddy yr Arran*, &c.

According to Mr Pennant *, this mountainous tract yields ſcarcely any corn. Its produce is cattle and ſheep; which, during ſummer, keep very high in the mountains, followed by their owners with their families, who reſide during that ſeaſon in *havodtys*, or "ſummer dairy-houſes," as the farmers in the Swiſs Alps do in their *ſennes*. Theſe houſes conſiſt of a long low room, with a hole at one end to let out the ſmoke from the fire which is made beneath. Their furniture is very ſimple; ſtones are ſubſtituted for ſtools, and their beds are of hay, ranged along the ſides. They manufacture their own clothes, and dye them with the *lichen omphaloides* and *lichen parietinus*, moſſes collected from the rocks. During ſummer the men paſs their time in tending their herds or in making hay, &c. and the women in milking or in making butter and cheeſe. For their own uſe they milk both ewes and goats, and make cheeſe of the milk. Their diet conſiſts of milk, cheeſe, and butter; and their ordinary drink is whey; though they have, by way of reſerve, a few bottles of very ſtrong beer, which they uſe as a cordial when ſick. They are people of good underſtanding, wary, and circumſpect; tall, thin,

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* *Journey to Snowdon.*

thin, and of ſtrong conſtitutions. In the winter-time they deſcend into the *hen-dref*, or “ old dwelling,” where they paſs their time in inactivity.

The view from the higheſt peak of Snowdon is very extenſive. From it Mr Pennant ſaw the county of Cheſter, the high hills of Yorkſhire, part of the north of England, Scotland, and Ireland; a plain view of the iſle of Man; and that of Angleſea appeared like a map extended under his feet, with every rivulet viſible. Our author took much pains to have this view to advantage; ſat up at a farm on the weſt till about 12, and walked up the whole way. The night was remarkably fine and ſtarry; towards morning the ſtars faded away, leaving an interval of darkneſs, which, however, was ſoon diſpelled by the dawn of day. The body of the ſun appeared moſt diſtinct, with the roundneſs of the moon, before it appeared too brilliant to be looked at. The ſea, which bounded the weſtern part of the proſpect, appeared gilt with the ſun-beams, firſt in ſlender ſtreaks, and at length glowed with redneſs. The proſpect was diſcloſed like the gradual drawing up of a curtain in a theatre; till at laſt the heat became ſufficiently ſtrong to raiſe miſts from the various lakes, which in a ſlight degree obſcured the proſpect. The ſhadow of the mountain extended many miles, and ſhowed its bicapitated form; the Wyddfa making one head, and Crib y Diſtill the other. At this time he counted between 20 and 30 lakes either in Caernarvon or in Merionethſhire. In making another viſit, the ſky was obſcured very ſoon after he got up. A vaſt miſt involved the whole circuit of the mountain, and the proſpect down was horrible. It gave an idea of numbers of abyſſes, concealed by a thick ſmoke furiouſly circulating around them. Very often a guſt of wind made an opening in the clouds, which gave a fine and diſtinct viſta of lake and valley. Sometimes they opened in one place, at others in many at once; exhibiting a moſt ſtrange and perplexing ſight of water, fields, rocks, and chaſms. They then cloſed again, and every thing was involved in darkneſs; in a few minutes they would ſeparate again, and repeat the above-mentioned ſcene with infinite variety. From this proſpect our traveller deſcended with great reluctance; but before he had reached the place where his horſes were left, he was overtaken by a thunder ſtorm. The rolling of the thunder-claps, being reiterated by the mountains, was inexpreſſibly awful; and after he had mounted, he was in great danger of being ſwept away by the torrents which poured down in conſequence of a very heavy rain.

It is very rare (Mr Pennant obſerves) that the traveller gets a proper day to aſcend this hill: it indeed often appears clear; but by the evident attraction of the clouds by this lofty mountain, it becomes ſuddenly and unexpectedly enveloped in miſt, when the clouds have juſt before appeared very high and very remote. At times he obſerved them lower to half their height; and notwithſtanding they have been diſperſed to the right and left, yet they have met from both ſides, and united to involve the ſummit in one great obſcurity.

The height of Snowdon was meaſured, in 1682, by Mr Caſwell, with inſtruments made by Flamſtead: according to his menſuration, the height is 3720 feet; but more moderate computations make it only 3568, reckoning from the quay at Caernarvon to the higheſt peak. The ſtone that compoſes this mountain is exceſſively hard. Large coarſe cryſtals, and frequently cubic pyrites, are found in the fiſſures. An immenſe quantity of water ruſhes down the ſides of Snowdon and the neighbouring mountains, inſomuch that Mr Pennant ſuppoſes, if collected into one ſtream, they would exceed the waters of the Thames.

SNUFF, a powder chiefly made of tobacco, the uſe of which is too well known to need any deſcription here.

Tobacco is uſually the baſis of ſnuff; other matters being only added to give it a more agreeable ſcent, &c. The kinds of ſnuff, and their ſeveral names, are infinite, and new ones are daily invented; ſo that it would be difficult, not to ſay impoſſible, to give a detail of them. We ſhall only ſay, that there are three principal ſorts: the firſt granulated; the ſecond an impalpable powder; and the third the bran, or coarſe part remaining after ſifting the ſecond ſort.

“ Every profeſſed, inveterate, and incurable ſnuff-taker (ſays Lord Stanhope), at a moderate computation, takes one pinch in ten minutes. Every pinch, with the agreeable ceremony of blowing and wiping the noſe and other incidental circumſtances, conſumes a minute and a half. One minute and a half out of every ten, allowing 16 hours to a ſnuff-taking day, amounts to two hours and 24 minutes out of every natural day, or one day out of every ten. One day out of every 10 amounts to 36 days and a half in a year. Hence if we ſuppoſe the practice to be perſiſted in 40 years, two entire years of the ſnuff-taker's life will be dedicated to tickling his noſe, and two more to blowing it. The expence of ſnuff, ſnuff-boxes, and handkerchiefs, will be the ſubject of a ſecond eſſay; in which it will appear, that this luxury encroaches as much on the income of the ſnuff-taker as it does on his time; and that by a proper application of the time and money thus loſt to the public, a fund might be conſtituted for the diſcharge of the national debt.” See NICOTIANA.

SNYDERS, FRANCIS, a Flemiſh painter, born at Antwerp in 1579, and bred under his countryman Henry Van Balen. His genius firſt diſplayed itſelf in painting fruit: he afterwards attempted animals, huntings, &c. in which he exceeded all his predeceſſors. He alſo painted kitchens, &c. and gave dignity to ſubjects that ſeemed incapable of it. He was made painter to Ferdinand and Iſabella, archduke and ducheſs, and became attached to the houſe of the cardinal infant of Spain. The king of Spain and the elector Palatine adorned their palaces with huntings by this artiſt. Rubens, Jordaens, and Snyders, uſed to co-operate in the enriching of each other's pictures according to their ſeveral talents; and thus they became more valuable than if finiſhed by either of them ſingly. Snyders died in 1657.

SOAL-FISH. See PLEURONECTES, ICHTHYOLOGY *Index*.

SOAP, a compoſition of cauſtic, fixed alkaline ſalt, and oil, ſometimes hard and dry, ſometimes ſoft and liquid; much uſed in waſhing, whitening linens, and by dyers and fullers.—Soap may be made by ſeveral methods, which, however, all depend upon the ſame principle. The ſoap which is uſed in medicine is made without heat.

In manufactures where large quantities of it are prepared, ſoap is made with heat. A lixivium of quicklime and

and ſoda is made, but is leſs concentrated than that above referred to, and only ſo much that it can ſuſtain a freſh egg. A part of this lixivium is to be even diluted and mixed with an equal weight of oil of olives. The mixture is to be put on a gentle fire, and agitated, that the union may be accelerated. When the mixture begins to unite well, the reſt of the lixivium is to be added to it; and the whole is to be digeſted with a very gentle heat, till the ſoap be completely made. A trial is to be made of it, to examine whether the juſt proportion of oil and alkali has been obſerved. Good ſoap of this kind ought to be firm, and very white when cold; not ſubject to become moiſt by expoſure to air, and entirely miſcible with pure water, to which it communicates a milky appearance, but without any drops of oil floating on the ſurface. When the ſoap has not theſe qualities, the combination has not been well made, or the quantity of ſalt or oil is too great, which faults muſt be corrected.

In ſoft or liquid ſoaps, green or black ſoaps, cheaper oils are employed, as oil of nuts, of hemp, of fiſh, &c. Theſe ſoaps, excepting in conſiſtence, are not eſſentially different from white ſoap.

Fixed alkalies are much diſpoſed to unite with oils that are not volatile, both vegetable and animal, ſince this union can be made even without heat. The compound reſulting from this union partakes at the ſame time of the properties of oil and of alkali; but theſe properties are modified and tempered by each other, according to the general rule of combinations. Alkali formed into ſoap has not nearly the ſame acrimony as when it is pure; it is even deprived of almoſt all its cauſticity, and its other ſaline alkaline properties are almoſt entirely aboliſhed. The ſame oil contained in ſoap is leſs combuſtible, than when pure, from its union with the alkali, which is an uninflammable body. It is miſcible, or even ſoluble, in water, to a certain degree, by means of the alkali. Soap is entirely ſoluble in ſpirit of wine; and ſtill better in aquavitæ ſharpened by a little alkaline ſalt, according to an obſervation of Mr Geoffroy.

The manufacture of ſoap in London firſt began in the year 1524; before which time this city was ſerved with white ſoap from foreign countries, and with gray ſoap ſpeckled with white from Briſtol, which was ſold for a penny a pound; and alſo with black ſoap, which ſold for a halfpenny the pound.

The principal ſoaps of our own manufacture are the ſoft, the hard, and the ball ſoap. The ſoft ſoap is either white or green. The proceſs of making each of theſe ſhall now be deſcribed.

Green ſoft ſoap. The chief ingredients uſed in making this are lees drawn from potaſh and lime, boiled up with tallow and oil. Firſt, the ley of a proper degree of ſtrength (which muſt be eſtimated by the weight of the liquor), and tallow, are put into the copper together, and as ſoon as they boil up the oil is added; the fire is then damped or ſtopped up, while the ingredients remain in the copper to unite; when they are united, the copper is again made to boil, being fed or filled with lees as it boils, till there be a ſufficient quantity put into it; then it is boiled off and put into caſks. When this ſoap is firſt made it appears uniform; but in about a week's time the tallow ſeparates from the oil into thoſe white grains which we ſee in common ſoap. Soap thus made would appear yellow, but by a mixture of indigo added at the end of the boiling, it is rendered green, that being the colour which reſults from the mixture of yellow and blue.

White ſoap. Of this one ſort is made after the ſame manner as green ſoft ſoap, oil alone excepted, which is not uſed in white. The other ſort of white ſoft ſoap is made from the lees of aſhes of lime boiled up two different times with tallow. Firſt, a quantity of lees and tallow are put into the copper together, and kept boiling, being fed with lees as they boil, until the whole is boiled ſufficiently; then the lees are ſeparated or diſcharged from the tallowiſh part, which part is removed into a tub, and the lees are thrown away; this is called the *firſt half-boil:* then the copper is filled again with freſh tallow and lees, and the firſt half-boil is put out of the tub into the copper a ſecond time, where it is kept boiling with freſh lees and tallow till the ſoap is produced. It is then put out of the copper into the ſame ſort of caſks as are uſed for green ſoft ſoap. The common ſoft ſoap uſed about London, generally of a greeniſh hue, with ſome white lumps, is prepared chiefly with tallow: a blackiſh ſort, more common in ſome other places, is ſaid to be made with whale oil.

Hard ſoap is made with lees from aſhes and tallow, and is moſt commonly boiled twice: the firſt, called the *half-boil*, hath the ſame operation as the firſt half-boil of ſoft white ſoap. Then the copper is charged with freſh lees again, and the firſt half-boil put into it, where it is kept boiling, and fed with lees as it boils, till it grains or is boiled enough: then the ley is diſcharged from it, and the ſoap put into a frame to cool and harden. Common ſalt is made uſe of for the purpoſe of graining the ſoap; for when the oil or tallow has been united with the ley, after a little boiling, a quantity of ſalt is thrown into the maſs, which diſſolving readily in water, but not in the oil or tallow, draws out the water in a conſiderable degree, ſo that the oil or tallow united with the ſalt of the ley ſwims on the top. When the ley is of a proper ſtrength, leſs ſalt is neceſſary to raiſe the curd than when it is too weak. It muſt be obſerved, that there is no certain time for bringing off a boiling of any of theſe ſorts of ſoap: it frequently takes up part of two days.

Ball ſoap, commonly uſed in the north, is made with lees from aſhes and tallow. The lees are put into the copper, and boiled till the watery part is quite gone, and there remains nothing in the copper but a ſort of ſaline matter (the very ſtrength or eſſence of the ley); to this the tallow is put, and the copper is kept boiling and ſtirring for above half an hour, in which time the ſoap is made; and then it is put out of the copper into tubs or baſkets with ſheets in them, and immediately (whilſt ſoft) made into balls. It requires near 24 hours in this proceſs to boil away the watery part of the ley.

When oil unites with alkali in the formation of ſoap, it is little altered in the connection of its principles; for it may be ſeparated from the alkali by decompoſing ſoap with any acid, and may be obtained nearly in its original ſtate.

Concerning the decompoſition of ſoap by means of acids, we muſt obſerve, firſt, that all acids, even the weakeſt vegetable acids, may occaſion this decompoſition, becauſe every one of them has a greater affinity than

than oil with fixed alkali. Secondly, theſe acids, even when united with any baſis, excepting fixed alkali, are capable of occaſioning the ſame decompoſition; whence all ammoniacal ſalts, all ſalts with baſes of earth, and all thoſe with metallic baſes, are capable of decompoſing ſoap, in the ſame manner as diſengaged acids are; with this difference, that the oil ſeparated from the fixed alkali, by the acid of theſe ſalts, may unite more or leſs intimately with the ſubſtance which was the baſis of the neutral ſalt employed for the decompoſition.

Soap may alſo be decompoſed by diſtillation, as Lemery has done. When firſt expoſed to fire, it yields a phlegm called by him a *ſpirit;* which nevertheleſs is neither acid nor alkaline, but ſome water which enters into the compoſition of ſoap. It becomes more and more coloured and empyreumatic as the fire is increaſed, which ſhows that it contains the moſt ſubtle part of the oil. It ſeems even to raiſe along with it, by help of the oil and action of the fire, a ſmall part of the alkali of the ſoap: for as the ſame chemiſt obſerves, it occaſions a precipitate in a ſolution of corroſive ſublimate. After this phlegm the oil riſes altered, preciſely as if it had been diſtilled from quicklime, that is, empyreumatic, ſoluble in ſpirit of wine, at firſt ſufficiently ſubtle and afterwards thicker. An alkaline reſiduous coal remains in the retort, conſiſting chiefly of the mineral alkali contained in the ſoap, and which may be diſengaged from the coal by calcination in an open fire, and obtained in its pure ſtate.

Alkaline ſoaps are very uſeful in many arts and trades, and alſo in chemiſtry and medicine. Their principal utility conſiſts in a deterſive quality that they receive from their alkali, which, although it is in ſome meaſure ſaturated with oil, is yet capable of acting upon oily matters, and of rendering them ſaponaceous and miſcible with water. Hence ſoap is very uſeful to cleanſe any ſubſtances from all fat matters with which they happen to be ſoiled. Soap is therefore daily uſed for the waſhing and whitening of linen, for the cleanſing of woollen cloths from oil, and for whitening ſilk and freeing it from the reſinous varniſh with which it is naturally covered. Pure alkaline lixiviums being capable of diſſolving oils more effectually than ſoap, might be employed for the ſame purpoſes; but when this activity is not mitigated by oil, as it is in ſoap, they are capable of altering, and even of deſtroying entirely by their cauſticity, moſt ſubſtances, eſpecially animal matters, as ſilk, wool, and others: whereas ſoap cleanſes from oil almoſt as effectually as pure alkali, without danger of altering or deſtroying; which renders it very uſeful.

Woodville's Medical Botany, p. 390.

Soap was imperfectly known to the ancients. It is mentioned by Pliny as made of fat and aſhes, and as an invention of the Gauls. Aretæus and others inform us, that the Greeks obtained their knowledge of its medical uſe from the Romans. Its virtues, according to Bergius, are detergent, reſolvent, and aperient, and its uſe recommended in jaundice, gout, calculous complaints, and in obſtructions of the viſcera. The efficacy of ſoap in the firſt of theſe diſeaſes was experienced by Sylvius, and ſince recommended very generally by various authors who have written on this complaint; and it has alſo been thought of uſe in ſupplying the place of bile in the primæ viæ. The utility of this medicine in icterical caſes was inferred chiefly from its ſuppoſed power of diſſolving biliary concretions; but this medicine has loſt much of its reputation in jaundice, ſince it is now known that gall-ſtones have been found in many after death who had been daily taking ſoap for ſeveral months and even years. Of its good effects in urinary calculous affections, we have the teſtimony of ſeveral, eſpecially when diſſolved in lime-water, by which its efficacy is conſiderably increaſed; for it thus becomes a powerful ſolvent of mucus, which an ingenious modern author ſuppoſes to be the chief agent in the formation of calculi; it is, however, only in the incipient ſtate of the diſeaſe that theſe remedies promiſe effectual benefit; though they generally abate the more violent ſymptoms where they cannot remove the cauſe. With Boerhaave ſoap was a general medicine: for as he attributed moſt complaints to viſcidity of the fluids, he, and moſt of the Boerhaavian ſchool, preſcribed it in conjunction with different reſinous and other ſubſtances, in gout, rheumatiſm, and various viſceral complaints. Soap is alſo externally employed as a reſolvent, and gives name to ſeveral officinal preparations.

From the properties of ſoap we may know that it muſt be a very effectual and convenient anti-acid. It abſorbs acids as powerfully as pure alkalies and abſorbent earths, without having the cauſticity of the former, and without oppreſſing the ſtomach by its weight like the latter.

Laſtly, we may perceive that ſoap muſt be one of the beſt of all antidotes to ſtop quickly, and with the leaſt inconvenience, the bad effects of acid corroſive poiſons, as aquafortis, corroſive ſublimate, &c.

Soap imported is ſubject by 10 Ann. cap. 19. to a duty of 2d. a pound (over and above former duties); and by 12 Ann. ſtat. 2. cap. 9. to the farther ſum of 1d. a-pound. And by the ſame acts, the duty on ſoap made in the kingdom is 1½d. a-pound. By 19 G. III. cap. 52. no perſon within the limits of the head office of exciſe in London ſhall be permitted to make any ſoap unleſs he occupy a tenement of 10l. a year, be aſſeſſed, and pay the pariſh rates; or elſewhere, unleſs he be aſſeſſed, and pay to church and poor. Places of making are to be entered on pain of 50l. and covers and locks to be provided under a forfeiture of 100l.; the furnace-door of every utenſil uſed in the manufacture of ſoap ſhall be locked by the exciſe officer, as ſoon as the fire is damped or drawn out, and faſtenings provided, under the penalty of 50l.; and opening or damaging ſuch faſtening incurs a penalty of 100l. Officers are required to enter and ſurvey at all times, by day or night, and the penalty of obſtructing is 20l.; and they may unlock and examine every copper, &c. between the hours of five in the morning and eleven in the evening, and the penalty of obſtructing is 100l. Every maker of ſoap before he begins any making, if within the bills of mortality, ſhall give 12 hours, if elſewhere 24 hours, notice in writing to the officer, of the time when he intends to begin, on pain of 50l. No maker ſhall remove any ſoap unſurveyed on pain of 20l. without giving proper notice of his intention. And if any maker ſhall conceal any ſoap or materials, he ſhall forfeit the ſame, and alſo 500l. Every barrel of ſoap ſhall contain 256lb. avoirdupois, half barrel 128lb. firkin 64 lb. half-firkin 32 lb. beſides the weight or tare of each caſk: and all ſoap, excepting hard cake ſoap and ball ſoap, ſhall be put into ſuch caſks and no other, on pain of forfeiture, and 5l. The maker ſhall,

weekly

weekly enter in writing at the next office the ſoap made by him in each week, with the weight and quantity at each boiling, on pain of 50l.; and within one week after entry clear off the duties, on pain of double duty. See, beſides the ſtatutes above cited, 5 Geo. III. cap. 43. 12 Geo. III. cap. 46. 11 Geo. cap. 30. 1 Geo. ſtat. 2. cap. 36.

Acid SOAP. This is formed by the addition of concentrated acids to the expreſſed oils. Thus the oil is rendered partially ſoluble in water; but the union is not ſufficiently complete to anſwer any valuable purpoſe.

SOAP-Berry Tree. See SAPINDUS, BOTANY *Index.*

SOAP-Earth. See STEATITES, MINERALOGY *Index.*

SOAPWORT. See SAPONARIA, BOTANY *Index.*

SOC (Sax.), ſignifies power or liberty to miniſter juſtice or execute laws; alſo the circuit or territory wherein ſuch power is exerciſed. Whence our law-Latin word *ſocca* is uſed for a ſeigniory or lordſhip enfranchiſed by the king, with the liberty of holding or keeping a court of his *ſockmen:* And this kind of liberty continues in divers parts of England to this day, and is known by the names of *ſoke* and *ſoken.*

SOCAGE, in its moſt general and extenſive ſignification, ſeems to denote a tenure by any certain and determinate ſervice. And in this ſenſe it is by our ancient writers conſtantly put in oppoſition to chivalry or knight-ſervice, where the render was precarious and uncertain. The ſervice muſt therefore be certain, in order to denominate it ſocage; as to hold by fealty and 20s. rent; or, by homage, fealty, and 20s. rent; or, by homage and fealty without rent; or, by fealty and certain corporal ſervice, as ploughing the lord's land for three days; or, by fealty only without any other ſervice: for all theſe are tenures in ſocage.

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Socage is of two ſorts: *free-*ſocage, where the ſervices are not only certain but honourable; and *villein-*ſocage, where the ſervices, though certain, are of a baſer nature (ſee VILLENAGE). Such as hold by the former tenure are called, in Glanvil and other ſubſequent authors, by the name of *liberi ſokemanni,* or tenants in free-ſocage. The word is derived from the Saxon appellation *ſoc,* which ſignifies liberty or privilege; and, being joined to an uſual termination, is called *ſocage,* in Latin *ſocagium;* ſignifying thereby a free or privileged tenure.

It ſeems probable that the ſocage-tenures were the relics of Saxon liberty; retained by ſuch perſons as had neither forfeited them to the king, nor been obliged to exchange their tenure for the more honourable, as it was called, but at the ſame time more burthenſome, tenure of knight-ſervice. This is peculiarly remarkable in the tenure which prevails in Kent, called *gavelkind,* which is generally acknowledged to be a ſpecies of ſocage-tenure; the preſervation whereof inviolate from the innovations of the Norman conqueror is a fact univerſally known. And thoſe who thus preſerved their liberties were ſaid to hold in free and common ſocage.

As therefore the grand criterion and diſtinguiſhing mark of this ſpecies of tenure are the having its renders or ſervices aſcertained, it will include under it all other methods of holding free lands by certain and invariable rents and duties; and in particular, *Petit SERJEANTY, Tenure in BURGAGE,* and GAVELKIND. See theſe articles.

1 finition.

SOCIETY, a number of rational and moral beings, united for their common preſervation and happineſs.

2 How far brutes are capable of a ſocial ſtate.

There are ſhoals of fiſhes, herds of quadrupeds, and flocks of birds. But till obſervation enable us to determine with greater certainty, how far the inferior animals are able to look through a ſeries of means to the end which theſe are calculated to produce, how far their conduct may be influenced by the hope of reward and the fear of puniſhment, and whether they are at all capable of moral diſtinctions—we cannot with propriety apply to them the term *Society.* We call crows and beavers, and ſeveral other ſpecies of animals, *gregarious;* but it is hardly good Engliſh to ſay that they are *ſocial.*

3 Mankind the only ſocial beings ſubject to our obſervation

It is only human ſociety, then, that can become the ſubject of our preſent inveſtigation. The phenomena which it preſents are highly worthy of our notice.

4 A ſocial and a ſavage ſtate.

Such are the advantages which each individual evidently derives from living in a ſocial ſtate; and ſo helpleſs does any human being appear in a ſolitary ſtate, that we are naturally led to conclude, that if there ever was a period at which mankind were ſolitary beings, that period could not be of long duration; for their averſion to ſolitude and love of ſociety would ſoon induce them to enter into ſocial union. Such is the opinion which we are led to conceive, when we compare our own condition as members of civilized and enlightened ſociety with that of the brutes around us, or with that of ſavages in the earlier and ruder periods of ſocial life. When we hear of Indians wandering naked through the woods, deſtitute of arts, unſkilled in agriculture, ſcarce capable of moral diſtinctions, void of all religious ſentiments, or poſſeſſed with the moſt abſurd notions concerning ſuperior powers, and procuring means of ſubſiſtence in a manner equally precarious with that of the beaſts of prey—we look down with pity on their condition, or turn from it with horror. When we view the order of cultivated ſociety, and conſider our inſtitutions, arts, and manners—we rejoice over our ſuperior wiſdom and happineſs.

Man in a civilized ſtate appears a being of a ſuperior order to man in a ſavage ſtate; yet ſome philoſophers tell us, that it is only he who, having been educated in ſociety, has been taught to depend upon others, that can be helpleſs or miſerable when placed in a ſolitary ſtate. They view the ſavage who exerts himſelf with intrepidity to ſupply his wants, or bears them with fortitude, as the greateſt hero, and poſſeſſing the greateſt happineſs. And therefore if we agree with them, that the propenſities of nature may have prompted men to enter into ſocial union, though they may have hoped to enjoy ſuperior ſecurity and happineſs by engaging to protect and ſupport each other, we muſt conclude that the Author of the univerſe has deſtined man to attain greater dignity and happineſs in a ſavage and ſolitary than in a ſocial ſtate; and therefore that theſe diſpoſitions and views which lead us to ſociety are fallacious and inimical to our real intereſt.

Whatever be the ſuppoſed advantages of a ſolitary ſtate, certain it is that mankind, at the earlieſt periods, were united in ſociety. Various theories have been formed concerning the circumſtances and principles which gave riſe to this union: but we have elſewhere ſhown, that the greater part of them are founded in error; that they ſuppoſe the original ſtate of man to have been

been that of ſavages; and that ſuch a ſuppoſition is contradicted by the moſt authentic records of antiquity. For though the records of the earlier ages are generally obſcure, fabulous, and imperfect; yet happily there is *one* free from the imperfections of the reſt, and of undoubted authenticity, to which we may ſafely have recourſe *. This record is the Pentateuch of Moſes, which preſents us with a genuine account of the origin of man and of ſociety, perfectly conſonant to what we have laid down in the article referred to (ſee SAVAGE).

5
First ſtate of ſociety according to authentic hiſtory.

According to Moſes, the firſt ſociety was that of a huſband and wife united in the bonds of marriage: the firſt government that of a father and huſband, the maſter of his family. Men lived together under the patriarchal form of government while they employed themſelves chiefly in tending flocks and herds. Children in ſuch circumſtances cannot ſoon riſe to an equality with their parents, where a man's importance depends on his property, not on his abilities. When flocks and herds are the chief articles of property, the ſon can only obtain theſe from his father; in general therefore the ſon muſt be entirely dependent on the father for the means of ſubſiſtence. If the parent during his life beſtow on his children any part of his property, he may do it on ſuch conditions as ſhall make their dependence upon him continue till the period of his death. When the community are by this event deprived of their head, inſtead of continuing in a ſtate of union, and ſelecting ſome one from among themſelves whom they may inveſt with the authority of a parent, they ſeparate into ſo many diſtinct tribes, each ſubjected to the authority of a different lord, the maſter of the family, and the proprietor of all the flocks and herds belonging to it. Such was the ſtate of the firſt ſocieties which the narrative of Moſes exhibits to our attention.

6
Theories of philoſophers concerning the origin of ſociety

Thoſe philoſophers who have made ſociety, in its various ſtages between rudeneſs and refinement, the ſubject of their ſpeculations, have generally conſidered mankind, in whatever region of the globe, and under whatever climate, as proceeding uniformly through certain regular gradations from one extreme to the other. They regard them, firſt, as gaining a precarious ſubſiſtence by gathering the ſpontaneous fruits of the earth, preying on the inhabitants of the waters, if placed on the ſea-ſhore, or along the banks of large rivers; or hunting wild beaſts, if in a ſituation where theſe are to be found in abundance; without foreſight or induſtry to provide for future wants when the preſent call of appetite is gratified. Next, they ſay, man riſes to the ſhepherd ſtate, and next to that of huſbandmen, when they turn their attention from the management of flocks to the cultivation of the ground. Next, theſe huſbandmen improve their powers, and better their condition, by becoming artizans and merchants; and the beginning of this period is the boundary between barbarity and civilization.

Theſe are the ſtages through which they who have employed themſelves on the natural hiſtory of ſociety have generally conducted mankind in their progreſs from rudeneſs to refinement: but they ſeem to have overlooked the manner in which mankind were at firſt eſtabliſhed on this earth; for the circumſtances in which the parents of the human race were originally placed; for the degree of knowledge communicated to them; and for the inſtruction which they muſt have been capable of communicating to their poſterity. They rather appear to conſider the inhabitants of every different region of the globe as aborigines, ſpringing at firſt from the ground, or dropped on the ſpot which they inhabit; no leſs ignorant than infants of the nature and relations of the objects around them, and of the purpoſes which they may accompliſh by the exerciſe of their organs and faculties.

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The abſurdity of this theory has been fully demonſtrated in another place: and if we agree to receive the Moſaic account of the original eſtabliſhment of mankind, we ſhall be led to view the phenomena of ſocial life in a light very different. We muſt firſt allow, that though many of the rudeſt tribes are found in the ſtate of *hunters* or *fiſhers*; yet the hunting or fiſhing ſtate cannot have been invariably the primary form of ſociety. Notwithſtanding the powers with which we are endowed, we are in a great meaſure the creatures of circumſtances. Phyſical cauſes exert, though indirectly, a mighty influence in forming the character and directing the exertions of the human race. From the information of Moſes we gather, that the firſt ſocieties of men lived under the patriarchal form of government, and employed themſelves in the cultivation of the ground and the management of flocks. And as we know that mankind, being ſubjected to the influence both of phyſical and moral cauſes, are no leſs liable to degeneracy than capable of improvement; we may eaſily conceive, that though deſcending all from the ſame original pair, and though enlightened with much traditionary knowledge relative to the arts of life, the order of ſociety, moral diſtinctions, and religious obligations; yet as they were gradually, and by various accidents, diſperſed over the earth, being removed to ſituations in which the arts with which they were acquainted could but little avail them, where induſtry was overpowered, or indolence encouraged, by the ſeverity or the profuſion of nature, they might degenerate and fall into a condition almoſt as humble and precarious as that of the brutal tribes. Other moral cauſes might alſo concur to debaſe or elevate the human character in that early period. The particular character of the original ſettlers in any region, the manner in which they were connected with one another, and the arts which they were beſt qualified to exerciſe, with various other cauſes of a ſimilar nature, would have conſiderable influence in determining the character of the ſociety.

When laying aſide the ſpirit of theory and ſyſtem, we ſet ourſelves, with due humility, to trace facts, and to liſten to evidence, though our diſcoveries may be fewer than we ſhould otherwiſe fancy them; yet the knowledge which we thus acquire will be more uſeful and ſolid, and our ſpeculations more conſiſtent with the ſpirit of true philoſophy. Here, though we learn from the information of the ſacred writings, that the firſt family of mankind was not cruelly expoſed in this world, as children whom the inhumanity of their parents induces them to deſert; yet we are not, in conſequence of admitting this fact, laid under any neceſſity of denying or explaining away any of the other phenomena which occur to our obſervation when tracing the natural hiſtory of ſociety. Tradition may be corrupted; arts and ſciences may be loſt; the ſublimeſt religious doctrines may be debaſed into abſurdity.

If then we are deſirous of ſurveying ſociety in its rudeſt

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* See *Scripture*, N° 7—15.

deſt form, we muſt look, not to the earlieſt period of its exiſtence, but to thoſe diſtricts of the globe where external circumſtances concur to drive them into a ſtate of ſtupidity and wretchedneſs. Thus in many places of the happy clime of Aſia, which a variety of ancient records concur with the ſacred writings in repreſenting as the firſt peopled quarter of the globe, we cannot trace the form of ſociety backwards beyond the ſhepherd ſtate. In that ſtate indeed the bonds which connect ſociety extend not to a wide range of individuals, and men remain for a long period in diſtinct families; but yet that ſtate is highly favourable to knowledge, to happineſs, and to

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virtue. Again, the torrid and the frozen regions of the earth, though probably peopled at a later period, and by tribes ſprung from the ſame ſtock with the ſhepherds of Aſia, have yet exhibited mankind in a much lower ſtate. It is in the parched deſerts of Africa and the wilds of America that human beings have been found in a condition approaching the neareſt to that of the brutes.

We may therefore with ſome propriety deſert the order of time, and take a view of the different ſtages through which philoſophers have conſidered mankind as advancing, beginning with that of rudeneſs, though we have ſhown that it cannot have been the firſt in the progreſs.

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deſt ſtate
firſt ſtage
ſociety.

Where the human ſpecies are found in the loweſt and rudeſt ſtate, their rational and moral powers are very faintly diſplayed; but their external ſenſes are acute, and their bodily organs active and vigorous. Hunting and fiſhing are then their chief employments on which they depend for ſupport. During that portion of their time which is not ſpent in theſe purſuits, they are ſunk in liſtleſs indolence. Deſtitute of foreſight, they are rouſed to active exertion only by the preſſure of immediate neceſſity or the urgent calls of appetite. Accuſtomed to endure the ſeverity of the elements, and but ſcantily provided with the means of ſubſiſtence, they acquire habits of reſignation and fortitude, which are beheld with aſtoniſhment by thoſe who enjoy the plenty and indulgence of cultivated life. But in this ſtate of want and depreſſion, when the powers and poſſeſſions of every individual are ſcarcely ſufficient for his own ſupport, when even the calls of appetite are repreſſed becauſe they cannot always be gratified, and the more refined paſſions, which either originate from ſuch as are merely animal, or are intimately connected with them, have not yet been felt—in this ſtate all the milder affections are unknown; or if the breaſt is at all ſenſible to their impulſe, it is extremely feeble. Huſband and wife, parent and child, brother and brother, are united by the weakeſt ties. Want and misfortune are not pitied. Why indeed ſhould they, where they cannot be relieved? It is impoſſible to determine how far beings in this condition can be capable of moral diſtinctions. One thing certain is, that in no ſtate are the human race entirely incapable of theſe. If we liſten, however, to the relations of reſpectable travellers, we muſt admit that human beings have ſometimes been found in that abject ſtate where no proper ideas of ſubordination, government, or diſtinction of ranks, could be formed. No diſtinct notions of Deity can be here entertained. Beings in ſo humble a condition cannot look through the order of the univerſe and the harmony of nature to that Eternal Wiſdom and Goodneſs which contrived, and that Almighty Power which brought into exiſtence, the ſyſtem of things. Of arts they muſt be almoſt totally deſtitute. They may uſe ſome inſtruments for fiſhing or the chace; but theſe muſt be extremely rude and ſimple. If they be acquainted with any means to ſhelter them from the inclemency of the elements, both their houſes and clothing will be awkward and inconvenient.

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progreſs of
ſociety.

But human beings have not been often found in ſo rude a ſtate as this. Even thoſe tribes which we denominate ſavage, are for the moſt part farther removed from mere animal life. They generally appear united under ſome ſpecies of government, exerciſing the powers of reaſon, capable of morality, though that morality be not always very refined; diſplaying ſome degree of ſocial virtues, and acting under the influence of religious ſentiments. Thoſe who may be conſidered as but one degree higher in the ſcale than the ſtupid and wretched beings whoſe condition we have ſurveyed, are to be found ſtill in the hunting and fiſhing ſtate; but they are farther advanced towards ſocial life, and are become more ſenſible to the impulſe of ſocial affection. By unavoidable intercourſe in their employments, a few individual hunters or fiſhers contract a certain degree of fondneſs for each other's company, and are led to take ſome part in each other's joys and ſorrows; and when the ſocial affections thus generated (ſee Passion) begin to exert themſelves, all the other powers of the mind are at the ſame time called forth, and the circumſtances of the little ſociety are immediately improved. We behold its members in a more comfortable condition, and find reaſon to view the human character with more complacency and reſpect. Huts are now built, more commodious clothes are faſhioned, inſtruments for the annoyance of wild beaſts and even of enemies are contrived; in ſhort, arts, and ſcience, and ſocial order, and religious ſentiment, and ceremonies, now make their appearance in the riſing ſociety, and ſerve to characterize it by the particular form which diſtinguiſhes each of them. But though ſocial order is no longer unknown nor unobſerved, yet the form of government is ſtill extremely ſimple, and its ties are but looſe and feeble. It will perhaps bear ſome reſemblance to the patriarchal; only all its members are on a more equal footing, and at the ſame time leſs cloſely connected than in the ſhepherd ſtate, to which that form of government ſeems almoſt peculiar. The old men are treated with veneration; but the young are not entirely ſubject to them. They may liſten reſpectfully to their advice; but they do not ſubmit to their arbitrary commands. Where mankind are in the ſtate of hunters and fiſhers, where the means of ſubſiſtence are precariouſly acquired, and prudent foreſight does not prompt to accumulate much proviſion for the future, no individual can acquire comparative wealth. As ſoon as the ſon is grown up, he ceaſes to be dependent on his father, as well as on the ſociety in general. Difference of experience therefore conſtitutes the only diſtinction between the young and the old; and if the old have experience, the young have ſtrength and activity. Here, then, neither age nor property can give riſe to any ſtriking diſtinction of ranks. All who have attained to manhood, and are not diſabled by unuſual deficiency of ſtrength or agility, or by the infirmities of old age, are on an equal footing; or if any one poſſeſs a pre-eminence over the reſt, he owes it to

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ſuperior addreſs or fortitude. The whole tribe deliberate; the old give their advice; each individual of the aſſembly receives or rejects it at his pleaſure (for the whole body think not of exerciſing any compulſatory power over the will of individuals); and the warrior who is moſt diſtinguiſhed for ſtrength, addreſs, and valour, leads out the youth of the tribe to the chace or againſt the enemy. War, which in the former ſtage did not prevail, as they who were ſtrangers to ſocial ſentiments were, at the ſame time, ſcarce capable of being enemies, now firſt begins to depopulate the thinly inhabited regions where thoſe hunters and fiſhers purſue their prey. They are ſcattered, poſſibly in ſcanty and ſeparate tribes, over an immenſe tract of country; but they know no medium between the affection which brethren of the ſame tribe bear to each other and the hatred of enemies. Though thinly ſcattered over the earth, yet the hunting parties of different tribes will ſometimes meet as they range the foreſts; and when they meet, they will naturally view each other with a jealous eye; for the ſucceſs of the one party in the chace may cauſe the other to be unſucceſsful; and while the one ſnatches the prey, the other muſt return home to all the pangs of famine. Inveterate hoſtility will therefore long prevail among neighbouring tribes in the hunting ſtate.

If we find them not incapable of ſocial order, we may naturally expect that their conduct will be influenced by ſome ſentiments of religion. They have at this period ideas of ſuperior beings. They alſo practiſe certain ceremonies to recommend them to thoſe beings; but both their ſentiments and ceremonies are ſuperſtitious and abſurd.

We have elſewhere ſhown (ſee POLYTHEISM) how ſavage tribes have probably degenerated from the pure worſhip of the one true God to the adoration of a multitude of imaginary divinities in heaven, earth, and hell. We have traced this idolatrous worſhip from that of the heavenly bodies, through all the gradations of dæmon-worſhip, hero-worſhip, and ſtatue-worſhip, to that wonderful inſtance of abſurd ſuperſtition which induced the inhabitants of ſome countries to fall proſtrate in adoration before the vileſt reptiles. But though we are convinced that the heavenly bodies have by all idolaters been conſidered as their firſt and greateſt gods, we pretend not that the progreſs through the other ſtages of polytheiſm has been everywhere in the very ſame order. It is indeed impoſſible to exhibit under one general view an account of arts, manners, and religious ſentiments, which may apply to ſome certain period in the hiſtory of every nation. The characters and circumſtances of nations are ſcarce leſs various and anomalous than thoſe of individuals. Among many of the American tribes, among the ancient inhabitants of the foreſts of Germany, whoſe manners have been ſo accurately delineated by the maſterly pen of Tacitus, and in ſome of the iſlands ſcattered over the ſouthern ocean, religion, arts, and government, have been found in that ſtate which we have deſcribed as characteriſing the ſecond ſtage of ſocial life. But neither can we pretend that all thoſe ſimple and rude ſocieties have been deſcribed by hiſtorians and travellers as agreeing preciſely in their arts, manners, and religious ſentiments; or that the difference of circumſtances always enables us to account in a ſatisfactory manner for the diſtinction of their characters. There is a variety of facts in the hiſtory of the early periods of ſociety, which no ingenuity, no induſtry, however painful, can reduce under general heads. Here, as well as when we attempt to philoſophize on the phenomena of the material world, we find reaſon to confeſs that our powers are weak, and our obſervation confined within a narrow ſphere.

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But we may now carry our views a little forward, and ſurvey human life as approaching ſomewhat nearer to a civilized and enlightened ſtate. As property is acquired, inequality and ſubordination of ranks neceſſarily follow: and when men are no longer equal, the many are ſoon ſubjected to the will of the few. But what gives riſe to theſe new phenomena is, that after having often ſuffered from the precariouſneſs of the hunting and fiſhing ſtate, men begin to extend their cares beyond the preſent moment, and to think of providing ſome ſupply for future wants. When they are enabled to provide ſuch a ſupply, either by purſuing the chace with new eagerneſs and perſeverance, by gathering the ſpontaneous fruits of the earth, or by breeding tame animals—theſe acquiſitions are at firſt the property of the whole ſociety, and diſtributed from a common ſtore to each individual according to his wants: But as various reaſons will ſoon concur to convince the community, that by this mode of diſtribution, induſtry and activity are treated with injuſtice, while negligence and indolence receive more than their due, each individual will in a ſhort time become his own ſteward, and a community of goods will be aboliſhed. As ſoon as diſtinct ideas of property are formed, it muſt be unequally diſtributed; and as ſoon as property is unequally diſtributed, there ariſes an inequality of ranks. Here we have the origin of the depreſſion of the female ſex in rude ages, of the tyrannical authority exerciſed by parents over their children, and perhaps of ſlavery. The women cannot diſplay the ſame perſeverance, or activity, or addreſs, as the men, in purſuing the chace. They are therefore left at home; and from that moment are no longer equals, but ſlaves and dependants, who muſt ſubſiſt by the bounty of the males, and muſt therefore ſubmit with implicit obedience to all their capricious commands. Even before the era of property, the female ſex were viewed as inferiors; but till that period they were not reduced to a ſtate of abject ſlavery.

In this period of ſociety new notions are formed of the relative duties. Men now become citizens, maſters, and ſervants, huſbands, parents, &c. It is impoſſible to enumerate all the various modes of government which take place among the tribes who have advanced to this ſtage; but one thing certain is, that the authority of the few over the many is now firſt eſtabliſhed, and that the riſe of property firſt introduces inequality of ranks. In one place, we ſhall perhaps find the community ſubjected during this period to the will of a ſingle perſon; in another, power may be lodged in the hands of a number of chiefs; and in a third, every individual may have a voice in creating public officers, and in enacting laws for the ſupport of public order. But as no code of laws is formed during this period, juſtice is not very impartially adminiſtered, nor are the rights of individuals very faithfully guarded. Many actions, which will afterwards be conſidered as heinouſly immoral, are now conſidered as praiſe-worthy or indifferent. This is the age of hero-worſhip, and of houſehold and tutelary gods; for

for it is in this ſtage of ſociety that the invention of arts, which gave riſe to that worſhip, contributes moſt conſpicuouſly to the public good. War, too, which we conſidered as beginning firſt to ravage the earth during the former period, and which is another cauſe of the deification of dead men, will ſtill prevail in this age, and be carried on with no leſs ferocity than before, though in a more ſyſtematic form.

The prevalence of war, and the means by which ſubſiſtence is procured, cannot but have conſiderable influence on the character and ſentiments of ſocieties and individuals. The hunter and the warrior are characters in many reſpects different from the ſhepherd and the huſbandman. Such, in point of government, arts, and manners, religious and moral ſentiments, were ſeveral of the German tribes deſcribed by Tacitus; and the Britons whoſe character has been ſketched by the pen of Cæſar: ſuch, too, were the Romans in the early period of their hiſtory; ſuch too the inhabitants of Aſia Minor about the time of the ſiege of Troy, as well as the Greeks whom Homer celebrates as the deſtroyers of the Trojan ſtate: the northern tribes alſo, who poured through Aſia, Africa, and Europe, and overthrew the Roman empire, appear to have been of a nearly ſimilar character. It ſeems to be a general opinion among thoſe who have directed their attention to the hiſtory of ſociety, that, in the ſcale aſcending from the loweſt condition of human beings to the moſt civilized and enlightened ſtate of ſociety, the ſhepherd ſtate is the next in order above the hunting; and that as mankind improve in knowledge and in moral ſentiments, and as the foreſts are gradually depopulated of their inhabitants, inſtead of deſtroying the inferior animals, men become their guardians and protectors. But we cannot unreſervedly ſubſcribe to this opinion: we believe, that in the ſhepherd ſtate ſocieties have been ſometimes found ſuperior to the moſt poliſhed tribes of hunters; but upon viewing the annals of mankind in early ages, we obſerve that there is often no inconſiderable reſemblance even between hunters and ſhepherds in point of the improvement of the rational faculties and the moral ſenſe; and we are therefore led to think, that theſe two ſtates are ſometimes parallel: for inſtance, ſeveral of the American tribes, who ſtill procure their ſubſiſtence by hunting, appear to be nearly in the ſtate which we have deſcribed as the third ſtage in the progreſs of ſociety; and the ancient ſhepherds of Aſia do not appear to have been much more cultivated and refined. We even believe that men have ſometimes turned their attention from hunting to agriculture, without paſſing through any intermediate ſtate. Let us remember, that much depends upon local circumſtances, and ſomewhat undoubtedly on original inſpiration and traditionary inſtruction. In this period of ſociety the ſtate of the arts well deſerves our attention. We ſhall find, that the ſhepherds and the hunters are in that reſpect on a pretty equal footing. Whether we examine the records of ancient hiſtory, or view the iſlands ſcattered through the South ſea, or range the wilds of America, or ſurvey the ſnowy waſtes of Lapland and the frozen coaſt of Greenland—ſtill we find the uſeful arts in this period, though known and cultivated, in a very rude ſtate; and the fine arts, or ſuch as are cultivated merely to pleaſe the fancy or to gratify caprice, diſplaying an old and fantaſtic, not a true or natural, taſte; yet this is the period in which eloquence ſhines with the trueſt luſtre: all is metaphor or glowing ſentiment. Languages are not yet copious; and therefore ſpeech is figurative, expreſſive, and forcible. The tones and geſtures of nature, not being yet laid aſide, as they generally are, from regard to decorum, in more poliſhed ages, give a degree of force and expreſſion to the harangues of the ruſtic or ſavage orator, which the moſt laborious ſtudy of the rules of rhetoric and elocution could not enable even a more poliſhed orator to diſplay.

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Fourth ſtage; in which agriculture flouriſhes, the arts are ſubdivided, commerce and regular government are introduced.

But let us advance a little farther, and contemplate our ſpecies in a new light, where they will appear with greater dignity and amiableneſs of character. Let us view them as huſbandmen, artizans, and legiſlators. Whatever circumſtances might turn the attention of any people from hunting to agriculture, or cauſe the herdſman to yoke his oxen for the cultivation of the ground, certain it is that this change in the occupation would produce a happy change on the character and circumſtances of men; it would oblige them to exert a more regular and perſevering induſtry. The hunter is like one of thoſe birds that are deſcribed as paſſing the winter in a torpid ſtate. The ſhepherd's life is extremely indolent. Neither of theſe is very favourable to refinement. But different is the condition of the huſbandman. His labours ſucceed each other in regular rotation through the year. Each ſeaſon with him has its proper employments: he therefore muſt exert active perſevering induſtry; and in this ſtate we often find the virtues of rude and poliſhed ages united. This is the period where barbariſm ends and civilization begins. Nations have exiſted for ages in the hunting or the ſhepherd ſtate, fixed as by a kind of ſtagnation, without advancing farther. But ſcarcely any inſtances occur in the hiſtory of mankind of thoſe who once reached the ſtate of huſbandmen, remaining long in that condition without riſing to a more civilized and poliſhed ſtate. Where a people turn their attention in any conſiderable degree to the objects of agriculture, a diſtinction of occupations naturally ariſes among them. The huſbandman is ſo cloſely employed through the ſeveral ſeaſons of the year in the labours of the field, that he has no longer leiſure to exerciſe all the rude arts known among his countrymen. He has not time to faſhion the inſtruments of huſbandry, to prepare his clothes, to build his houſe, to manufacture houſehold utenſils, or to tend thoſe tame animals which he continues to rear. Thoſe different departments therefore now begin to employ different perſons; each of whom dedicates his whole time and attention to his own occupation. The manufacture of cloth is for a conſiderable time managed excluſively by the women; but ſmiths and joiners ariſe from among the men. Metals begin now to be conſidered as valuable materials. The intercourſe of mankind is now placed on a new footing. Before, every individual practiſed all the arts that were known, as far as was neceſſary for ſupplying himſelf with the conveniences of life. Now he confines himſelf to one or to a few of them; and, in order to obtain a neceſſary ſupply of the productions of thoſe arts which he does not cultivate himſelf, he gives in exchange a part of the productions of his own labours. Here we have the origin of commerce.

After continuing perhaps for ſome time in this ſtate, as arts and diſtinctions multiply in ſociety, the exchange

change of one commodity for another is found troubleſome and inconvenient. It is ingeniouſly contrived to adopt a medium of commerce, which being eſtimated not by its intrinſic value, but by a certain nominal value which it receives from the agreement of the ſociety among whom it is uſed, ſerves to render the exchange of property, which is ſo neceſſary for the purpoſes of ſocial life, eaſy and expeditious. Wherever metals have been known, they appear to have been adopted as the medium of commerce almoſt as ſoon as ſuch a medium began to be uſed: and this is one important purpoſe for which they ſerve; but they have ſtill more important uſes. Almoſt all the neceſſary arts depend on them. Where the metals are known, agriculture practiſed, and the neceſſary arts diſtributed among different orders of artiſans—civilization and refinement, if not obſtructed by ſome accidental circumſtances, advance with a rapid progreſs. With regard to the firſt applying of the precious metals as the medium of commerce, we may obſerve, that this was probably not accompliſhed by means of a formal contract. They might be firſt uſed as ornaments; and the love of ornament, which prevails among rude as much as among civilized nations, would render every one willing to receive them in exchange for ſuch articles as he could ſpare. Such might be the change produced on ſociety with regard to the neceſſary arts by the origin of agriculture. As ſoon as ornament and amuſement are thought of, the fine arts begin to be cultivated. In their origin therefore they are not long poſterior to the neceſſary and uſeful arts. They appear long before men reach the comfortable and reſpectable condition of huſbandmen; but ſo rude is their character at their firſt origin, that our *Dilettanti* would probably view the productions of that period with unſpeakable contempt and diſguſt. But in the period of ſociety which we now conſider, they have aſpired to a higher character; yet poetry is now perhaps leſs generally cultivated than during the ſhepherd ſtate. Agriculture, conſidered by itſelf, is not directly favourable either to refinement of manners or to the fine arts. The converſation of ſhepherds is generally ſuppoſed to be far more elegant than that of huſbandmen; but though the direct and immediate effects of this condition of life be not favourable to the fine arts, yet indirectly it has a ſtrong tendency to promote their improvement. Its immediate influence is extremely favourable to the neceſſary and uſeful arts; and theſe are no leſs favourable to the fine arts.

One of the nobleſt changes which the introduction of the arts by agriculture produces on the form and circumſtances of ſociety, is the introduction of regular government and laws. In tracing the hiſtory of ancient nations, we ſcarcely ever find laws introduced at an earlier period. Minos, Solon, and Lycurgus, do not appear to have formed codes of wiſdom and juſtice for regulating the manners of their countrymen, till after the Cretans, the Athenians, and even the Lacedæmonians, had made ſome progreſs in agriculture and the uſeful arts.

Religion, under all its various forms, has in every ſtage of ſociety a mighty influence on the ſentiments and conduct of men (ſee Religion); and the arts cultivated in ſociety have on the other hand ſome influence on the ſyſtem of religious belief. One happy effect which will reſult from the invention of arts, though perhaps not immediately, will be, to render the character of the deities more benevolent and amiable, and the rites of their worſhip more mild and humane.

The female ſex in this period generally find the yoke of their ſlavery ſomewhat lightened. Men now become eaſier in their cirumſtances; the ſocial affections aſſume ſtronger influence over the mind; plenty, and ſecurity, and eaſe, at once communicate both delicacy and keenneſs to the ſenſual deſires. All theſe circumſtances concur to make men relax in ſome degree that tyrannic ſway by which they before depreſſed the ſofter ſex. The foundation of that empire, where beauty triumphs over both wiſdom and ſtrength, now begins to be laid. Such are the effects which hiſtory warrants as to attribute to agriculture and the arts; and ſuch the outlines of the character of that which we reckon the fourth ſtage in the progreſs of ſociety from rudeneſs to refinement.

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Let us advance one ſtep farther. We have not yet ſurveyed mankind in their moſt poliſhed and cultivated ſtate. Society is rude at the period when the arts firſt begin to ſhow themſelves, in compariſon of that ſtate to which it is raiſed by the induſtrious cultivation of them. The neighbouring commonwealths of Athens and Lacedæmon afford us a happy opportunity of comparing this with the former ſtage in the progreſs of ſociety. The chief effect produced by the inſtitutions of Lycurgus ſeems to have been, to fix the manners of his countrymen for a conſiderable period in that ſtate to which they had attained in his days. Spartan virtue has been admired and extolled in the language of enthuſiaſm; but in the ſame manner has the character and the condition of the ſavage inhabitants of the wilds of America, been preferred by ſome philoſophers, to the virtues and the enjoyments of ſocial life in the moſt poliſhed and enlightened ſtate. The Spartans in the days of Lycurgus had begun to cultivate the ground, and were not unacquainted with the uſeful arts. They muſt ſoon have advanced farther had not Lycurgus ariſen, and by effecting the eſtabliſhment of a code of laws, the tendency of which appears to have been in many particulars directly oppoſite to the deſigns of nature, retarded their progreſs towards complete civilization and refinement. The hiſtory of the Lacedæmonians, therefore, while the laws of Lycurgus continued in force, exhibits the manners and character of a people in that which we have denominated the fourth ſtage in the progreſs of ſociety. But if we turn our eyes to their neighbours the Athenians, we behold in their hiſtory the natural progreſs of opinions, arts, and manners. The uſeful arts are firſt cultivated with ſuch ſteady induſtry, as to raiſe the community to opulence, and to furniſh them with articles for commerce with foreign nations. The uſeful arts cannot be raiſed to this height of improvement without leading men to the purſuit of ſcience. Commerce with foreign nations, ſkill in the uſeful arts, and a taſte for ſcience, mutually aid each other, and conſpire to promote the improvement of the fine arts. Hence magnificent buildings, noble ſtatues, paintings expreſſive of life, action, and paſſion; and poems in which imagination adds new grace and ſublimity to nature, and gives the appearances of ſocial life more irreſiſtible power over the affections of the heart. Hence are moral diſtinctions more carefully ſtudied, and the

the rights of every individual and every order in ſociety better underſtood and more accurately defined. Moral ſcience is generally the firſt ſcientific purſuit which ſtrongly attracts the attention of men. Lawgivers appear before geometricians and aſtronomers. Some particular circumſtances may cauſe theſe ſciences to be cultivated at a very early period. In Egypt the overflowing of the Nile cauſed geometry to be early cultivated. Cauſes no leſs favourable to the ſtudy of aſtronomy, concurred to recommend that ſcience to the attention of the Chaldeans long before they had attained the height of refinement. But, in general, we find, that the laws of morality are underſtood, and the principles of morals inquired into, before men make any conſiderable progreſs in phyſical ſcience, or even proſecute it with any degree of keenneſs. Accordingly, when we view the ſtate of literature in this period (for it is now become an object of ſo much importance as to force itſelf on our attention), we perceive that poetry, hiſtory, and morals, are the branches chiefly cultivated. Arts are generally caſual inventions, and long practiſed before rules and principles on which they are founded aſſume the form of ſcience. But morality, if conſidered as an art, is that art which men have ſooneſt and moſt conſtantly occaſion to practiſe. Beſides, we are ſo conſtituted by the wiſdom of nature, that human actions, and the events which befal human beings, have more powerful influence than any other object to engage and fix our attention. Hence we are enabled to explain why morality, and thoſe branches of literature more immediately connected with it, are almoſt always cultivated in preference to phyſical ſcience. Though poetry, hiſtory, and morals, be purſued with no ſmall eagerneſs and ſucceſs in that period of ſociety which we now conſider, we need not therefore be greatly ſurpriſed that natural philoſophy is neither very generally nor very ſucceſsfully cultivated. Were we to conſider each particular in that happy change which is now produced on the circumſtances of mankind, we ſhould be led into a too minute and perhaps unimportant detail. This is the period when human virtue and human abilities ſhine with moſt ſplendour. Rudeneſs, ferocity, and barbariſm, are now baniſhed. Luxury has made her appearance; but as yet ſhe is the friend and the benefactreſs of ſociety. Commerce has ſtimulated and rewarded induſtry, but has not yet contracted the heart and debaſed the character. Wealth is not yet become the ſole object of purſuit. The charms of ſocial intercourſe are known and reliſhed; but domeſtic duties are not yet deſerted for public amuſements. The female ſex acquire new influence, and contribute much to refine and poliſh the manners of their lords. Religion now aſſumes a milder and more pleaſing form; ſplendid rites, magnificent temples, pompous ſacrifices, and gay feſtivals, give even ſuperſtition an influence favourable to the happineſs of mankind. The gloomy notions and barbarous rites of former periods fall into diſuſe. The ſyſtem of theology produced in former ages ſtill remains: but only the mild and amiable qualities of the deities are celebrated; and none but the gay, humane, and laughing divinities, are worſhipped. Philoſophy alſo teaches men to diſcard ſuch parts of their religion as are unfriendly to good morals, and have any tendency to call forth or cheriſh unſocial ſentiments in the heart. War (for in this period of ſociety enough of cauſes will ariſe to arm one nation againſt another)—war, however, no longer retains its former ferocity; nations no longer ſtrive to extirpate one another: to procure redreſs for real or imaginary injuries; to humble, not to deſtroy, is now its object. Priſoners are no longer murdered in cold blood, ſubjected to horrid and excruciating tortures, or condemned to hopeleſs ſlavery. They are ranſomed or exchanged; they return to their country, and again fight under its banners. In this period the arts of government are likewiſe better underſtood, and practiſed ſo as to contribute moſt to the intereſts of ſociety. Whether monarchy, or democracy, or ariſtocracy, be the eſtabliſhed form, the rights of individuals and of ſociety are in general reſpected. The intereſts of ſociety are ſo well underſtood, that the few, in order to preſerve their influence over the many, find it neceſſary to act rather as the faithful ſervants than the imperious lords of the public. Though the liberties of a nation in this ſtate be not accurately defined by law, nor their property guaranteed to them by any legal inſtitutions, yet their governors dare not violate their liberties, nor deprive them wantonly of their properties. This is truly the golden age of ſociety: every trace of barbariſm is entirely effaced; and vicious luxury has not yet begun to ſap the virtue and the happineſs of the community. Men live not in liſtleſs indolence; but the induſtry in which they are engaged is not of ſuch a nature as to overpower their ſtrength or exhauſt their ſpirits. The ſocial affections have now the ſtrongeſt influence on men's ſentiments and conduct.

14
Degeneracy and decline of ſociety.

But human affairs are ſcarcely ever ſtationary. The circumſtances of mankind are almoſt always changing, either growing better or worſe. Their manners are ever in the ſame fluctuating ſtate. They either advance towards perfection or degenerate. Scarcely have they attained that happy period in which we have juſt contemplated them, when they begin to decline till they perhaps fall back into a ſtate nearly as low as that from which we ſuppoſe them to have emerged. Inſtances of this unhappy degeneracy occur more than once in the hiſtory of mankind; and we may finiſh this ſhort ſketch of the hiſtory of ſociety by mentioning in what manner this degeneracy takes place. Perhaps, ſtrictly ſpeaking, every thing but the ſimple neceſſaries of life may be denominated luxury: For a long time, however, the welfare of ſociety is beſt promoted, while its members aſpire after ſomething more than the mere neceſſaries of life. As long as theſe ſuperfluities are to be obtained only by active and honeſt exertion; as long as they only engage the leiſure hours, without becoming the chief objects of purſuit—the employment which they give to the faculties is favourable both to the virtue and the happineſs of the human race.

The period arrives, however, when luxury is no longer ſerviceable to the intereſts of nations; when ſhe is no longer a graceful, elegant, active form, but a languid, overgrown, and bloated carcaſe. It is the love of luxury, which contributed ſo much to the civilization of ſociety, that now brings on its decline. Arts are cultivated and improved, and commerce extended, till enormous opulence be acquired: the effect of opulence is to awaken the fancy, to conceive ideas of new and capricious wants, and to inflame the breaſt with new deſires. Here we have the origin of that ſelfiſhneſs which, operating in conjunction with caprice and the violence of unbridled paſſions, contributes ſo much to the corruption of virtuous manners. Selfiſhneſs, caprice, indolence, effeminacy, all join to looſen the bonds of ſociety, to bring on the degeneracy both of the uſeful and the fine arts, to baniſh at once the mild and the auſtere virtues, to deſtroy civil order and ſubordination, and to introduce in their room anarchy or deſpotiſm.

Scarcely could we have found an example of the beautiful form of ſociety which we laſt attempted to deſcribe. Never, at leaſt, has any nation continued long to enjoy ſuch happy circumſtances, or to diſplay ſo amiable and reſpectable a character. But when we ſpeak of the declining ſtate of ſociety, we have no difficulty in finding inſtances to which we may refer. Hiſtory tells of the Aſſyrians, the Egyptians, and the Perſians, all of them once flouriſhing nations, but brought low by luxury and an unhappy corruption of manners. The Greeks, the Romans, and the Aſſyrians, owed their fall to the ſame cauſes; and we know not if a ſimilar fate does not now threaten many of thoſe nations who have long made a diſtinguſhed figure in the ſyſtem of Europe. The Portugueſe, the Venetians, and the Spaniards, have already fallen; and what is the preſent ſtate of our neighbours the French? They have long been a people deſtitute of religion, corrupted in morals, unſteady in conduct, and ſlaves to pleaſure and public amuſements. Among them luxury had arrived at its higheſt pitch; and the conſequence has been, that after capriciouſly ſhaking off the yoke of deſpotiſm, they have eſtabliſhed, or rather ſet up (for eſtabliſhed it cannot be), a motley kind of government, which, in the courſe of a few years, has exhibited ſcenes of tyranny and oppreſſion, to which we doubt if the annals of the world can furniſh any parallel. Yet this is the people whoſe manners the other nations of Europe were ambitious to imitate. May thoſe nations take warning in time, and avoid the rocks upon which they have ſplit.

15
Concluding remarks.

THUS have we viewed the ſeveral ſtages in which ſociety appears in its progreſs from rudeneſs to refinement and decay. The intelligent reader will perceive, that the various and anomalous phenomena which occur in the natural hiſtory of ſociety, cannot eaſily be ſolved; becauſe the neceſſary information cannot be obtained. Others have been well accounted for by the reſearches of curious philoſophical inquirers. Local circumſtances, the influence of climate, the intercourſe of nations in different ſtates of civilization, have been taken notice of, as cauſes ſerving to accelerate or retard the progreſs of arts and manners. But our proper buſineſs here was merely to mark the gradations between barbariſm and refinement: and as the painter who is to exhibit a ſeries of portraits repreſenting the human form in infancy, puerility, youth, and manhood, will not think of delineating all that variety of figures and faces which each of thoſe periods of life affords, and will find himſelf unable to repreſent in any ſingle figure all diverſities of form and features; ſo we have not once thought of deſcribing particularly under this article, all the various national characters reducible to any one of thoſe diviſions under which we have viewed the progreſs of ſociety, nor have found it poſſible to comprehend under one conſiſtent view, all the particulars which may be gathered from the remains of antiquity, from the relations of later travellers, and the general records of hiſtory concerning the progreſſive character of mankind in various regions, and under the influence of various accidents and circumſtances. This indeed would even have been improper, as all that information appears under other articles in this Work.

SOCIETIES, aſſociations voluntarily formed by a number of individuals for promoting knowledge, induſtry, or virtue. They may therefore be divided into three claſſes; ſocieties for promoting ſcience and literature, ſocieties for encouraging and promoting arts and manufactures, and ſocieties for diffuſing religion and morality and relieving diſtreſs. Societies belonging to the firſt claſs extend their attention to all the ſciences and literature in general, or devote it to one particular ſcience. The ſame obſervation may be applied to thoſe which are inſtituted for improving arts and manufactures. Thoſe of the third claſs are eſtabliſhed, either with a view to prevent crimes, as the Philanthropic Society; for the diffuſion of the Chriſtian religion among unenlightened nations, as the Society for the Propagation of the Goſpel in Foreign Parts; or for introducing arts and civilization, along with a knowledge of the Chriſtian religion, as the Sierra Leona Company.

The honour of planning and inſtituting ſocieties for thoſe valuable purpoſes is due to modern times. A literary aſſociation is ſaid to have been formed in the reign of Charlemagne (ſee ACADEMY); but the plan ſeems to have been rude and defective. Several others were inſtituted in Italy in the 16th century; but from the accounts which we have ſeen of them, they ſeem to have been far inferior to thoſe which are moſt flouriſhing at preſent. The moſt enlarged idea of literary ſocieties ſeems to have originated with the great Lord Bacon, the father of modern philoſophy, who recommended to the reigning prince to inſtitute ſocieties of learned men, who ſhould give to the world from time to time a regular account of their reſearches and diſcoveries. It was the idea of this great philoſopher, that the learned world ſhould be united, as it were, into one immenſe republic; which, though conſiſting of many detached ſtates, ſhould hold a ſtrict union and preſerve a mutual intelligence with each other, in every thing that regards the common intereſt. The want of this union and intelligence he laments as one of the chief obſtacles to the advancement of ſcience; and, juſtly conſidering the inſtitution of public ſocieties, in the different countries of Europe, under the auſpices of the ſovereign, to be the beſt remedy for that defect, he has given, in his fanciful work, the New Atlantis, the delineation of a philoſophical ſociety on the moſt extended plan, for the improvement of all arts and ſciences; a work which, though written in the language, and tinctured with the colouring of romance, is full of the nobleſt philoſophic views. The plan of Lord Bacon, which met with little attention from the age in which he lived, was deſtined to produce its effect in a period not very diſtant. The ſcheme of a philoſophical college by Cowley is acknowledged to have had a powerful influence in procuring the eſtabliſhment of the Royal Society of London by charter from Charles II. †; and Cowley's plan is manifeſtly copied in almoſt all its parts from that in the New Atlantis. The inſtitution of the Royal Society of London was ſoon followed by the eſtabliſhment of the Royal Academy

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† *Sprat'* *Hiſtory o* *the Roya* *Society,* 2d edit. p. 39.

demy of Sciences at Paris; and theſe two have ſerved as models to the philoſophical academies of higheſt reputation in the other kingdoms of Europe.

The experience of ages has ſhown, that improvements of a public nature are beſt carried on by ſocieties of liberal and ingenious men, uniting their labours without regard to nation, ſect, or party, in one grand purſuit alike intereſting to all, whereby mutual prejudices are worn off, and a humane philoſophical ſpirit is cheriſhed. Men united together, and frequently meeting for the purpoſe of advancing the ſciences, the arts, agriculture, manufactures, and commerce, may oftentimes ſuggeſt ſuch hints to one another as may be improved to important ends; and ſuch ſocieties, by being the repoſitories of the obſervations and diſcoveries of the learned and ingenious, may from time to time furniſh the world with uſeful publications which might otherwiſe be loſt: for men of ingenuity and modeſty may not chooſe to riſk their reputation, by ſending abroad unpatronized what a learned ſociety might judge richly worth the public eye; or perhaps their circumſtances being ſtraitened, they may not be able to defray the expence of publication. Societies inſtituted for promoting knowledge may alſo be of eminent ſervice, by exciting a ſpirit of emulation, and by enkindling thoſe ſparks of genius which otherwiſe might for ever have been concealed; and if, when poſſeſſed of funds ſufficient for the purpoſe, they reward the exertions of the induſtrious and enterpriſing with pecuniary premiums or honorary medals, many important experiments and uſeful diſcoveries will be made, from which the public may reap the higheſt advantages.

Eminent inſtances of the beneficial effects of ſuch inſtitutions we have in the Royal Academy of Sciences at Paris, the Royal Society, and the Society inſtituted for the Encouragement of Arts, Manufactures, and Commerce, in London, and many others of a ſimilar kind. Hereby a ſpirit of diſcovery and improvement has been excited among the ingenious in almoſt every nation; knowledge of various kinds, and greatly uſeful to mankind, has taken place of the dry and unintereſting ſpeculations of ſchoolmen; and bold and erroneous hypotheſis has been obliged to give way to demonſtrative experiment. In ſhort, ſince the eſtabliſhment of theſe ſocieties, ſolid learning and philoſophy have more increaſed than they had done for many centuries before.

As to thoſe ſocieties eſtabliſhed for promoting induſtry, religion and morality, and relieving diſtreſs, the deſign is laudable and excellent, and preſents a beautiful picture of the philanthropy of modern times. We are happy to find, from the minutes of ſome of theſe ſocieties, that their beneficial effects are already conſpicuous.

We will now give ſome account of the moſt eminent ſocieties; arranging them under the three claſſes into which we have divided them: I. *Religious and Humane Societies.* II. *Societies for Promoting Science and Literature.* III. *Societies for Encouraging Arts, Manufactures*, &c.

I. Religious and Humane Societies.

1. *Society for the Propagation of the Goſpel in Foreign Parts*, was inſtituted by King William III. in 1701, in order to ſecure a maintenance for an orthodox clergy, and to make other proviſions for propagating the goſpel in the plantations, colonies, and factories beyond the ſeas. To that end he incorporated the archbiſhops, ſeveral of the biſhops, and others of the nobility, gentry, and clergy, to the number of 90, into one body, which, by the name of *The Society for the Propagation of the Goſpel in Foreign Parts*, was to plead and be impleaded; to have perpetual ſucceſſion, with privilege to purchaſe 2000l. a-year inheritance, and eſtates for lives or years, with other goods and chattels to any value. By its charter the ſociety is authoriſed to uſe a common ſeal; and to meet annually on the third Friday in February for the purpoſe of chooſing a preſident, vice preſident, and officers for the year enſuing; and on the third Friday in every month, or oftener if there ſhould be occaſion, to tranſact buſineſs, and to depute perſons to take ſubſcriptions, and collect money contributed for the purpoſes aforeſaid; and of all moneys received and laid out, it is obliged to give account yearly to the lord-chancellor or keeper, the lord-chief juſtice of the King's-bench, the lord-chief-juſtice of the Common-pleas, or to any two of theſe magiſtrates. Of this ſociety there is a ſtanding committee at St Paul's chapter-houſe, to prepare matters for the monthly meeting, which is held at St Martin's library.

Before the incorporation of the ſociety for the propagation of the goſpel in foreign parts, there had been formed, for the promoting of Chriſtian knowledge both at home and in the colonies, a voluntary aſſociation of perſons of rank and reſpectability, who in March 1699 began to hold ſtated meetings in London for that purpoſe, regulating themſelves by the laws of the land and the canons of the church; and when the new ſociety was formed, they had already tranſmitted to America and the Weſt Indies 800l. worth of Bibles, Books of Common Prayer, and treatiſes of practical religion, beſides ſecuring a tolerable maintenance to ſeveral clergymen on that continent. This aſſociation ſtill ſubſiſts under the denomination of *The Society for Promoting Chriſtian Knowledge*, and has been productive of much good in the cities of London and Weſtminſter; but upon the formation of the new ſociety, into which all its original members were incorporated by name, the care which the voluntary aſſociation had taken of the colonies devolved of courſe upon the incorporated ſociety; of which incorporation we believe the object has been ſometimes miſtaken, and the labours of its miſſionaries groſsly miſrepreſented. It has by many been ſuppoſed that the ſociety was incorporated for the *ſole* purpoſe of converting the ſavage Americans; and it has been much blamed for ſending miſſionaries into provinces where, in the common language of the complainers, a *goſpel-miniſtry* was already eſtabliſhed. But an impartial view of the riſe and progreſs of the American provinces, now become independent ſtates, will ſhow the folly and injuſtice of thoſe complaints.

The Engliſh colonies in North America were in the laſt century formed and firſt peopled by religious men; who, made uneaſy at home by their intolerant brethren, left the *old world* to enjoy in peace that firſt and chief prerogative of man, *the free worſhip of God according to his own conſcience.* At one time PURITANS were driven acroſs the Atlantic by the epiſcopal church; at another, CHURCHMEN were forced away by the preſbyterians, juſt as the revolutions of ſtate threw the civil power into the hands of the one or the other party; and not a few members of the CHURCH OF ROME were chaſed to the wilds of America by the united exertions of both. It has been often obſerved, that people perſecuted for their religion become for the moſt part enthuſiaſtically attached to it; and the conduct of thoſe coloniſts was in perfect harmony with this obſervation. Their zeal, inflamed by their violent removal to the other hemiſphere, kept religion alive and active among themſelves; but their poverty diſabled them from ſupplying fuel to the flame, by making proviſion for a miniſtry to inſtruct their offspring. The conſequence was, that the new Chriſtian commonwealth, without the kindly aſſiſtance of its mother-country, would have been, in the words of the Roman hiſtorian, *Res unius ætatis*. Againſt this danger a timely aid was to be provided by the ſociety; which, as it conſiſted not of fanatical members, would not intruſt the important buſineſs of the miſſion to fanatical preachers, who, though always ready for ſuch ſpiritual enterpriſes, are never qualified to carry them on with ſucceſs.

It was therefore thought fit to aſſign a decent maintenance for clergymen of the church of England, who might preach the goſpel to their brethren in America: and though thoſe miſſionaries in general carefully avoided the conduct of thoſe of Rome, whoſe principal aim is to reduce all churches under ſubmiſſion to the papal tyranny; yet ſo lately as 1765, did ſome of the colonies, in which the puritanic ſpirit of the laſt century characteriſed the church eſtabliſhed by law, raiſe a hideous outcry againſt the ſociety for ſending a miſſion into their quarters, though only for the ſervice of the diſperſed members of the Epiſcopal church reſiding among them, and for the converſion of thoſe men whom their rigid fanaticiſm had prejudiced againſt Chriſtianity itſelf.

Indeed the commodity called FREETHINKING, as Biſhop Warburton expreſſes it, was at an early period imported by the opulent and faſhionable coloniſts. The celebrated Berkeley, who had reſided ſome years in Rhode Iſland, and at his return was called upon to preach the anniverſary ſermon before the ſociety*, informs us, that the iſland where he lived was inhabited by an Engliſh colony, conſiſting chiefly of ſectaries of many different denominations; that ſeveral of the better ſort of the inhabitants of towns were accuſtomed to aſſemble themſelves regularly on the Lord's day for the performance of divine worſhip; but that moſt of thoſe who were diſperſed through the colony rivalled ſome well-bred people of other countries, in a thorough indifference for all that is ſacred, being equally careleſs of outward worſhip and of inward principles. He adds, that the miſſionaries had done, and were continuing to do, good ſervice in bringing thoſe planters to a ſerious ſenſe of religion. "I ſpeak it knowingly (ſays he), that the miniſters of the goſpel, in thoſe provinces which go by the name of New England, ſent and ſupported at the expence of the ſociety, have, by their ſobriety of manners, diſcreet behaviour, and a competent degree of uſeful knowledge, ſhown themſelves worthy of the choice of thoſe who ſent them." We have the honour to be acquainted with ſome of the miſſionaries ſent at a later period, and have reaſon to believe that, down to the era of the American revolution, they had the ſame virtues, and were doing the ſame good ſervices, which procured to their predeceſſors this honourable teſtimony from one of the greateſt and the beſt of men. Surely ſuch a miſſion deſerved not to be evil ſpoken of by ſectariſts of any denomination who believe in Chriſt; eſpecially as the very charter of incorporation aſſigns as a reaſon for miſſionaries being ſent to the colonies, "that by reaſon of their poverty thoſe colonies were deſtitute and unprovided of a MAINTENANCE for miniſters and the public worſhip of God."

The ſociety, however, was incorporated for other purpoſes than this. It was obliged by its charter to attempt the converſion of the native Americans and the negro ſlaves; and we have reaſon to believe, that, as ſoon as the ſpiritual wants of the coloniſts were decently ſupplied, it was not inattentive to theſe glorious objects. Its ſucceſs indeed in either purſuit has not been ſo great as could be wiſhed; but it would be raſh and unfair to attribute this failure to the preſident, vice-preſident, or other officers of the corporation at home. An erroneous notion, that the being baptized is inconſiſtent with a ſtate of ſlavery, rendered the ſelfiſh coloniſts for a long time averſe from the converſion of their negroes, and made them throw every obſtacle in the way of all who made the attempt; while the difficulties of the Indian miſſion are ſuch as hardly any clergyman educated in a Proteſtant country can be ſuppoſed able to ſurmount.

He who hopes ſucceſsfully to preach the goſpel among a tribe of ſavage wanderers, muſt have an ardent zeal and unwearied diligence; appetites ſubdued to all the diſtreſſes of want; and a mind ſuperior to all the terrors of mortality. Theſe qualities and habits may be acquired in the church of Rome by him who from infancy has been trained up in the ſeverities of ſome of the monaſtic orders, and afterwards ſent to the college *de propaganda fide* to be inſtructed in the languages, and inured to the manners and cuſtoms, of the barbarous nations whoſe converſion he is deſtined to attempt. But in the reformed churches of Britain there are no monaſtic orders, nor any college *de propaganda fide;* and yet without the regular preparation, which is to be looked for in ſuch inſtitutions alone, it is not in nature, whatever grace may effect, for any man chearfully, and at the ſame time ſoberly, to undergo all the accumulated diſtreſſes ever ready to overtake a faithful miſſionary among ſavage idolaters. A fanatic zealot will indeed undertake it, though he is totally unqualified for every ſober and important work; and a man of ruined fortunes may be preſſed into the ſervice, though the impotency of his mind has ſhown him unable to bear either poverty or riches. The failure of the ſociety therefore in its attempts to convert the American Indians may be attributed, we think, in the firſt inſtance, to the want of a college *de propaganda* for training up young men for the American miſſion.

Perhaps another cauſe of this failure may be found in the conduct of the miſſionaries, who, it is to be preſumed, have not always employed in a proper manner even the ſcanty qualifications which they actually poſſeſſed. The goſpel, plain and ſimple as it is, and fitted in its nature for what it was ordained to effect, cannot be apprehended but by an intellect ſomewhat raiſed above that of a ſavage. Such of the miſſionaries therefore as began their work with *preaching to ſavage and brutal men*, certainly ſet out at the wrong end; for to make the goſpel underſtood, and much more to propagate

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* See his *Sermon*, vol. ii. of his *Works*, 4to.

gate and eſtabliſh it, thoſe ſavages ſhould have been firſt taught the neceſſary arts of civil life, which, while they improve every bodily accommodation, tend at the ſame time to enlarge and enlighten the underſtanding. For want of this previous culture, we doubt not, it hath happened that ſuch of the ſavages as have been baptized into the faith have ſo ſeldom perſevered themſelves, or been able in any degree to propagate among their tribes the Chriſtianity which they had been taught, and that ſucceſſive miſſions have always found it neceſſary to begin anew the work of converſion.

To one or other of theſe cauſes, or to both, may juſtly be attributed the little progreſs which reformed Chriſtianity has made among the Indians of North America; and not to any want of zeal, attention, or liberality, in the directors of the ſociety at home. During the dependence of the United States on the mother-country, great part of the ſociety's funds was properly expended in keeping alive a juſt ſenſe of religion among the Chriſtian coloniſts from Europe, who had ſurely the firſt claims upon this beſt of charities; but now that America has ſeparated herſelf from Great Britain, and ſhown that ſhe is able to maintain her independence, and to make ample proviſion for a regular clergy of her own, the members of the corporation muſt feel themſelves at liberty to beſtow greater attention, and to expend more money than they could formerly do, on the converſion of ſuch Indians as have any intercourſe with the ſettlements which we ſtill poſſeſs. To a body ſo reſpectable, we preſume not to offer advice; but we cannot help thinking, with Biſhop Berkeley, that the moſt ſucceſsful miſſionaries would be children of Indians, educated in a conſiderable number together from the age of ten or twelve in a college *de propaganda fide*, where they ſhould be in no danger of loſing their mother-tongue while they were acquiring a competent knowledge of religion, morality, hiſtory, practical mathematics, and agriculture. "If there were a yearly ſupply (ſays he) of a dozen ſuch miſſionaries ſent abroad into their reſpective countries, after they had received the degree of maſter of arts, and been admitted into holy orders, it is hardly to be doubted but that in a little time the world would ſee good and great effects of their miſſion."

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2. *Society in Scotland for Propagating Chriſtian Knowledge*, was inſtituted in the beginning of the 18th century. At that period the condition of the Scotch Highlanders was truly deplorable. Shut up in deſolate iſlands by tempeſtuous ſeas, or diſperſed over a wide extent of country, interſected by high mountains, rapid rivers, and arms of the ſea, without bridges or highways, by which any communication could be kept open either with remote or neighbouring diſtricts, they lived in ſmall detached companies in hamlets or ſolitary huts. Being thus ſecluded from intercourſe with the more civilized part of the iſland, they could not enjoy the advantages of trade and manufactures. As their ſoil was barren and their climate ſevere, in agriculture no progreſs was to be expected: and as they were acquainted with no language but Gaelic, in which no books were then written, to poſſeſs knowledge was impoſſible. Their pariſhes being of great extent, often 30 or 40 miles long and of a proportionable breadth, and ſometimes conſiſting of ſeveral iſlands ſeparated by ſeas, which are often impaſſable, a conſiderable number of the inhabitants was entirely deprived of religious inſtruction or fell a prey to Popiſh emiſſaries. A ſingle ſchool in ſuch extenſive pariſhes could be of little benefit; yet many pariſhes were entirely deſtitute even of this reſource; and where ſchools were eſtabliſhed, the want of books prevented them from producing the uſeful effects otherwiſe to have been expected from them (A). To all this we muſt add, that they lived in a ſtate of the greateſt oppreſſion: For though the Highlands formed a part of the Britiſh empire, the bleſſings of the Britiſh conſtitution had not reached them. The feudal ſyſtem reigned in its utmoſt rigour; the chieftains exerciſing the moſt deſpotic ſway over the inferior Highlanders, whom at their pleaſure they deprived of their lives or property (B).

Thus the Highlanders were ignorant, oppreſſed, and uncivilized; ſlaves rather than ſubjects; and either entirely deſtitute of the advantages of the Chriſtian religion, or unqualified to improve them. Hitherto they had been unhappy and uſeleſs to themſelves and dangerous to the ſtate; for they were ready at the call of their chieftains to iſſue from their mountains, and to turn their arms againſt their lawful king and his loyal ſubjects. This character, however, aroſe from their ſituation. It was therefore impoſſible for benevolent minds to contemplate this unhappy ſituation of their countrymen without feeling a deſire to raiſe them to the dignity of rational beings, and to render them uſeful as citizens.

Accordingly, in the year 1701, ſome private gentlemen of the city of Edinburgh, who had formed themſelves into a ſociety for the reformation of manners, directed their attention to the Highlands of Scotland, and endeavoured to deviſe ſome plan for alleviating the diſtreſſes of the inhabitants. The remedy which promiſed to be moſt efficacious was, to eſtabliſh charity ſchools in different places. But as the exigency was great, it was no eaſy matter to raiſe a ſufficient fund for this purpoſe. They began therefore with what voluntary ſubſcriptions they could procure, hoping afterwards to increaſe their capital by vacant ſtipends and public contributions. A memorial with this view was preſented to the General Aſſembly in 1704, which received their approbation; and they accordingly paſſed an act, recommending a general contribution. In 1706 the General Aſſembly appointed ſome of their number to inquire more carefully into the ſtate of the Highlands, and the year following appointed a ſelect committee to confer with the gentlemen who had ſuggeſted the plan. The reſult of theſe conferences was the publication of propoſals "for propagating Chriſtian knowledge

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(A) Even ſo late as the year 1758, not fewer than 175 pariſhes, within the bounds of 39 preſbyteries, had no parochial ſchool. We are ſorry to add, that even in the preſent enlightened and benevolent age the complaint is not entirely removed.

(B) The feudal ſyſtem was at length aboliſhed in the year 1748 by the juriſdiction act.

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ledge in the Highlands and Iſlands of Scotland, and in foreign parts of the world." Copies of theſe propoſals, with ſubſcription papers, were diſtributed through the kingdom; and the contributions having ſoon amounted to 1000l. her majeſty Queen Anne encouraged this infant ſociety by her royal proclamation, and at the ſame time iſſued letters patent under the great ſeal of Scotland for erecting certain of the ſubſcribers into a corporation; the firſt nomination of whom was lodged with the lords of council and ſeſſion.

This corporation held its firſt meeting on Thurſday 3d November 1709. It was attended by ſeveral of the nobility, fourteen of the lords of ſeſſion, many gentlemen of rank, together with moſt of the miniſters of the city of Edinburgh and neighbourhood. A preſident, ſecretary, and treaſurer, with a committee of fifteen directors, were appointed for the diſpatch of buſineſs. At their ſecond meeting in January 1710, a ſcheme of management was formed and approved; in which it was propoſed, 1. To erect and maintain ſchools in ſuch places of Scotland, particularly in the Highlands and Iſlands, as ſhould be found to need them moſt; in which ſchools all perſons whatſoever ſhould be taught by fit and well qualified ſchoolmaſters, appointed by the ſociety, to read the Holy Scriptures and other pious books; as alſo to write, and to underſtand the common rules of arithmetic, with ſuch other things as ſhould be thought ſuitable to their circumſtances. 2. That the ſchoolmaſters ſhould be particularly careful to inſtruct their ſcholars in the principles of the Chriſtian reformed religion; and for that end ſhould be obliged to catechiſe them at leaſt twice a week, and to pray publicly with them twice a-day. 3. That not only ſuch as were unable to pay ſhould be taught gratis, but that thoſe whoſe circumſtances required it, ſhould have ſuch farther encouragement as the ſociety ſhould think fit in a conſiſtency with their patent. 4. To name ſome prudent perſons, miniſters and others, to be overſeers of thoſe ſchools, who ſhould take care that the ſchoolmaſters do their duty, and that the inſtructions to be given from time to time by the ſociety or their committee be punctually obſerved; which overſeers ſhould make their report to the ſociety quarterly or half-yearly at fartheſt. 5. To give ſuitable encouragement to ſuch miniſters or catechiſts as ſhould be willing to contribute their aſſiſtance towards the farther inſtruction of the ſcholars remote from church, by not only catechiſing, but preaching to them; which miniſters or catechiſts ſhould take the ſame care of the other inhabitants as of the ſcholars. 6. To extend their endeavours for the advancement of the Chriſtian religion to heathen nations; and for that end to give encouragement to miniſters to preach the goſpel among them.

Having thus formed a plan, they immediately proceeded to eſtabliſh ſchools in the moſt uſeful and economical manner; and as the capital continued to accumulate, the intereſt was faithfully applied, and the utility of the inſtitution was more extenſively diffuſed.

Until the year 1738 the attention of the ſociety had been wholly directed to the eſtabliſhment of ſchools; but their capital being then conſiderably augmented, they began to extend their views of utility much farther. The grand object of all public aſſociations ought certainly to be the promoting of religion and morality. It muſt, however, be evident to every man of reflection, that theſe can neither be propagated nor preſerved among a people without agriculture, unaccuſtomed to commerce and manufactures, and conſequently without labour or exertion. Languor and debility of mind muſt always be the companions of idleneſs. While the Highlanders roved about with arms in their hands, the latent vigour of their minds muſt often have been called forth into action; but when their arms were taken away, and themſelves confined to a domeſtic life, where there was nothing to rouſe their minds, they muſt have ſunk into indolence and inactivity. All attempts therefore to inſtruct them in religion and morality, without introducing among them ſome of the neceſſary arts of life, would probably have been unavailing. The ſociety accordingly reſolved to adopt what appeared to them the moſt effectual methods of introducing induſtry among the Highlanders. But as their patent did not extend far enough, they applied to his majeſty George II. for an enlargement of their powers; and accordingly obtained a ſecond patent, by which they are empowered, "beſides fulfilling the purpoſes of their original patent, to cauſe ſuch of the children as they ſhall think fit to be bred to huſbandry and houſewifery, to trades and manufactures, or in ſuch manual occupations as the ſociety ſhall think proper."

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The objects of this ſecond patent the ſociety have not failed to purſue; and though many obſtacles and diſcouragements to their efforts occurred among a rude and barbarous people, yet their perſeverance, and the obvious utility of their plans, at length ſo far overcame the reluctance of the inhabitants, that not fewer than 94 ſchools of induſtry in various parts of the Highlands and Iſlands are now upon their eſtabliſhment, at which are educated 2360 ſcholars.

The ſociety, while anxiouſly endeavouring to diffuſe a ſpirit of induſtry through the Highlands, were ſtill equally ſolicitous to promote the knowledge of the Chriſtian religion. As the Engliſh language had been the only channel by which knowledge was conveyed to them (a language which, being not uſed in converſation, was in all reſpects foreign to them), it was judged requiſite that they ſhould have the Scriptures in their vernacular tongue. The ſociety therefore firſt appointed a tranſlation of the New Teſtament to be made into Gaelic: A tranſlation was accordingly undertaken by the Rev. Mr Stewart miniſter of Killin in Perthſhire, and printed in 1767, which is ſaid to be executed with much fidelity. Of this work many thouſand copies have been diſtributed in the Highlands. The greater part of the Old Teſtament has alſo been tranſlated by the Rev. Dr Smith of Campbelton and others, but chiefly by the Rev. Dr Stewart of Luſs, by the appointment and at the expence of the ſociety: and as ſoon as the remaining part can be got ready, the whole will be ſold at ſo low a price as the poor may without difficulty afford. This plan the ſociety have judiciouſly choſen, in order to prevent diſcontent and murmuring; effects which the diffuſion of the Scriptures ought never to produce; but which could not poſſibly have been prevented, had the diſtribution been gratuitous, and of courſe partial.

For ſome years paſt the funds of the ſociety have rapidly

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pidly accumulated, from the very liberal donations of ſeveral individuals.

Lady Glenorchy,	-	L. 5,000
By a perſon unknown,	-	10,000
Lord Van Vryhouven of Holland,		20,000
Miſs Gray of Teaſſes,	-	3,500

In conſequence of theſe great additions to their ſtock, inſinuations have been thrown out that the ſociety have become ſo wealthy as to be at a loſs for proper objects on which to beſtow their increaſed revenue. If ſuch an opinion be *ſeriouſly* entertained by any one, we muſt beg him to remember, that the ſociety have erected and endowed not fewer than 323 ſchools for religion, the firſt principles of literature and induſtry, at the annual expence of 3214l. 10s. ſterling; and that at theſe ſeminaries are educated from 14,000 to 15,000 children; who, but for the means of inſtruction thus obtained, would in all probability be bred up in ignorance and idleneſs: That they employ 12 miſſionary miniſters and catechiſts in remote parts of the Highlands and iſlands, or among the ignorant Highlanders ſettled in the great towns of Scotland, at the annual expence of 296l.: That they beſtow a burſary or penſion of 15l. per annum on each of ſix ſtudents of divinity having the Gaelic language: That they employ two miſſionary miniſters and one ſchoolmaſter among the Oneida and Stockbridge Indians of North America (being the deſtination of certain legacies bequeathed to them for that purpoſe), at the annual expence of 140l. Such is their fixed ſcheme of annual expenditure, amounting in all to 3740l. 10s. ſterling—a ſum it will be acknowledged of very conſiderable magnitude. The whole of their incidental expences ariſing from the Gaelic tranſlation of the Scriptures of the Old Teſtament; from annuities which they have to pay, in conſequence of ſums left them as reſiduary legatees; from land and houſe taxes; from enabling candidates for the office of ſchoolmaſter to come to Edinburgh for examination; from furniſhing books to poor ſcholars in their various ſchools; and from removing ſchoolmaſters from one ſtation to another, is generally about 875l. which added to the former ſum makes the whole annual expence amount to 4615l. 10s.

If it be inquired at what expence, in the *management* of it, this extenſive and complicated charity is annually conducted, we are authoriſed to ſay, that the treaſurer, bookholder, and clerk, are allowed each 25l. per annum, the ſame ſalaries which were annexed to theſe offices from the commencement of the ſociety. The beadle or officer is allowed 12l. per annum. No ſalary whatever is enjoyed by any of the other officers of the ſociety. The ſecretary, comptroller, accountant, and librarian, although ſubjected, ſome of them eſpecially, to no ſmall expence of time and labour, have no pecuniary recompenſe or emolument. Theirs are labours of love, for which they ſeek and expect no other reward than the conſciouſneſs of endeavouring to promote the beſt intereſts of mankind. The whole amount of the expence of managing the buſineſs of the ſociety, including the above ſalaries, and coals, candle, ſtationary ware, poſtages, and other incidents, exceeds not at an average 115l. per annum. From this ſtatement it appears, that hitherto at leaſt the directors have been at no loſs for important objects within the proper ſphere of their inſtitution on which to beſtow their increaſed funds. They have, it is true, the diſpoſal of very conſiderable ſums for promoting the objects of the inſtitution; but they are ſo far from accumulating wealth, that every year their expenditure, notwithſtanding the late increaſe of their capital, exceeds rather than falls ſhort of their income. They have depended upon a kind Providence and a generous public to refund theſe anticipations of their revenue, and hitherto they have never been diſappointed.

Thus has the Society for Propagating Chriſtian Knowledge proceeded for almoſt a century. It was founded by the pious exertions of a few private individuals, whoſe names are unknown to the world; and its funds, by faithful and judicious management, as well as by generous contributions, have now become of ſuch magnitude, as to excite the hope that they will be productive of the moſt valuable effects. The benefits ariſing from public ſocieties, it is well known, depend entirely upon the management of their directors. If ſo, the advantages which have accrued from this ſociety intitle it to the praiſe and gratitude of the nation. While eager to increaſe the number of ſchools, the ſociety have not been inattentive to their proſperity. In the year 1771 Mr Lewis Drummond, a gentleman in whom they placed great confidence, was commiſſioned by them to viſit their ſchools, and to make an exact report of their ſtate and circumſtances. Again, in the year 1790, a commiſſion was granted to the Rev. Dr Kemp, one of the miniſters of Edinburgh and ſecretary to the ſociety, to viſit all the ſchools on their eſtabliſhment. This laborious and gratuitous taſk he accompliſhed in the courſe of four ſummers with much ability and care, and highly to the ſatisfaction of the ſociety. At his return he communicated a variety of important information reſpecting the ſtate of the Highlands and Iſlands, and the means neceſſary for their improvement in religion, literature, and induſtry; an abſtract of which was publiſhed by the ſociety in appendixes to the anniverſary ſermons preached before them in the years 1789, 90, 91, and 92 (c).

The following table will exhibit at a glance the funds, eſtabliſhment, and expenditure, of the ſociety, from a few years after its commencement to the preſent time.

Where

(c) It is well known, that the number of Roman Catholics in the Highlands is conſiderable; but it muſt give much pleaſure to the Proteſtant reader to be informed, that the ancient malignant ſpirit of Popery has in that diſtrict given place to mildneſs and liberality. This is chiefly owing to the gentleman who ſuperintends the prieſts in that quarter, whoſe mind is enlightened by ſcience and learning. So far from being hoſtile to the views of the ſociety, he recommended to his clergy to promote them. They accordingly received the ſecretary with much politeneſs; exhorted the people to ſend their children to the Proteſtant ſchools to be inſtructed in literature, to be taught to read the Scriptures in their own language, and to be made acquainted with thoſe great principles of religion in which all Chriſtians are agreed. What a bleſſed reformation!

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Where the number of ſcholars is not mentioned, the defect may be ſupplied by taking an average from thoſe years where a computation has been made. Where the capital is not mentioned, it may eaſily be made out by conſidering the ſalaries as the intereſt.

A.D.	Capital.	Schools.	Scholars.
1713		12	
1715	L. 6,177	25	
1719	8,168	48	
1727	9,131	78	2757
1732	13,318	109	
1742	19,287	128	
1753	24,308	152	
1758	28,413	176	6409
1781	34,000	180	7000
	Salaries		
1793	3,080	307	12,913
1794	3,214	323	14,370

Hitherto we have taken no notice of the correſponding board which was eſtabliſhed at London ſo early as the year 1729, to receive ſubſcriptions and lay out ſums. That board indeed remained long inactive; but in 1773 its members began to co-operate more cordially with their brethren in Scotland. Since that period an annual ſermon has been preached in recommendation of the charity; and the preacher is now ſelected without any regard to the religious denomination to which he belongs; ſometimes from the church of England, ſometimes from the church of Scotland, and ſometimes from ſectaries of different perſuaſions. The meetings of the correſpondent board have been attended by many of the nobility and gentry, who have made great exertions to promote the views of the ſociety. From its preſent flouriſhing ſtate therefore, from the indefatigable exertion and laudable zeal of the managers, and from the countenance and ſupport which they have received from perſons of the firſt rank and reſpectability in the nation, the benevolent mind may look forward with much confidence and ſatisfaction to a period not very diſtant, when its beneficial effects ſhall be felt not only in the Highlands, but ſhall be communicated to the reſt of the nation. We have been thus particular in our account of the Society for Propagating Chriſtian Knowledge, becauſe we have had acceſs to the moſt authentic ſources of information, and becauſe we know it to be an inſtitution calculated to enlighten and improve a conſiderable part of the Britiſh nation.

3. *Society of the Sons of the Clergy*, was incorporated by King Charles II. in 1678, by the name of *The Governors of the Charity for Relief of the Poor Widows and Children of Clergymen*. This ſociety is under the direction and management of a preſident and vice-preſident, three treaſurers, and a court of aſſiſtants compoſed of forty members. Several hundreds of widows and children of the clergy have annually received conſiderable relief from this uſeful charity.

4. *Society for the Sons of the Clergy of the Eſtabliſhed Church of Scotland*, was inſtituted at Edinburgh in February 1790, and was conſtituted a body corporate by his majeſty's royal charter in 1792. The ſociety, after ſeveral meetings, are of opinion, that the period in which the families of clergymen feel moſt urgently the need both of friends and of pecuniary aid, is that which commences with the introduction of the ſons either to an univerſity or to buſineſs, and terminates with their eſtabliſhment in their reſpective profeſſions; that many of the miniſters of this church, living at great diſtances from the ſeats either of univerſities or of buſineſs, poſſeſs incomes which, in the preſent ſtate of the country, are inadequate to the purpoſes of procuring for their ſons either the literary or profeſſional education which might enable them to come forward with credit and ſucceſs in the world; that the ſons of clergymen, from domeſtic tuition and example, have in general very advantageous means of receiving in their early years the impreſſions of virtue and honour, together with the rudiments of liberal knowledge; and that of courſe the public intereſt may be promoted, by enabling this claſs of young men to obtain their ſhare in the reſpectable ſituations of life. The views of the ſociety have been limited to the ſons only of clergymen; as they are of opinion, that within the limits which they have fixed, the field of beneficence will be ſtill very extenſive, and the claims for aid as many and as great as their funds can be ſuppoſed able to anſwer, at leaſt for many years to come. If the ſociety ſhall ever be in a ſituation to undertake more than the aids which will be neceſſary in bringing forward the ſons of the clergy, it may then be conſidered in what manner the daughters alſo may become ſharers in its bounty.

A ſociety of the ſame nature, and having the ſame objects in view, was inſtituted at Glaſgow we think the year before; and both ſocieties, we know, have in many caſes proved highly beneficial in promoting the views for which they were inſtituted.

5. *Royal Humane Society*, was inſtituted in London in 1774, for the recovery of perſons drowned or otherwiſe ſuffocated. We have already given ſome account of ſocieties inſtituted in other countries with the ſame views, and have alſo copied the directions of this ſociety for the recovery of life, for which ſee the article DROWNING. We have therefore only to ſtate, that the plan of this ſociety is ſo averſe to any private intereſted views, that it acquits its founders of all ſordid motives. For the medical practitioners accept no pecuniary recompenſe for the time which they devote to a difficult and tedious proceſs; for the anxiety which they feel while the event is doubtful: for the mortification which they too often undergo, when death, in ſpite of all their efforts, at laſt carries off his prey; nor for the inſults to which they willingly expoſe themſelves from vulgar incredulity. Their ſole reward is in the holy joy of doing good. Of an inſtitution thus free in its origin from the ſuſpicion of ambitious views, and in its plan renouncing ſelf-intereſt in every ſhape, philanthropy muſt be the only baſis. The good intention therefore of the ſociety is proved by its conſtitution; the wiſdom and utility of the undertaking are proved by its ſucceſs: not fewer than 3000 fellow-creatures having ſince its commencement been (1794) reſtored to the community by its timely and indefatigable exertions. For it is to be obſerved, that the benefit of this ſociety is by no means confined to the two caſes of drowning and ſuſpenſion. Its timely ſuccours have rouſed the lethargy of opium taken in immoderate and repeated doſes; they have reſcued the wretched victims of intoxication; rekindled the life extinguiſhed by the ſudden ſtroke of lightning; recovered the apoplectic; reſtored life to the infant that had loſt it in the birth; they have proved

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efficacious in caſes of accidental ſmothering and of ſuffocation by noxious damps; in inſtances in which the tenderneſs of the infant body or the debility of old age greatly leſſened the previous probability of ſucceſs: inſomuch that no ſpecies of death ſeems to be placed beyond the reach of this ſociety's aſſiſtance, where the miſchief had gone no farther than an obſtruction of the movements of the animal machine without any damage of the organs themſelves. In conſequence of every neceſſary aſſiſtance afforded by this ſociety, ſimilar inſtitutions have been eſtabliſhed at Algiers, Liſbon, Philadelphia, Boſton, Jamaica, Dublin, Leith, Glaſgow, Paiſley, Aberdeen, Birmingham, Glouceſter, Shropſhire, Northamptonſhire, Lancaſter, Briſtol, Whitehaven, Norwich, Exeter, Kent, and Newcaſtle. The ſociety has publiſhed an 8vo volume with plates, conſiſting of caſes, correſpondence, and a variety of intereſting matter relating to the object of this benevolent inſtitution.

6. *The Philanthropic Society*, was inſtituted in September 1788. It aims at the prevention of crimes, by removing out of the way of evil counſel, and evil company, thoſe children who are, in the preſent ſtate of things, deſtined to ruin. It propoſes to educate and inſtruct in ſome uſeful trade or occupation the children of convicts or other infant poor who are engaged in vagrant or criminal courſes; thus to break the chain of thoſe pernicious confederacies, deprive the wicked of ſucceſſors, the gaols of inhabitants, juſtice of its victims, and by all theſe means add citizens to ſociety. This inſtitution is not only calculated to decreaſe vice and infamy, but to increaſe uſeful induſtry; ſo that thoſe children who would otherwiſe ſucceed to their parents hereditary crimes, and become the next race of beggars and thieves, will now be taught to ſupply by honeſt means their own wants and the wants of others.

To carry into effect theſe deſirable purpoſes, it is the firſt buſineſs of the ſociety to ſelect from priſons, and from the haunts of vice, profligacy, and beggary, ſuch objects as appear moſt likely to become obnoxious to the laws, or prejudicial to the community; and, in the execution of this duty, the aſſiſtance of the magiſtrates, the clergy, and all who are intereſted in the promotion of good morals and good government, is moſt earneſtly requeſted. For the employment of the children, ſeveral houſes are ſupported, at Cambridge Heath, near Hackney, in each of which a maſter-workman is placed for the purpoſe of teaching the children ſome uſeful trade. The trades already eſtabliſhed are thoſe of a printer, carpenter, ſhoemaker, and taylor. The girls are at preſent educated as menial ſervants.

In the year 1791 not fewer than 70 children were under the protection of this ſociety, among whom were many who have been guilty of various felonies, burglaries, and other crimes. Yet, ſingular as it may appear, in leſs than two years thoſe very children became no leſs remarkable for induſtry, activity, decency, and obedience, than they formerly were for the contrary vices. Such are the grounds on which the Philanthropic Society now claims the attention and ſolicits the patronage of the public. If we regard humanity and religion, this inſtitution opens an aſylum to the moſt forlorn and abject of the human race; it befriends the moſt friendleſs; it ſaves from the certain and fatal conſequences of infamy and vicious courſes orphans and deſerted children. If we regard national proſperity and the public welfare, it is calculated to increaſe induſtry; and it directs that induſtry into the moſt uſeful and neceſſary channels. If we regard ſelf-intereſt, its immediate object is to protect our perſons from aſſault and murder, our property from depredation, and our peaceful habitations from the deſperate fury of midnight incendiaries.

Religious and Humane Societies.

One guinea per annum conſtitutes a member of the ſociety; and 10l. at one payment a member for life. A life-ſubſcription, or an annual payment of at leaſt two guineas, is a neceſſary qualification for being elected into the committee.

II. Societies for Promoting Science and Literature.

1. *The Royal Society of London* is an academy or body of perſons of eminent learning, inſtituted by Charles II. for the promoting of natural knowledge. The origin of this ſociety is traced by Dr Sprat, its earlieſt hiſtorian, no farther back than to "ſome ſpace after the end of the civil wars" in the 17th century. The ſcene of the firſt meetings of the learned men who laid the foundation of it, is by him fixed in the univerſity of Oxford, at the lodgings of Dr Wilkins warden of Wadham college. But Dr Birch, on the authority of Dr Wallis, one of its earlieſt and moſt conſiderable members, aſſigns it an earlier origin. According to him, certain worthy perſons, reſiding in London about the year 1645, being "inquiſitive into natural and the new and experimental philoſophy, agreed to meet weekly on a certain day, to diſcourſe upon ſuch ſubjects, and were known by the title of *The Inviſible* or *Philoſophical College*." In the years 1648 and 1649, the company who formed theſe meetings was divided, part retiring to Oxford and part remaining in London; but they continued the ſame purſuits as when united, correſponding with each other, and giving a mutual account of their reſpective diſcoveries. About the year 1659 the greater part of the Oxford ſociety returned to London, and again uniting with their fellow-labourers, met once, if not twice, a-week at Greſham college, during term time, till they were ſcattered by the public diſtractions of that year, and the place of their meeting made a quarter for ſoldiers. On the reſtoration 1660 their meetings were revived, and attended by a greater concourſe of men eminent for their rank and learning. They were at laſt taken notice of by the king, who having himſelf a conſiderable taſte for phyſical ſcience, was pleaſed to grant them an ample charter, dated the 15th of July 1662, and afterwards a ſecond dated 15th April 1763, by which they were erected into a corporation, conſiſting of a preſident, council, and fellows, for promoting natural knowledge; and to give their inveſtigations, againſt which ſtrange prejudices were entertained, every poſſible ſupport, he ſometimes honoured their meetings with his preſence.

Their manner of electing fellows is by balloting. Their council are in number 21, including the preſident, vice-preſident, treaſurer, and two ſecretaries; 11 of which are continued for the next year, and 10 more added to them; all choſen on St Andrew's day. Each member at his admiſſion ſubſcribes an engagement that he will endeavour to promote the good of the ſociety; from which he may be freed at any time, by ſignifying to the preſident that he deſires to withdraw. The charges have been different at different times, and were at firſt irregularly paid: but they are now five guineas paid to the treaſurer at admiſſion, and 13s. per quarter ſo long as the perſon continues a member; or, in lieu of the annual ſubſcription, a compoſition of 25 guineas in one payment.

Their deſign is, to "make faithful records of all the works of nature or art which come within their reach; ſo that the preſent as well as future ages may be enabled to put a mark on errors which have been ſtrengthened by long preſcription; to reſtore truths that have been neglected; to puſh thoſe already known to more various uſes; to make the way more paſſable to what remains unrevealed," &c. To this purpoſe they have made a great number of experiments and obſervations on moſt of the works of nature; and alſo numbers of ſhort hiſtories of nature, arts, manufactures, uſeful engines, contrivances, &c. The ſervices which they have rendered to the public are very great. They have improved naval, civil, and military architecture; advanced the ſecurity and perfection of navigation; improved agriculture; and put not only this kingdom, but alſo Ireland, the plantations, &c. upon planting. They have regiſtered experiments, hiſtories, relations, obſervations, &c. and reduced them into one common ſtock; and have, from time to time, publiſhed thoſe which they reckoned moſt uſeful, under the title of *Philoſophical Tranſactions*, &c. and laid the reſt up in public regiſters, to be nakedly tranſmitted to poſterity, as a ſolid groundwork for future ſyſtems.

They have a library adapted to their inſtitution; towards which Mr Henry Howard, afterwards duke of Norfolk, contributed the Norfolcian library, and which is, at this time, greatly increaſed by a continual ſeries of benefactions. The muſeum or repoſitory of natural and artificial rarities, given them by Daniel Colwal, Eſq. and ſince enriched by many others, is now removed to the Britiſh muſeum, and makes a part of that great repoſitory. Their motto is *Nullius in verba;* and their place of aſſembling is Somerſet houſe in the Strand. Sir Godfrey Copley, baronet, left five guineas to be given annually to the perſon who ſhould write the beſt paper in the year, under the head of experimental philoſophy. This reward, which is now changed to a gold medal, is the higheſt honour the ſociety can beſtow. It is conferred on St Andrew's day.

2. *The Royal Society of Edinburgh*, was incorporated by royal charter on the 29th of March 1783, and has for its object the cultivation of every branch of ſcience, erudition, and taſte. Its riſe and progreſs towards its preſent ſtate was as follows: In the year 1718 a literary ſociety was eſtabliſhed in Edinburgh by the learned Ruddiman and others, which in 1731 was ſucceeded by a ſociety inſtituted for the improvement of medical knowledge. In the year 1739 the celebrated Maclaurin conceived the idea of enlarging the plan of this ſociety, by extending it to ſubjects of philoſophy and literature. The inſtitution was accordingly new-modelled by a printed ſet of laws and regulations, the number of members was increaſed, and they were diſtinguiſhed from that time by the title of *The Society for Improving Arts and Sciences*, or more generally by the title of *The Philoſophical Society of Edinburgh*. Its meetings, however, were ſoon interrupted by the diſorders of the country during the rebellion in 1745; and they were not renewed till the year 1752. Soon after this period the firſt volume of the Tranſactions of the Philoſophical Society of Edinburgh was publiſhed, under the title of *Eſſays and Obſervations, Phyſical and Literary*, and was followed by other volumes of acknowledged merit. About the end of the year 1782, in a meeting of the profeſſors of the univerſity of Edinburgh, many of whom are likewiſe members of the Philoſophical Society, and warmly attached to its intereſts, a ſcheme was propoſed by the Rev. Dr Robertſon, principal of the univerſity, for the eſtabliſhment of a new ſociety on a more extended plan, and after the model of ſome of the foreign academies. It appeared an expedient meaſure to ſolicit the royal patronage to an inſtitution of this nature, which promiſed to be of national importance, and to requeſt an eſtabliſhment by charter from the crown. The plan was approved and adopted; and the Philoſophical Society, joining its influence as a body in ſeconding the application from the univerſity, his majeſty, as we have already obſerved, was moſt graciouſly pleaſed to incorporate The Royal Society of Edinburgh by charter.

The ſociety conſiſts of ordinary and honorary members; and the honorary places are reſtricted to perſons reſiding out of Great Britain and Ireland. The election of new members is appointed to be made at two ſtated general meetings, which are to be held on the fourth Monday of January and the fourth Monday of June. A candidate for the place of an ordinary member muſt ſignify by a letter, addreſſed to one of the members, his wiſh to be received into the ſociety. He muſt then be publicly propoſed at leaſt a month before the day of election. If the propoſal be ſeconded by two of the members preſent, his name is to be inſerted in the liſt of candidates, and hung up in the ordinary place of meeting. The election is made by ballot, and is determined in favour of a candidate, if he ſhall have the votes of two-thirds of thoſe preſent, in a meeting conſiſting of at leaſt 21 members. The general buſineſs of the ſociety is managed by a preſident, two vice-preſidents, with a council of 12, a general ſecretary, and a treaſurer. Theſe officers are choſen by ballot annually on the laſt Monday of November. All public deeds, whether of a civil or of a literary nature, are tranſacted by this board, and proceed in the name of the preſident or vice-preſident.

As it was thought that the members would have a greater inducement to punctual attendance on the meetings of the ſociety, if they had ſome general intimation of the nature of the ſubjects which were to be conſidered, and made the topics of converſation, it was therefore reſolved to divide the ſociety into two claſſes, which ſhould meet and deliberate ſeparately. One of theſe claſſes is denominated the *Phyſical Claſs*, and has for its department the ſciences of mathematics, natural philoſophy, chemiſtry, medicine, natural hiſtory, and whatever relates to the improvement of arts and manufactures. The other is denominated the *Literary Claſs*, and has for its department literature, philology, hiſtory, antiquities, and ſpeculative philoſophy. Every member is deſired at his admiſſion to intimate which of thoſe claſſes he wiſhes to be more particularly aſſociated with; but he is at the ſame time intitled to attend the meetings of the other claſs, and to take part in all its proceedings. Each of the claſſes has four preſidents and two ſecretaries, who officiate by turns. The meetings of the phyſical claſs are held on the firſt Mondays of January, February, March, April, July, Auguſt, November, and December; and the meetings of the Literary claſs are held on the third Mondays of January, February, March, April, June, July, November, and December, at 7 o'clock afternoon.

At theſe meetings the written eſſays and obſervations of the members of the ſociety, or their correſpondents, are read publicly, and become the ſubjects of converſation. The ſubjects of theſe eſſays and obſervations are announced at a previous meeting, in order to engage the attendance of thoſe members who may be particularly intereſted in them. The author of each diſſertation is likewiſe deſired to furniſh the ſociety with an abſtract of it, to be read at the next enſuing meeting, when the converſation is renewed with increaſed advantage, from the knowledge previouſly acquired of the ſubject. At the ſame meetings are exhibited ſuch ſpecimens of natural or artificial curioſities, ſuch remains of antiquity, and ſuch experiments, as are thought worthy of the attention of the ſociety. All objects of natural hiſtory preſented to the ſociety, are ordered by the charter of the inſtitution to be depoſited, on receipt, in the muſeum of the univerſity of Edinburgh; and all remains of antiquity, public records, or ancient manuſcripts, in the library belonging to the faculty of advocates at Edinburgh.

The ordinary members, whoſe uſual reſidence is in the city of Edinburgh or its immediate neighbourhood, are expected to attend regularly the monthly meetings; and are required to defray, by an annual contribution, the current expences of the inſtitution. The members who reſide at ſuch a diſtance from Edinburgh, that they cannot enjoy the advantages ariſing from a regular attendance on the meetings of the ſociety, are not ſubjected to any contribution for defraying its expences, but have a right to attend thoſe meetings when occaſionally in Edinburgh, and to take part in all their proceedings.

Five volumes of the Tranſactions of the ſociety have been publiſhed, which bear ample teſtimony to the learning and acuteneſs of their various authors.

3. *Medical Society* of London, inſtituted in the year 1752, on the plan recommended by Lord Bacon (*De Augm. Scient.* lib. iv. cap. 2.), to revive the Hippocratic method of compoſing narratives of particular caſes, in which the nature of the diſeaſe, the manner of treating it, and the conſequences, are to be ſpecified; to attempt the cure of thoſe diſeaſes which, in his opinion, have been too boldly pronounced incurable; and, laſtly, to extend their inquiries after the powers of particular medicines in the cure of particular caſes; the collections of this ſociety have been already publiſhed, under the title of *Medical Obſervations and Inquiries*, in ſeveral volumes.

4. *The Medical Society* of Edinburgh was incorporated by royal charter in 1778; but there appears to have been in that city a voluntary aſſociation of the ſame name from the firſt eſtabliſhment of a regular ſchool of phyſic in the univerſity. To the voluntary ſociety the public is indebted for ſix volumes of curious and uſeful eſſays, collected principally by the late Dr Monro from June 1731 to June 1736; but in the year 1739 that ſociety was united to another, as we have already obſerved in a former article. The ordinary members of the preſent medical ſociety are elected by ballot, and three diſſentients exclude a candidate; an ordinary member may alſo be elected an honorary member, who enjoys the privileges of the others, and receives a diploma, but is freed from the obligation of attendance, delivering papers in rotation, &c. to which the ordinary members are ſubject; but in this caſe the votes muſt be unanimous. The meetings of this ſociety are held every Friday evening (formerly Saturday) in their own hall, during the winter ſeaſon, when papers on medical ſubjects are delivered by the ſeveral members in rotation; and four of theſe are annually elected to fill the chair in rotation, with the title of annual preſidents. This ſociety poſſeſſes an excellent library of books on ſubjects connected with its purſuits.

5. *The Royal Medical Society* of Paris was inſtituted in 1776. The members are divided into aſſociates ordinary, limited to 30, honorary to 12, extraordinary to 60, and foreign to 60, and correſpondents. This ſociety has publiſhed ſeveral volumes of Memoirs in 4to.

6. *Aſiatic Society*, an inſtitution planned by the late illuſtrious Sir William Jones, and actually formed at Calcutta on the 15th of January 1784, for the purpoſe of tracing the hiſtory, antiquities, arts, ſciences, and literatnre, of the immenſe continent of Aſia. As it was reſolved to follow as nearly as poſſible the plan of the ROYAL SOCIETY of London, of which the king is *patron*, the patronage of the Aſiatic Society was offered to the governor-general and council, as the executive power in the territories of the company. By their acceptance of this offer, Mr Haſtings, as governor-general, appeared among the patrons of the new ſociety; "but he ſeemed in his private ſtation, as the firſt liberal promoter of uſeful knowledge in Bengal, and eſpecially as the great encourager of Perſian and Shanſcrit literature, to deſerve a particular mark of diſtinction:" he was requeſted, therefore, to accept the honorary title of preſident. This was handſomely declined in a letter from Mr Haſtings, in which he requeſted "to yield his pretenſions to the gentleman whoſe genius planned the inſtitution, and was moſt capable of conducting it to the attainment of the great and ſplendid purpoſes of its formation." On the receipt of this letter, Sir William Jones was nominated preſident of the ſociety; and we cannot give the reader a view of the object of the inſtitution in clearer language than that which he employed in his firſt diſcourſe from the chair.

"It is your deſign, I conceive (ſaid the preſident), to take an ample ſpace for your learned inveſtigations, bounding them only by the geographical limits of Aſia; ſo that, conſidering Hindoſtan as a centre, and turning your eyes in idea to the north, you have on your right many important kingdoms in the eaſtern peninſula, the ancient and wonderful empire of China with all her Tartarian dependencies, and that of Japan, with the cluſter of precious iſlands, in which many ſingular curioſities have too long been concealed: before you lies that prodigious chain of mountains, which formerly perhaps were a barrier againſt the violence of the ſea, and beyond them the very intereſting country of Tibet, and the vaſt regions of Tartary, from which, as from the Trojan horſe of the poets, have iſſued ſo many conſummate warriors, whoſe domain has extended at leaſt from the banks of the Ilyſſus to the mouths of the Ganges: on your left are the beautiful and celebrated provinces of of Iran or Perſia, the unmeaſured and perhaps unmeaſurable deſerts of Arabia, and the once flouriſhing kingdom of Yemen, with the pleaſant iſles that the Arabs have ſubdued or colonized; and farther weſtward, the Aſiatic dominions of the Turkiſh ſultans, whoſe moon ſeems approaching rapidly to its wane. By this great circumference the field of your uſeful reſearches will be incloſed; but ſince Egypt had unqueſtionably an old connection with this country, if not with China, ſince the language and literature of the Abyſſinians bear a manifeſt affinity to thoſe of Aſia, ſince the Arabian arms prevailed along the African coaſt of the Mediterranean, and even erected a powerful dynaſty on the continent of Europe, you may not be diſpleaſed occaſionally to follow the ſtreams of Aſiatic learning a little beyond its natural boundary; and, if it be neceſſary or convenient that a ſhort name or epithet be given to our ſociety, in order to diſtinguiſh it in the world, that of *Aſiatic* appears both claſſical and proper, whether we conſider the place or the object of the inſtitution, and preferable to *Oriental*, which is in truth a word merely relative, and though commonly uſed in Europe, conveys no very diſtinct idea.

“If now it be aſked, What are the intended objects of our inquiries within theſe ſpacious limits? we anſwer, MAN and NATURE; whatever is performed by the *one* or produced by the *other*. Human knowledge has been elegantly analyſed according to the three great faculties of the mind, *memory*, *reaſon*, and *imagination*, which we conſtantly find employed in arranging and retaining, comparing and diſtinguiſhing, combining and diverſifying, the ideas, which we receive through our ſenſes, or acquire by reflection; hence the three main branches of learning are, *hiſtory*, *ſcience*, and *art*; the firſt comprehends either an account of natural productions, or the genuine records of empires and ſtates; the ſecond embraces the whole circle of pure and mixed mathematics, together with ethics and law, as far as they depend on the reaſoning faculty; and the third includes all the beauties of imagery and the charms of invention, diſplayed in modulated language, or repreſented by colour, figure, or ſound.

“Agreeable to this analyſis, you will inveſtigate whatever is rare in the ſtupendous fabric of nature, will correct the geography of Aſia by new obſervations and diſcoveries; will trace the annals and even traditions of thoſe nations who from time to time have peopled or deſolated it; and will bring to light their various forms of government, with their inſtitutions civil and religious; you will examine their improvements and methods in arithmetic and geometry; in trigonometry, menſuration, mechanics, optics, aſtronomy, and general phyſics; their ſyſtems of morality, grammar, rhetoric, and dialect; their ſkill in chirurgery and medicine; and their advancement, whatever it may be, in anatomy and chemiſtry. To this you will add reſearches into their agriculture, manufactures, trade; and whilſt you inquire with pleaſure into their muſic, architecture, painting, and poetry, will not neglect thoſe inferior arts by which the comforts and even elegancies of ſocial life are ſupplied or improved. You may obſerve, that I have omitted their languages, the diverſity and difficulty of which are a ſad obſtacle to the progreſs of uſeful knowledge; but I have ever conſidered languages as the mere inſtruments of real learning, and think them improperly confounded with learning itſelf: the attainment of them is, however, indiſpenſably neceſſary; and if to the Perſian, Armenian, Turkiſh, and Arabic, could be added not only the Shanſcrit, the treaſures of which we may now hope too ſee unlocked, but even the Chineſe, Tartarian, Japaneſe, and the various inſular dialects, an immenſe mine would then be open, in which we might labour with equal delight and advantage.”

Of this ſociety three volumes of the Tranſactions have been publiſhed, which are replete with information in a high degree curious and important; and we hope that the European world ſhall ſoon be favoured with another. The much-to-be-lamented death of the accompliſhed preſident may indeed damp the ſpirit of inveſtigation among the members; for to conquer difficulties ſo great as they muſt meet with, a portion ſeems to be neceſſary of that enthuſiaſm which accompanied all the purſuits of Sir William Jones; but his ſucceſſor is a man of great worth and learning, and we truſt will uſe his utmoſt endeavours to have the plan completed of which Sir William gave the outlines.

5. *The American Philoſophical Society*, held at Philadelphia, was formed in January 1769 by the union of two ſocieties which had formerly ſubſiſted in that city. This ſociety extends its attention to geography, mathematics, natural philoſophy, and aſtronomy; medicine and anatomy; natural hiſtory and chemiſtry; trade and commerce; mechanics and architecture; huſbandry and American improvements. Its officers are a patron, preſident, three vice-preſidents, one treaſurer, four ſecretaries, and three curators, who are annually choſen by ballot. The duty of the preſident, vice-preſidents, treaſurer, and ſecretaries, is the ſame as in other ſocieties. The buſineſs of the curators is to take the charge of all ſpecimens of natural productions, whether of the animal, vegetable, or foſſil kingdom; all models of machines and inſtruments; and all other matters belonging to the ſociety which ſhall be intruſted to them. The ordinary meetings are held on the firſt and third Fridays of every month from October to May incluſive. This ſociety was incorporated by charter 15th March 1780; and has publiſhed three volumes of its Tranſactions, containing many ingenious papers on general literature and the ſciences, as well as reſpecting thoſe ſubjects peculiar to America. It is a delightful proſpect to the philoſopher to conſider, that Aſia, Europe, and America, though far ſeparated and divided into a variety of political ſtates, are all three combined to promote the cauſe of knowledge and truth.

6. *A Literary and Philoſophical Society* of conſiderable reputation has been lately eſtabliſhed at Mancheſter, under the direction of two preſidents, four vice-preſidents, and two ſecretaries. The number of members is limited to 50; beſides whom there are ſeveral honorary members, all of whom are elected by ballot; and the officers are choſen annually in April. Five volumes of valuable eſſays have been already publiſhed by this ſociety.

A ſociety on a ſimilar plan has been eſtabliſhed at Newcaſtle. It is compoſed of a number of moſt reſpectable members, and poſſeſſes a very valuable library and philoſophical apparatus. Lectures on the different branches of natural philoſophy have been delivered for ſeveral years at this inſtitution.

7. *Society for Promoting the Diſcovery of the Interior*

Parts of Africa. This ſociety or aſſociation for exploring the internal diſtricts of Africa, of which ſo little is at preſent known, was formed in London by ſome opulent individuals in 1788; who, ſtrongly impreſſed with a conviction of the practicability and utility of thus enlarging the fund of human knowledge, determined if poſſible to reſcue the age from that ſtigma which attaches to its ignorance of ſo large and ſo near a portion of the globe. The founders of this ſociety reſolved to admit no man a member for a ſhorter period than three years, during which he muſt pay annually into the public fund five guineas. After three years, any member, upon giving a year's notice, may withdraw himſelf from the aſſociation. During the firſt 12 months each of the members was allowed to recommend for the approbation of the ſociety ſuch of his friends as he might think proper to be admitted into it; but ſince that period we believe all additional members have been elected by a ballot of the aſſociation at large. A committee was choſen by ballot to manage the funds of the ſociety, to chooſe proper perſons to be ſent on the diſcovery of the interior parts of Africa, and to carry on the ſociety's correſpondence, with expreſs injunctions to diſcloſe no intelligence received from their agents but to the ſociety at large. But a fuller account of the nature of this eſtabliſhment, and the very happy efforts they have made, may be ſeen in the ſuperb edition of their proceedings printed in 1790, 4to, for their own uſe; or in the 8vo edition ſince made public. They ſoon found two gentlemen, Mr Lucas and Mr Ledyard, who were ſingularly well qualified for the important miſſion. The information they have acquired will be found in the above work; with a new map by Mr Rennel, exhibiting the geographical knowledge collected by the African aſſociation. Mr Ledyard very unfortunately died during his reſearches at Cairo.

Few of our readers are unacquainted with the travels of Mr Park under the patronage of the ſociety. For an account of which ſee AFRICA. A ſecond journey was undertaken by the ſame gentleman within theſe three years; but as he has not been heard of for a long time, the moſt ſerious apprehenſions are entertained that he and his companions have fallen victims either to the inhoſpitable climate, or to the watchful jealouſy of the Moors. Another enterpriſing traveller, Mr Horneman, was ſent out by the ſociety about 1800. He departed from Cairo with a caravan, and reached Mourzouk, a place ſituated ſouth from Tripoli; and from thence ſent a communication to his conſtituents which has ſince been publiſhed by the ſociety. This is the laſt account that was received of this traveller, from which it is feared that he has alſo periſhed.

8. *The Society of Antiquaries of London*, was founded about the year 1572 by Archbiſhop Parker, a munificent patron of learned men. For the ſpace of 20 years it aſſembled in the houſe of Sir Robert Cotton; in 1589 they reſolved to apply to Queen Elizabeth for a charter and a public building where they might hold their meetings; but it is uncertain whether any ſuch application was ever made. In the mean time, the reputation of the ſociety gradually increaſed, and at length it excited the jealouſy of James I. who was afraid leſt it ſhould preſume to canvaſs the ſecret tranſactions of his government. He accordingly diſſolved it. But in the beginning of the laſt century, the Antiquarian ſociety began to revive; and a number of gentlemen, eminent for their affection to this ſcience, had weekly meetings, in which they examined the antiquities and hiſtory of Great Britain preceding the reign of James I. but without excluding any other remarkable antiquities that might be offered to them. From this time the ſociety grew in importance; and in 1750 they unanimouſly reſolved to petition the king for a charter of incorporation. This they obtained the year following, by the influence of the celebrated earl of Hardwicke, then lord chancellor, and Martin Folkes, Eſq; who was then their preſident. The king declared himſelf their founder and patron, and empowered them to have a body of ſtatutes, and a common ſeal, and to hold in perpetuity lands, &c. to the yearly value of 1000l.

The chief object of the inquiries and reſearches of the ſociety are Britiſh antiquities and hiſtory; not, however, wholly excluding thoſe of other countries. It muſt be acknowledged, that the ſtudy of antiquity offers to the curious and inquiſitive a large field for reſearch and amuſement. The inquirer in this branch furniſhes the hiſtorian with his beſt materials, while he diſtinguiſhes from truth the fictions of a bold invention, and aſcertains the credibility of facts; and to the philoſopher he preſents a fruitful ſource of ingenious ſpeculation, while he points out to him the way of thinking, and the manners of men, under all the varieties of aſpect in which they have appeared.

An antiquarian ought to be a man of ſolid judgment, poſſeſſed of learning and ſcience, that he may not be an enthuſiaſtic admirer of every thing that is ancient merely becauſe it is ancient; but be qualified to diſtinguiſh between thoſe reſearches which are valuable and important, and thoſe which are trifling and uſeleſs. It is from the want of theſe qualifications that ſome men have contracted ſuch a blind paſſion for every thing that is ancient, that they have expoſed themſelves to ridicule, and their ſtudy to contempt. But if a regard to utility were always to regulate the purſuits of the antiquarian, the ſhafts of ſatire would no longer be levelled at him; but he would be reſpected as the man who labours to reſtore or to preſerve ſuch ancient productions as are ſuited to illuminate religion, philoſophy, and hiſtory, or to improve the arts of life.

We by no means intend to apply theſe obſervations to any particular ſociety of antiquarians; but we throw them out, becauſe we know that an aſſiduous ſtudy of antiquity is apt, like the ardent purſuit of money, to loſe ſight of its original object, and to degenerate into a paſſion which miſtakes the mean for the end, and conſiders poſſeſſion without a regard to utility as enjoyment.

An aſſociation ſimilar to that of the Antiquarian Society of London was founded in *Edinburgh* in 1780, and received the royal charter in 1783. A volume of the tranſactions of this ſociety has been publiſhed; but with the exception of two or three memoirs, it contains little worthy of notice; and accordingly, it has never attracted the attention of the public.

Beſides theſe literary ſocieties here mentioned, there are a great number more in different parts of Europe, ſome of which are noticed under the article ACADEMY. Thoſe which are omitted are not omitted on account of any idea of their inferior importance; but either becauſe

Societies for Encouraging and Promoting Arts, Manufactures, &c.

cauſe we have had no acceſs to authentic information, or becauſe they reſemble the ſocieties already deſcribed ſo cloſely, that we could have given nothing but their names.

III. Societies for Encouraging and Promoting Arts, Manufactures, &c.

1. *London Society for the Encouragement of Arts, Manufactures, and Commerce*, was inſtituted in the year 1754 by Lord Folkſtone, Lord Romney, Dr Stephen Hales, and a few private gentlemen; but the merit of this inſtitution chiefly belonged to Mr William Shipley, an ingenious mechanic; who, though deriving no advantages from learning, by unwearied perſonal attendance found means to engage a few perſons of rank and fortune to meet at Peele's coffeehouſe in Fleet-ſtreet, and to adopt a plan for promoting arts and manufactures.

The office-bearers of this ſociety are a preſident, 12 vice-preſidents, a ſecretary, and regiſter. Their proceedings are regulated by a body of rules and orders eſtabliſhed by the whole ſociety, and printed for the uſe of the members. All queſtions and debates are determined by the holding up of hands, or by ballot if required; and no matter can be confirmed without the aſſent of a majority at two meetings. They invite all the world to propoſe ſubjects for encouragement; and whatever is deemed deſerving of attention is referred to the conſideration of a committee, which, after due inquiry and deliberation, make their report to the whole ſociety, where it is approved, rejected, or altered. A liſt is printed and publiſhed every year of the matters for which they propoſe to give premiums; which premiums are either ſums of money, and thoſe ſometimes very conſiderable ones; or the ſociety's medal in gold or ſilver, which they conſider as the greateſt honour they can beſtow. All poſſible care is taken to prevent partiality in the diſtribution of their premiums, by deſiring the claimants names to be concealed, and by appointing committees (who when they find occaſion call to their aſſiſtance the moſt ſkilful artiſts) for the ſtrict examination of the real merit of all matters and things brought before them, in conſequence of their premiums.

The chief objects of the attention of the Society for the Encouragement of Arts, Manufactures, and Commerce, in the application of their revenues, are ingenuity in the ſeveral branches of the polite and liberal arts, uſeful diſcoveries and improvements in agriculture, manufactures, mechanics, and chemiſtry, or the laying open of any ſuch to the public; and, in general, all ſuch uſeful inventions, diſcoveries, or improvements (though not mentioned in the book of premiums) as may appear to have a tendency to the advantage of trade and commerce.

The following are ſome of the moſt important regulations of this ſociety. It is required that the matters for which premiums are offered be delivered in without names, or any intimation to whom they belong; that each particular thing be marked in what manner each claimant thinks fit, ſuch claimant ſending with it a paper ſealed up, having on the outſide a correſponding mark, and on the inſide the claimant's name and addreſs; and all candidates are to take notice, that no claim for a premium will be attended to, unleſs the conditions of the advertiſement are fully complied with. No papers ſhall be opened but ſuch as ſhall gain premiums, unleſs where it appears to the ſociety abſolutely neceſſary for the determination of the claim: all the reſt ſhall be returned unopened, with the matters to which they belong, if inquired after by the marks within two years; after which time, if not demanded, they ſhall be publicly burnt unopened at ſome meeting of the ſociety. All the premiums of this ſociety are deſigned for that part of Great Britain called England, the dominion of Wales, and the town of Berwick upon Tweed, unleſs expreſsly mentioned to the contrary. No perſon ſhall receive any premium, bounty, or encouragement, from the ſociety for any matter for which he has obtained or propoſes to obtain a patent. No member of this ſociety ſhall be a candidate for or intitled to receive any premium, bounty, or reward whatever, except the honorary medal of the ſociety.

The reſpectability of the members who compoſe it may be ſeen by peruſing the liſt which generally accompanies their tranſactions. In the laſt volume (vol. xii.) it occupies no leſs than 43 pages. Some idea may be formed of the wealth of this ſociety, by obſerving that the liſt of their premiums fills 96 pages, and amounts to 250 in number. Theſe conſiſt of gold medals worth from 30 to 50, and in a few inſtances to 100 guineas; and ſilver medals valued at 10 guineas.

This ſociety is one of the moſt important in Great Britain. Much money has been expended by it, and many are the valuable effects of which it has been productive. Among theſe we reckon not only the diſcoveries which it has excited, but the inſtitution of other ſocieties on the ſame principles to which it has given birth; and we do not heſitate to conclude, that future ages will conſider the founding of this ſociety as one of the moſt remarkable epochs in the hiſtory of the arts. We contemplate with pleaſure the beneficial effects which muſt reſult to this nation and to mankind by the diffuſion of ſuch inſtitutions; and rejoice in the hope that the active minds of the people of Great Britain, inſtead of being employed as formerly in controverſies about religion, which engender ſtrife, or in diſcuſſions concerning the theory of politics, which lead to the adoption of ſchemes inconſiſtent with the nature and condition of man, will ſoon be more generally united into aſſociations for promoting uſeful knowledge and ſolid improvement, and for alleviating the diſtreſſes of their fellow creatures.

1. *Society inſtituted at Bath for the Encouragement of Agriculture, Arts, Manufactures, and Commerce.* It was founded in the year 1777 by ſeveral gentlemen who met at the city of Bath. This ſcheme met with a very favourable reception both from the wealthy and learned. The wealthy ſubſcribed very liberally, and the learned communicated many important papers. On application to the London and provincial ſocieties inſtituted for the like purpoſes, they very politely offered their aſſiſtance. Seven volumes of their tranſactions have already been publiſhed, containing very valuable experiments and obſervations, particularly reſpecting agriculture, which well deſerve the attention of all farmers in the kingdom. We have conſulted them with much ſatiſfaction on ſeveral occaſions, and have frequently referred to them in the courſe of this work; and therefore, with pleaſure, embrace

embrace the preſent opportunity of repeating our obligations. We owe the ſame acknowledgments to the Society for the Improvement of Arts, &c. of London.

3. *Society for working Mines*, an aſſociation lately formed on the continent of Europe. This inſtitution aroſe from the accidental meeting of ſeveral mineralogiſts at Skleno near Schemnitz in Hungary, who were collected in order to examine a new method of amalgamation. Struck with the ſhackles impoſed on mineralogy by monopolizers of new and uſeful proceſſes, they thought no method ſo effectual to break them, as forming a ſociety, whoſe common labours ſhould be directed to fix mining on its ſureſt principles; and whoſe memoirs, ſpread all over Europe, might offer to every adventurer the reſult of the reſearches, of which they are the object. By theſe means they ſuppoſed, that there would be a maſs of information collected; the intereſts of individuals would be loſt in the general intereſt; and the one would materially aſſiſt the other. Impoſture and quackery would, by the ſame means, be baniſhed from a ſcience, which muſt be improved by philoſophy and experience; and the ſociety, they ſuppoſed, would find, in the confidence which they inſpired, the reward and the encouragement of their labours. They deſign, that the memoirs which they publiſh ſhall be ſhort and clear; truth muſt be their baſis, and every idle diſcuſſion, every foreign digreſſion, muſt be baniſhed; politics and finance muſt be avoided, though the diſſertations may ſeem to lead towards them; and they oblige themſelves to oppoſe the affectation of brilliancies, and the oſtentation of empty ſpeculation, when compared with plain, ſimple, and uſeful facts.

The object of the ſociety is phyſical geography; mineralogy founded on chemiſtry; the management of ore in the different operations which it undergoes; ſubterraneous geometry; the hiſtory of mining; founderies, and the proceſſes for the extraction of metals from the ores, either by fuſion or amalgamation, in every inſtance applied to practice. The end of this inſtitution is to collect, in the moſt extenſive ſenſe, every thing that can aſſiſt the operations of the miner, and to communicate it to the different members, that they may employ it for the public good, in their reſpective countries. Each member muſt conſider himſelf as bound to ſend to the ſociety every thing which will contribute to the end of its inſtitution; to point out, with preciſion, the ſeveral facts and obſervations; to communicate every experiment which occurs, even the unſucceſsful ones, if the relation may ſeem to be advantageous to the public; to communicate to the ſociety their examination of ſchemes, and their opinions on queſtions propoſed by it; and to pay annually two ducats (about 18s. 6d.) to the direction every Eaſter. The ſociety, on the other hand, is bound to publiſh every novelty that ſhall be communicated to it; to communicate to each member, at the member's expence, the memoirs, deſigns, models, productions, and every thing connected with the inſtitution; to anſwer all the neceſſary demands made, relating in any reſpect to mining; and to give its opinion on every plan or project communicated through the medium of an honorary member.

The great centre of all intelligence is to be at Zellerfeld in Hartz, Brunſwick: but the ſociety is not fixed to any one ſpot; for every particular ſtate ſome practical mineralogiſt is nominated as director. Among theſe are the names of Baron Born, M. Pallas, M. Charpentier, M. Prebra, and M. Henkel. Their office is to propoſe the members; to take care that the views of the ſociety are purſued in the different countries where they reſide; to anſwer the requeſts of the members of their country who are qualified to make them; in caſe of the death of a director, to chooſe another; and the majority is to determine where the archives and the ſtrong box is to be placed.

All the eminent mineralogiſts in Europe are members of this ſociety. It is erected on ſo liberal and ſo extenſive a plan, that we entertain the higheſt hopes of its ſucceſs; and have only to add, that we wiſh much to ſee the ſtudy of ſeveral other ſciences purſued in the ſame manner.

4. *The Society for the Improvement of Naval Architecture*, was founded in 1791. The object of it is to encourage every uſeful invention and diſcovery relating to naval architecture as far as ſhall be in their power, both by honorary and pecuniary rewards. They have in view particularly to improve the theories of floating bodies and of the reſiſtance of fluids; to procure draughts and models of different veſſels, together with calculations of their capacity, centre of gravity, tonnage, &c.; to make obſervations and experiments themſelves, and to point out ſuch obſervations and experiments as appear beſt calculated to further their deſigns, and moſt deſerving thoſe premiums which the ſociety can beſtow. But though the improvement of naval architecture in all its branches be certainly the principal object of this inſtitution, yet the ſociety do not by any means intend to confine themſelves merely to the form and ſtructure of veſſels. Every ſubordinate and collateral purſuit will claim a ſhare of the attention of the ſociety in proportion to its merits; and whatever may have any tendency to render navigation more ſafe, ſalutary, and even pleaſant, will not be neglected.

This inſtitution owes its exiſtence to the patriotic diſpoſition and extraordinary attention of Mr Sewel a private citizen of London, who (though engaged in a line of buſineſs totally oppoſite to all concerns of this kind) has been led, by mere accident, to take ſuch ocular notice of, and make ſuch obſervations on, the actual ſtate of naval architecture in this country, as naturally occurred to a man of plain underſtanding, zealous for the honour and intereſt of his country, and willing to beſtow a portion of that time for the public good, which men of a different deſcription would rather have devoted to their own private advantage. His attention was the more ſeriouſly excited, by finding that it was the opinion of ſome private ſhip-builders, who, in a debate on the failure of one of our naval engagements, pronounced, that ſuch "would ever be the caſe while that buſineſs (the conſtruction of our ſhips of war) was not ſtudied as a ſcience, but carried on merely by precedent; that there had not been one improvement in our navy that did not originate with the French, who had naval ſchools and ſeminaries for the ſtudy of it; and that our ſhips were not a match for thoſe of that nation either ſingly or in a fleet," &c. &c.

In a ſhort time the ſociety were enabled to offer very conſiderable premiums for particular improvements in the conſtruction of our ſhipping, &c. &c. and alſo to encourage our philoſophers, mathematicians, and mechanics, to make ſatisfactory experiments, tending to aſcertain

certain the laws of reſiſtance of water to ſolids of different forms, in all varieties of circumſtance. On this head the reward is not leſs than one hundred pounds or a gold medal. Other premiums of 50, 30, and 20 guineas, according to the importance or difficulty of the particular ſubject or point of inveſtigation, are likewiſe offered, for different diſcoveries, inventions, or improvements. The terms of admiſſion into the ſociety are a ſubſcription of two guineas annually, or twenty guineas for life.

5. *Society of Artiſts of Great Britain*, which conſiſts of directors and fellows, was incorporated by charter in 1765, and empowered to purchaſe and hold lands, not exceeding 1000l. a-year. The directors of this ſociety, annually elected, are to conſiſt of 24 perſons, including the preſident, vice-preſident, treaſurer, and ſecretary; and it is required that they be either painters, ſculptors, architects, or engravers by profeſſion.

6. *Britiſh Society for Extending the Fiſheries and Improving the Sea-Coaſts of this Kingdom*, was inſtituted in 1786. The end and deſign of this ſociety will beſt appear from their charter, of which we preſent an abſtract.

The preamble ſtates, "the great want of improvement in fiſheries, agriculture, and manufactures, in the Highlands and Iſlands of North Britain; the prevalence of emigration from the want of employment in thoſe parts; the proſpect of a new nurſery of ſeamen, by the eſtabliſhment of fiſhing towns and villages in that quarter. The act therefore declares, that the perſons therein named, and every other perſon or perſons who ſhall thereafter become proprietors of the joint ſtock mentioned therein, ſhall be a diſtinct and ſeparate body politic and corporate, by the name of *The Britiſh Society for Extending the Fiſheries and Improving the Sea-coaſts of this Kingdom*: That the ſaid ſociety may raiſe a capital joint ſtock not exceeding 150,000l. to be applied to purchaſing or otherwiſe acquiring lands and tenements in perpetuity, for the building thereon, and on no other land whatever, free towns, villages, and fiſhing ſtations: That the joint ſtock ſhall be divided into ſhares of 50l. each: That no one perſon ſhall in his or her name poſſeſs more than ten ſhares, or 500l.: That the ſociety ſhall not borrow any ſum or ſums of money whatſoever: That the ſums to be advanced for this undertaking, and the profits ariſing therefrom, ſhall be divided proportionally to the ſum ſubſcribed; and that no perſon ſhall be liable for a larger ſum than he or ſhe ſhall have reſpectively ſubſcribed: That one or two ſhares ſhall entitle to one vote, and no more, in perſon or by proxy, at all meetings of proprietors; three or four ſhares to two votes; five, ſix, or ſeven ſhares, to three votes; eight or nine ſhares to four votes; and ten ſhares to five votes and no more: That more perſons than one inclining to hold in their joint names one or more ſhares ſhall be intitled to vote, by one of ſuch perſons, according to the priority of their names, or by proxy: That bodies corporate ſhall vote by proxy under their ſeal: That all perſons holding proxies ſhall be proprietors, and that no one perſon ſhall hold more than five votes by proxy: That the affairs of the ſociety ſhall be managed by a governor, deputy governor, and 13 other directors, to be elected annually on the 25th of March, from among the proprietors of the ſociety, holding at leaſt one full ſhare, by ſigned liſts of their names to be tranſmitted by the proprietors to the ſecretary of the ſociety: That five proprietors, not being governor, director, or other officer, ſhall be in like manner annually elected to audit the accounts of the ſociety: That there ſhall be one general meeting of the proprietors annually on the 25th of March: That occaſional general meetings ſhall be called on the requeſt of nine or more proprietors: That the general meetings of the proprietors ſhall make all byelaws and conſtitutions for the government of the ſociety, and for the good and orderly carrying on of the buſineſs of the ſame: That no transfer ſhall be made of the ſtock of the ſociety for three years from the 10th of Auguſt 1786: That the caſh of the ſociety ſhall be lodged in the bank of England, bank of Scotland, or the royal bank of Scotland: That no director, proprietor, agent, or officer of the ſociety, ſhall retain any ſum or ſums of money in his hands beyond the ſpace of 30 days on any account whatſoever: That all payments by the ſociety ſhall be made by drafts on the ſaid banks, under the hands of the governor or deputy-governor, counterſigned by the ſecretary or his deputy, and two or more directors: And that the books in which the accounts of the ſociety ſhall be kept ſhall be open to all the proprietors."

The inſtitution of this public-ſpirited ſociety was in a great meaſure owing to the exertions of the patriotic John Knox; who in the courſe of 23 years traverſed and explored the Highlands of Scotland not fewer than 16 times, and expended ſeveral thouſand pounds of his own fortune in purſuing his patriotic deſigns.

7. *Britiſh Wool* SOCIETY. See *Britiſh* WOOL *Society*.

SOCIETY Iſles, a cluſter of iſles, ſo named by Captain Cook in 1769. They are ſituated between the latitudes of 16. 10. and 16. 55. ſouth, and between the longitudes of 150. 57. and 152. weſt. They are eight in number; namely, Otaheite, Huaheine, Ulietea, Otaha, Bolabola, Maurua, Toobouai, and Tabooyamanoo or Saunders's iſland. The ſoil, productions, people, their language, religion, cuſtoms, and manners, are ſo nearly the ſame as at OTAHEITE, that little need be added here on that ſubject. Nature has been equally bountiful in uncultivated plenty, and the inhabitants are as luxurious and as indolent. A plantain branch is the emblem of peace, and exchanging names the greateſt token of friendſhip. Their dances are more elegant, their dramatic entertainments have ſomething of plot and conſiſtency, and they exhibit temporary occurrences as the objects of praiſe or ſatire; ſo that the origin of ancient comedy may be already diſcerned among them. The people of Huaheine are in general ſtouter and fairer than thoſe of Otaheite, and this iſland is remarkable for its populouſneſs and fertility. Thoſe of Ulietea, on the contrary, are ſmaller and blacker, and much leſs orderly. Captain Cook put on ſhore a Cape ewe at Bolabola, where a ram had been left by the Spaniards; and alſo an Engliſh boar and ſow, with two goats, at Ulietea. If the valuable animals which have been tranſported thither from Europe ſhould be ſuffered to multiply, no part of the world will equal theſe iſlands in variety and abundance of refreſhments for future navigators.

SOCINIANS, in church hiſtory, a ſect of Chriſtian heretics, ſo called from their founder Fauſtus Socinus (ſee SOCINUS). They maintain, "That Jeſus Chriſt was a mere man, who had no exiſtence before he was conceived by the Virgin Mary; that the Holy Ghoſt is no diſtinct perſon, but that the Father is truly and properly God. They own, that the name of God is given in the Holy Scriptures to Jeſus Chriſt; but contend, that it is only a deputed title, which, however, inveſts him with an abſolute ſovereignty over all created beings, and renders him an object of worſhip to men and angels. They deny the doctrines of ſatisfaction and imputed righteouſneſs; and ſay that Chriſt only preached the truth to mankind, ſet before them in himſelf an example of heroic virtue, and ſealed his doctrines with his blood. Original ſin and abſolute predeſtination they eſteem ſcholaſtic chimeras. They likewiſe maintain the ſleep of the ſoul, which they ſay becomes inſenſible at death, and is raiſed again with the body at the reſurrection, when the good ſhall be eſtabliſhed in the poſſeſſion of eternal felicity, while the wicked ſhall be conſigned to a fire that will not torment them eternally, but for a certain duration in proportion to their demerits."

This ſect has long been indignant at being ſtyled *Socinians*. They diſclaim every human leader; and profeſſing to be guided ſolely by the word of God and the deductions of reaſon, they call themſelves *Unitarians*, and affect to conſider all other Chriſtians, even their friends the Arians, as *Polytheiſts*. Modern Unitarianiſm, as taught by Dr Prieſtley, is, however, a very different thing from Socinianiſm, as we find it in the Racovian catechiſm and other ſtandard works of the ſect. This far-famed philoſopher has diſcovered, what eſcaped the ſagacity of all the *fratres poloni*, that Jeſus Chriſt was the ſon of Joſeph as well as Mary; that the evangeliſts miſtook the meaning of Iſaiah's prophecy, that "a virgin ſhould conceive and bear a ſon;" that the applying of this prophecy to the birth of our Saviour, led them to conclude that his conception was miraculous; and that we are not to wonder at this miſtake, as the apoſtles were not always inſpired, and were in general inconcluſive reaſoners. The modeſty of the writer in claiming the merit of ſuch diſcoveries will appear in its proper colours to all our readers: the truth of his doctrine ſhall be conſidered in another place. See THEOLOGY.

SOCINUS, LÆLIUS, the firſt author of the ſect of the Socinians, was born at Sienna in Tuſcany in 1525. Being deſigned by his father for the law, he began very early to ſearch for the foundation of that ſcience in the Word of God; and by that ſtudy diſcovered that the Romiſh religion taught many things contrary to revelation; when, being deſirous of penetrating farther into the true ſenſe of the Scriptures, he ſtudied Greek, Hebrew, and even Arabic. In 1547 he left Italy, to go and converſe with the Proteſtants; and ſpent four years in travelling through France, England, the Netherlands, Germany, and Poland, and at length ſettled at Zurich. He by this means became acquainted with the moſt learned men of his time, who teſtified by their letters the eſteem they had for him: but as he diſcovered to them his doubts, he was greatly ſuſpected of hereſy. He, however, conducted himſelf with ſuch addreſs, that he lived among the capital enemies of his opinions, without receiving the leaſt injury. He met with ſome diſciples, who heard his inſtructions with reſpect; theſe were Italians who left their native country on account of religion, and wandered about in Germany and Poland. He communicated likewiſe his ſentiments to his relations by his writings, which he cauſed to be conveyed to them at Sienna. He died at Zurich in 1562. Thoſe who were of ſentiments oppoſite to his, and were perſonally acquainted with him, confeſs that his outward behaviour was blameleſs. He wrote a Paraphraſe on the firſt chapter of St John; and other works are aſcribed to him.

SOCINUS, *Fauſtus*, nephew of the preceding, and principal founder of the Socinian ſect, was born at Sienna in 1539. The letters which his uncle Lælius wrote to his relations, and which infuſed into them many ſeeds of hereſy, made an impreſſion upon him; ſo that, knowing himſelf not innocent, he fled as well as the reſt when the inquiſition began to perſecute that family. He was at Lyons when he heard of his uncle's death, and departed immediately to take poſſeſſion of his writings. He returned to Tuſcany; and made himſelf ſo agreeable to the grand duke, that the charms which he found in that court, and the honourable poſts he filled there, hindered him for twelve years from remembering that he had been conſidered as the perſon who was to put the laſt hand to the ſyſtem of ſamoſatenian divinity, of which his uncle Lælius had made a rough draught. At laſt he went into Germany in 1574, and paid no regard to the grand duke's advices to return. He ſtaid three years at Baſil, and ſtudied divinity there, and having adopted a ſet of principles very different from the ſyſtem of Proteſtants, he reſolved to maintain and propagate them; for which purpoſe he wrote a treatiſe *De Ieſu Chriſto Servatore*. In 1579 Socinus retired into Poland, and deſired to be admitted into the communion of the Unitarians; but as he differed from them in ſome points, on which he refuſed to be ſilent, he met with a repulſe. However, he did not ceaſe to write in defence of their churches againſt thoſe who attacked them. At length his book againſt James Paleologus furniſhed his enemies with a pretence to exaſperate the king of Poland againſt him; but though the mere reading of it was ſufficient to refute his accuſers, Socinus thought proper to leave Cracow, after having reſided there four years. He then lived under the protection of ſeveral Poliſh lords, and married a lady of a good family; but her death, which happened in 1587, ſo deeply afflicted him as to injure his health; and to complete his ſorrow, he was deprived of his patrimony by the death of Francis de Medicis great duke of Florence. The conſolation he found in ſeeing his ſentiments at laſt approved by ſeveral miniſters, was greatly interrupted in 1598; for he met with a thouſand inſults at Cracow, and was with great difficulty ſaved from the hands of the rabble. His houſe was plundered, and he loſt his goods; but this loſs was not ſo uneaſy to him as that of ſome manuſcripts, which he extremely regretted. To deliver himſelf from ſuch dangers, he retired to a village about nine miles diſtant from Cracow, where he ſpent the remainder of his days at the houſe of Abraham Blonſki, a Poliſh gentleman, and died there in 1604. All Fauſtus Socinus's works are contained in the two firſt volumes of the *Bibliotheca Fratrum Polonorum*.

SOCMANS, SOKEMANS, or *Socmen* (*Socmanni*), are ſuch tenants as hold their lands and tenements by ſocage tenure. See SOCAGE.

SOCOTORA, an iſland lying between Aſia and Arabia Felix; about 50 miles in length, and 22 in breadth. It is particularly noted for its fine aloes, known by the name of *Socotrine* ALOES. The religion of the

Socotora, Socrates.

natives is a mixture of Mahometaniſm and Paganiſm; but they are civil to ſtrangers who call there in their paſſage to the Eaſt Indies. It abounds in fruit and cattle; and they have a king of their own, who is dependent on Arabia.

SOCRATES, the greateſt of the ancient philoſophers, was born at Alopece, a village near Athens, in the fourth year of the 77th olympiad. His parents were of low rank; his father Sophroniſcus being a ſtatuary, and his mother Phænareta a midwife. Sophroniſcus brought up his ſon, contrary to his inclination, in his own manual employment; in which Socrates, though his mind was continually aſpiring after higher objects, was not unſucceſsful, for whilſt he was a young man, he is ſaid to have formed ſtatues of the habited Graces, which were allowed a place in the citadel of Athens. Upon the death of his father he was left in ſuch ſtraitened circumſtances as laid him under the neceſſity of exerciſing that art to procure the means of ſubſiſtence, though he devoted, at the ſame time, all the leiſure which he could command to the ſtudy of philoſophy. His diſtreſs, however, was ſoon relieved by Crito, a wealthy Athenian; who, remarking his ſtrong propenſity to ſtudy, and admiring his ingenuous diſpoſition and diſtinguiſhed abilities, generouſly took him under his patronage, and intruſted him with the inſtruction of his children. The opportunities which Socrates by this means enjoyed of attending the public lectures of the moſt eminent philoſophers, ſo far increaſed his thirſt after wiſdom, that he determined to relinquiſh his occupation, and every proſpect of emolument which that might afford, in order to devote himſelf entirely to his favourite purſuits. Under Anaxagoras and Archelaus he proſecuted the ſtudy of nature in the uſual manner of the philoſophers of the age, and became well acquainted with their doctrines. Prodicus the ſophiſt was his preceptor in eloquence, Evenus in poetry, Theodorus in geometry, and Damo in muſic. Aſpaſia, a woman no leſs celebrated for her intellectual than her perſonal accompliſhments, whoſe houſe was frequented by the moſt celebrated characters, had alſo ſome ſhare in the education of Socrates. Under ſuch preceptors it cannot reaſonably be doubted but that he became maſter of every kind of learning which the age in which he lived could afford; and being bleſſed with very uncommon talents by nature, he appeared in Athens, under the reſpectable characters of a good citizen and a true philoſopher. Being called upon by his country to take arms in the long and ſevere ſtruggle between Athens and Sparta, he ſignalized himſelf at the ſiege of Potidæa, both by his valour and by the hardineſs with which he endured fatigue. During the ſeverity of a Thracian winter, whilſt others were clad in furs, he wore only his uſual clothing, and walked barefoot upon the ice. In an engagement in which he ſaw ALCIBIADES falling down wounded, he advanced to defend him, and ſaved both him and his arms: and though the prize of valour was on this occaſion unqueſtionably due to Socrates, he generouſly gave his vote that it might be beſtowed upon Alcibiades, to encourage his riſing merit. He ſerved in other campaigns with diſtinguiſhed bravery, and had the happineſs on one occaſion to ſave the life of Xenophon, by bearing him, when covered with wounds, out of the reach of the enemy.

Socrates.

It was not till Socrates was upwards of 60 years of age that he undertook to ſerve his country in any civil office, when he was choſen to repreſent his own diſtrict, in the ſenate of five hundred. In this office, though he at firſt expoſed himſelf to ſome degree of ridicule from the want of experience in the forms of buſineſs, he ſoon convinced his colleagues that he was ſuperior to them all in wiſdom and integrity. Whilſt they, intimidated by the clamours of the populace, paſſed an unjuſt ſentence of condemnation upon the commanders, who, after the engagement at the Arginuſian iſlands, had been prevented by a ſtorm from paying funeral honours to the dead, Socrates ſtood forth ſingly in their defence, and to the laſt refuſed to give his ſuffrage againſt them, declaring that no force ſhould compel him to act contrary to juſtice and the laws. Under the ſubſequent tyranny he never ceaſed to condemn the oppreſſive and cruel proceedings of the thirty tyrants; and when his boldneſs provoked their reſentment, ſo that his life was in hazard, fearing neither treachery nor violence, he ſtill continued to ſupport with undaunted firmneſs the rights of his fellow citizens.

Having given theſe proofs of public virtue both in a military and civil capacity, he wiſhed to do ſtill more for his country. Obſerving with regret how much the opinions of the Athenian youth were miſled, and their principles and taſte corrupted by philoſophers who ſpent all their time in refined ſpeculations upon nature and the origin of things, and by ſophiſts who taught in their ſchools the arts of falſe eloquence and deceitful reaſoning; Socrates formed the wiſe and generous deſign of inſtituting a new and more uſeful method of inſtruction. He juſtly conceived the true end of philoſophy to be, not to make an oſtentatious diſplay of ſuperior learning and ability in ſubtle diſputations or ingenious conjectures, but to free mankind from the dominion of pernicious prejudices; to correct their vices; to inſpire them with the love of virtue; and thus conduct them in the path of wiſdom to true felicity. He therefore aſſumed the character of a moral philoſopher; and, looking upon the whole city of Athens as his ſchool, and all who were diſpoſed to lend him their attention as his pupils, he ſeized every occaſion of communicating moral wiſdom to his fellow citizens. He paſſed the greater part of his time in public; and the method of inſtruction of which he chiefly made uſe was, to propoſe a ſeries of queſtions to the perſon with whom he converſed, in order to lead him to ſome unforeſeen concluſion. He firſt gained the conſent of his reſpondent to ſome obvious truths, and then obliged him to admit others from their relation or reſemblance to thoſe to which he had already aſſented. Without making uſe of any direct argument or perſuaſion, he choſe to lead the perſon he meant to inſtruct, to deduce the truths of which he wiſhed to convince him, as a neceſſary conſequence from his own conceſſions. He commonly conducted theſe conferences with ſuch addreſs, as to conceal his deſign till the reſpondent had advanced too far to recede. On ſome occaſions he made uſe of ironical language, that vain men might be caught in their own replies, and be obliged to confeſs their ignorance. He never aſſumed the air of a moroſe and rigid preceptor, but communicated uſeful inſtruction with all the eaſe and pleaſantry of polite converſation. Though eminently furniſhed with every kind of learning, he preferred moral to ſpeculative wiſdom. Convinced that philoſophy

loſophy is valuable, not as it furniſhes queſtions for the ſchools, but as it provides men with a law of life, he cenſured his predeceſſors for ſpending all their time in abſtruſe reſearches into nature, and taking no pains to render themſelves uſeful to mankind. His favourite maxim was, Whatever is above us doth not concern us. He eſtimated the value of knowledge by its utility, and recommended the ſtudy of geometry, aſtronomy, and other ſciences, only ſo far as they admit of a practical application to the purpoſes of human life. His great object in all his conferences and diſcourſes was, to lead men into an acquaintance with themſelves; to convince them of their follies and vices; to inſpire them with the love of virtue; and to furniſh them with uſeful moral inſtructions. Cicero might therefore very juſtly ſay of Socrates, that he was the firſt who called down philoſophy from heaven to earth, and introduced her into the public walks and domeſtic retirements of men, that ſhe might inſtruct them concerning life and manners.

Through his whole life this good man diſcovered a mind ſuperior to the attractions of wealth and power. Contrary to the general practice of the preceptors of his time, he inſtructed his pupils without receiving from them any gratuity. He frequently refuſed rich preſents, which were offered him by Alcibiades and others, though importunately urged to accept them by his wife. The chief men of Athens were his ſtewards: they ſent him in proviſions, as they apprehended he wanted them; he took what his preſent wants required, and returned the reſt. Obſerving the numerous articles of luxury which were expoſed to ſale in Athens, he exclaimed, "How many things are there which I do not want!" With Socrates, moderation ſupplied the place of wealth. In his clothing and food, he conſulted only the demands of nature. He commonly appeared in a neat but plain cloak, with his feet uncovered. Though his table was only ſupplied with ſimple fare, he did not ſcruple to invite men of ſuperior rank to partake of his meals; and when his wife, upon ſome ſuch occaſion, expreſſed her diſſatisfaction on being no better provided, he deſired her to give herſelf no concern; for if his gueſts were wiſe men, they would be contented with whatever they found at his table; if otherwiſe, they were unworthy of notice. Whilſt others, ſays he, live to eat, wiſe men eat to live.

Though Socrates was exceedingly unfortunate in his domeſtic connection, he converted this infelicity into an occaſion of exerciſing his virtues. Xantippe, concerning whoſe ill humour ancient writers relate many amuſing tales, was certainly a woman of a high and unmanageable ſpirit. But Socrates while he endeavoured to curb the violence of her temper, improved his own. When Alcibiades expreſſed his ſurpriſe that his friend could bear to live in the ſame houſe with ſo perverſe and quarrelſome a companion, Socrates replied, that being daily inured to ill humour at home, he was the better prepared to encounter perverſeneſs and injury abroad.

In the midſt of domeſtic vexations and public diſorders, Socrates retained ſuch an unruffled ſerenity, that he was never ſeen either to leave his own houſe or to return home with a diſturbed countenance. In acquiring this entire dominion over his paſſions and appetites, he had the greater merit, as it was not effected without a violent ſtruggle againſt his natural propenſities. Zopyrus, an eminent phyſiognomiſt, declared, that he diſcovered in the features of the philoſopher evident traces of many vicious inclinations. The friends of Socrates who were preſent ridiculed the ignorance of this pretender to extraordinary ſagacity. But Socrates himſelf ingenuouſly acknowledged his penetration, and confeſſed that he was in his natural diſpoſition prone to vice, but that he had ſubdued his inclinations by the power of reaſon and philoſophy.

Through the whole of his life Socrates gave himſelf up to the guidance of unbiaſſed reaſon, which is ſuppoſed by ſome to be all that he meant by the genius or *dæmon* from which he profeſſed to receive inſtruction. But this opinion is inconſiſtent with the accounts given by his followers of that dæmon, and even with the language in which he ſpoke of it himſelf. Plato ſometimes calls it his *guardian*, and Apuleius his *god*; and as Xenophon atteſts that it was the belief of his maſter that the gods occaſionally communicate to men the knowledge of future events, it is by no means improbable that Socrates admitted, with the generality of his countrymen, the exiſtence of thoſe intermediate beings called *dæmons*, of one of which he might fancy himſelf the peculiar care.

It was one of the maxims of Socrates, "That a wiſe man will worſhip the gods according to the inſtitutions of the ſtate to which he belongs." Convinced of the weakneſs of the human underſtanding, and perceiving that the pride of philoſophy had led his predeceſſors into futile ſpeculations on the nature and origin of things, he judged it moſt conſiſtent with true wiſdom to ſpeak with caution and reverence concerning the divine nature.

The wiſdom and the virtues of this great man, whilſt they procured him many followers, created him alſo many enemies. The Sophiſts*, whoſe knavery and ignorance he took every opportunity of expoſing to public contempt, became inveterate in their enmity againſt ſo bold a reformer, and deviſed an expedient, by which they hoped to check the current of his popularity. They engaged Ariſtophanes, the firſt buffoon of the age, to write a comedy, in which Socrates ſhould be the principal character. Ariſtophanes, pleaſed with ſo promiſing an occaſion of diſplaying his low and malignant wit, undertook the taſk, and produced the comedy of *The Clouds*, ſtill extant in his works. In this piece, Socrates is introduced hanging in a baſket in the air, and thence pouring forth abſurdity and profaneneſs. But the philoſopher, ſhowing in a crowded theatre that he was wholly unmoved by this ribaldry, the ſatire failed of its effect; and when Ariſtophanes attempted the year following to renew the piece with alterations and additions, the repreſentation was ſo much diſcouraged, that he was obliged to diſcontinue it.

From this time Socrates continued for many years to purſue without interruption his laudable deſign of inſtructing and reforming his fellow citizens. At length, however, when the inflexible integrity with which he had diſcharged the duty of a ſenator, and the firmneſs with which he had oppoſed every kind of political corruption and oppreſſion, had greatly increaſed the number of his enemies, clandeſtine arts were employed to raiſe a general prejudice againſt him. The people were induſtriouſly reminded, that Critias, who had been one of the moſt cruel of the thirty tyrants, and Alcibiades,

* See *Sophiſt.*

who had inſulted religion, by defacing the public ſtatues of Mercury, and performing a mock repreſentation of the Eleuſinian myſteries, had in their youth been diſciples of Socrates; and the minds of the populace being thus prepared, a direct accuſation was preferred againſt him before the ſupreme court of judicature. His accuſers were Anytus a leather-dreſſer, who had long entertained a perſonal enmity againſt Socrates, for reprehending his avarice, in depriving his ſons of the benefits of learning, that they might purſue the gains of trade; Melitus, a young rhetorician, who was capable of undertaking any thing for the ſake of gain; and Lycon, who was glad of any opportunity of diſplaying his talents. The accuſation, which was delivered to the ſenate under the name of Melitus, was this: "Melitus, ſon of Melitus, of the tribe of Pythos, accuſeth Socrates, ſon of Sophroniſcus, of the tribe of Alopece. Socrates violates the laws, in not acknowledging the gods which the ſtate acknowledges, and by introducing new divinities. He alſo violates the laws by corrupting the youth. Be his puniſhment DEATH."

This charge was delivered upon oath to the ſenate; and Crito a friend of Socrates became ſurety for his appearance on the day of trial. Anytus ſoon afterwards ſent a private meſſage to Socrates, aſſuring him that if he would deſiſt from cenſuring his conduct, he would withdraw his accuſation. But Socrates refuſed to comply with ſo degrading a condition; and with his uſual ſpirit replied, "Whilſt I live I will never diſguiſe the truth, nor ſpeak otherwiſe than my duty requires." The interval between the accuſation and the trial he ſpent in philoſophical converſations with his friends, chooſing to diſcourſe upon any other ſubject rather than his own ſituation.

When the day of trial arrived, his accuſers appeared in the ſenate, and attempted to ſupport their charge in three diſtinct ſpeeches, which ſtrongly marked their reſpective characters. Plato, who was a young man, and a zealous follower of Socrates, then roſe up to addreſs the judges in defence of his maſter; but whilſt he was attempting to apologiſe for his youth, he was abruptly commanded by the court to ſit down. Socrates, however, needed no advocate. Aſcending the chair with all the ſerenity of conſcious innocence, and with all the dignity of ſuperior merit, he delivered, in a firm and manly tone, an unpremeditated defence of himſelf, which ſilenced his opponents, and ought to have convinced his judges. After tracing the progreſs of the conſpiracy which had been raiſed againſt him to its true ſource, the jealouſy and reſentment of men whoſe ignorance he had expoſed, and whoſe vices he had ridiculed and reproved, he diſtinctly replied to the ſeveral charges brought againſt him by Melitus. To prove that he had not been guilty of impiety towards the gods of his country, he appealed to his frequent practice of attending the public religious feſtivals. The crime of introducing new divinities, with which he was charged, chiefly as it ſeems on the ground of the admonitions which he profeſſed to have received from an inviſible power, he diſclaimed, by pleading that it was no new thing for men to conſult the gods and receive inſtructions from them. To refute the charge of his having been a corrupter of youth, he urged the example which he had uniformly exhibited of juſtice, moderation, and temperance; the moral ſpirit and tendency of his diſcourſes: and the effect which had actually been produced by his doctrine upon the manners of the young. Then, diſdaining to ſolicit the mercy of his judges, he called upon them for that juſtice which their office and their oath obliged them to adminiſter; and profeſſing his faith and confidence in God, reſigned himſelf to their pleaſure.

The judges, whoſe prejudices would not ſuffer them to pay due attention to this apology, or to examine with impartiality the merits of the cauſe, immediately declared him guilty of the crimes of which he ſtood accuſed. Socrates, in this ſtage of the trial, had a right to enter his plea againſt the puniſhment which the accuſers demanded, and inſtead of the ſentence of death, to propoſe ſome pecuniary amercement. But he at firſt peremptorily refuſed to make any propoſal of this kind, imagining that it might be conſtrued into an acknowledgement of guilt; and aſſerted, that his conduct merited from the ſtate reward rather than puniſhment. At length, however, he was prevailed upon by his friends to offer upon their credit a fine of thirty *minæ*. The judges, notwithſtanding, ſtill remained inexorable: they proceeded, without farther delay, to pronounce ſentence upon him: and he was condemned to be put to death by the poiſon of hemlock.

The ſentence being paſſed, he was ſent to priſon: which, ſays Seneca, he entered with the ſame reſolution and firmneſs with which he had oppoſed the thirty tyrants; and took away all ignominy from the place, which could not be a priſon while he was there. He lay in fetters 30 days; and was conſtantly viſited by Crito, Plato, and other friends, with whom he paſſed the time in diſpute after his uſual manner. Anxious to ſave ſo valuable a life, they urged him to attempt his eſcape, or at leaſt to permit them to convey him away; and Crito went ſo far, as to aſſure him that, by his intereſt with the jailor, it might be eaſily accompliſhed, and to offer him a retreat in Theſſaly; but Socrates rejected the propoſal, as a criminal violation of the laws; and aſked them, whether there was any place out of Attica which death could not reach.

At length the day arrived when the officers to whoſe care he was committed delivered to Socrates early in the morning the final order for his execution, and immediately, according to the law, ſet him at liberty from his bonds. His friends, who came thus early to the priſon that they might have an opportunity of converſing with their maſter through the day, found his wife ſitting by him with a child in her arms. Socrates, that the tranquillity of his laſt moments might not be diſturbed by her unavailing lamentations, requeſted that ſhe might be conducted home. With the moſt frantic expreſſions of grief ſhe left the priſon. An intereſting converſation then paſſed between Socrates and his friends, which chiefly turned upon the immortality of the ſoul. In the courſe of this converſation, he expreſſed his diſapprobation of the practice of ſuicide, and aſſured his friends that his chief ſupport in his preſent ſituation was an expectation, though not unmixed with doubts, of a happy exiſtence after death. "It would be inexcuſable in me (ſaid he) to deſpiſe death, if I were not perſuaded that it will conduct me into the preſence of the gods, who are the moſt righteous governors, and into the ſociety of juſt and good men: but I derive confidence from the hope that ſomething of man remains after death, ates.

Socrates, Soda.

death, and that the condition of good men will then be much better than that of the bad." Crito afterwards aſking him in what manner he wiſhed to be buried? Socrates replied with a ſmile, "As you pleaſe, provided I do not eſcape out of your hands." Then, turning to the reſt of his friends, he ſaid, "Is it not ſtrange, after all that I have ſaid to convince you that I am going to the ſociety of the happy, that Crito ſtill thinks that this body, which will ſoon be a lifeleſs corpſe, is Socrates? Let him diſpoſe of my body as he pleaſes, but let him not at its interment mourn over it as if it were Socrates."

Towards the cloſe of the day he retired into an adjoining apartment to bathe; his friends, in the mean time, expreſſing to one another their grief at the proſpect of loſing ſo excellent a father, and being left to paſs the reſt of their days in the ſolitary ſtate of orphans. After a ſhort interval, during which he gave ſome neceſſary inſtructions to his domeſtics, and took his laſt leave of his children, the attendant of the priſon informed him that the time for drinking the poiſon was come. The executioner, though accuſtomed to ſuch ſcenes, ſhed tears as he preſented the fatal cup. Socrates received it without change of countenance or the leaſt appearance of perturbation: then offering up a prayer to the gods that they would grant him a proſperous paſſage into the inviſible world, with perfect compoſure he ſwallowed the poiſonous draught. His friends around him burſt into tears. Socrates alone remained unmoved. He upbraided their puſillanimity, and entreated them to exerciſe a manly conſtancy worthy of the friends of virtue. He continued walking till the chilling operation of the hemlock obliged him to lie down upon his bed. After remaining for a ſhort time ſilent, he requeſted Crito (probably in order to refute a calumny which might prove injurious to his friends after his deceaſe) not to neglect the offering of a cock which he had vowed to Eſculapius. Then, covering himſelf with his cloak, he expired. Such was the fate of the virtuous Socrates! A ſtory, ſays Cicero, which I never read without tears.

The friends and diſciples of this illuſtrious teacher of wiſdom were deeply afflicted by his death, and attended his funeral with every expreſſion of grief. Apprehenſive, however, for their own ſafety, they ſoon afterwards privately withdrew from the city, and took up their reſidence in diſtant places. Several of them viſited the philoſopher Euclid of Megara, by whom they were kindly received. No ſooner was the unjuſt condemnation of Socrates known through Greece, than a general indignation was kindled in the minds of good men, who univerſally regretted that ſo diſtinguiſhed an advocate for virtue ſhould have fallen a ſacrifice to jealouſy and envy. The Athenians themſelves, ſo remarkable for their caprice, who never knew the value of their great men till after their death, ſoon became ſenſible of the folly as well as criminality of putting to death the man who had been the chief ornament of their city and of the age, and turned their indignation againſt his accuſers. Melitus was condemned to death; and Anytus, to eſcape a ſimilar fate, went into voluntary exile. To give a farther proof of the ſincerity of their regret, the Athenians for a while interrupted public buſineſs; decreed a general mourning; recalled the exiled friends of Socrates; and erected a ſtatue to his memory in one of the moſt frequented parts of the city. His death happened in the firſt year of the 96th olympiad, and in the 70th year of his age.

Socrates left behind him nothing in writing; but his illuſtrious pupils Xenophon and Plato have in ſome meaſure ſupplied this defect. The Memoirs of Socrates, written by Xenophon, afford, however, a much more accurate idea of the opinions of Socrates, and of his manner of teaching, than the Dialogues of Plato, who every where mixes his own conceptions and diction with the ideas and language of his maſter. It is related, that when Socrates heard Plato recite his Lyſis, he ſaid, "How much does this young man make me ſay which I never conceived!"

His diſtinguiſhing character was that of a moral philoſopher; and his doctrine concerning God and religion was rather practical than ſpeculative. But he did not neglect to build the ſtructure of religious faith upon the firm foundation of an appeal to natural appearances: He taught that the Supreme Being, though inviſible, is clearly ſeen in his works: which at once demonſtrate his exiſtence and his wiſe and benevolent providence. He admitted, beſides the one Supreme Deity, the exiſtence of beings who poſſeſs a middle ſtation between God and man, to whoſe immediate agency he aſcribed the ordinary phenomena of nature, and whom he ſuppoſed to be particularly concerned in the management of human affairs. Hence he declared it to be the duty of every one, in the performance of religious rites, to follow the cuſtoms of his country. At the ſame time, he taught, that the merit of all religious offerings depends upon the character of the worſhipper, and that the gods take pleaſure in the ſacrifices of none but the truly pious.

Concerning the human ſoul, the opinion of Socrates, according to Xenophon, was, that it is allied to the Divine Being, not by a participation of eſſence, but by a ſimilarity of nature; that man excels all other animals in the faculty of reaſon; and that the exiſtence of good men will be continued after death in a ſtate in which they will receive the reward of their virtue. Although it appears that on this latter topic he was not wholly free from uncertainty, the conſolation which he profeſſed to derive from this ſource in the immediate proſpect of death, leaves little room to doubt that he entertained a real expectation of immortality: and there is reaſon to believe that he was the only philoſopher of ancient Greece whoſe principles admitted of ſuch an expectation (ſee METAPHYSICS, Part III. Chap. iv.). Of his moral ſyſtem, which was in a high degree pure, and founded on the ſureſt baſis, the reader will find a ſhort view in our article MORAL PHILOSOPHY, N° 4.

SOCRATES was alſo the name of an eccleſiaſtical hiſtorian of the 5th century, born at Conſtantinople in the beginning of the reign of Theodoſius: he profeſſed the law and pleaded at the bar, whence he obtained the name of *Scholaſticus*. He wrote an eccleſiaſtical hiſtory from the year 309, where Euſebius ended, down to 440; and wrote with great exactneſs and judgment. An edition of Euſebius and Socrates, in Greek and Latin, with notes by Reading, was publiſhed at London in 1720.

SODA, the name given by the French chemiſts to the mineral alkali, which is found native in many parts of the world: it is obtained alſo from common ſalt, and from

from the aſhes of the *kali*, a ſpecies of ſalſola. See CHEMISTRY *Index*, for an account of its properties and combinations: but long after that article was written, ſoda and potaſh were decompoſed by means of galvaniſm; and the alkalies, hitherto conſidered as ſimple ſubſtances, appear, from the experiments of Mr Davy, who firſt made the diſcovery, to be compounds of oxygen and a metallic baſe. Mr Davy's concluſions have been controverted by ſome of the French chemiſts; and as the ſubject may perhaps in a few months receive ſome farther elucidation, we ſhall delay our account of the whole till we come to deſcribe the apparatus by which the experiments are conducted. See TROUGH, *Galvanic*.

SODA is alſo a name for a heat in the ſtomach, or heart-burn, See MEDICINE, N° 275.

SODOM, formerly a town of Paleſtine in Aſia, famous in Scripture for the wickedneſs of its inhabitants, and their deſtruction by fire from heaven on account of that wickedneſs. The place where it ſtood is now covered by the waters of the Dead ſea, or the lake Aſphaltites. See ASPHALTITES.

SODOMY, an unnatural crime, ſo called from the city of Sodom, which was deſtroyed by fire for the ſame. The Levitical law adjudged thoſe guilty of this execrable crime to death; and the civil law aſſigns the ſame puniſhment to it. The law of England makes it felony. There is no ſtatute in Scotland againſt ſodomy; the libel of the crime is therefore founded on the divine law, and practice makes its puniſhment to be burned alive.

SODOR, a name always conjoined with Man, in mentioning the biſhop of Man's dioceſe. Concerning the origin and application of this word, very different opinions have been formed by the learned. Buchanan (lib. i. cap. 34.) ſays, that before his time the name of *Sodor* was given to a town in the iſle of Man. In Gough's edition of Camden's *Britannia* (vol. iii. p. 701.) it is ſaid, that after the iſle of Man was annexed to the crown of England, this appellation was given to a ſmall iſland within muſket-ſhot of Man, in which the cathedral ſtands, called by the Norwegians the *Holm*, and by the inhabitants the *Peel*. In ſupport of this opinion, a charter is quoted A. D. 1505, in which Thomas earl of Derby and lord of Man confirms to Huan Heſketh biſhop of Sodor all the lands, &c. anciently belonging to the biſhops of Man. "Eccleſiam cathedralem ſancti Germani in *Holm Sodor vel Pele* vocatam, eccleſiam ſancti Patricii ibidem, et locum præfatum in quo eccleſiæ præfatæ ſitæ ſunt." The truth of either, or perhaps of both, theſe accounts might be allowed; but neither of them is ſufficient to account for the conſtant conjunction of Sodor and Man, in charters, regiſters, and hiſtories. If Sodor was a ſmall town or iſland belonging to Man, it cannot be conceived why it is always mentioned before it, or rather why it ſhould be mentioned at all in ſpeaking of a biſhop's dioceſe. To ſpeak of the biſhopric of Sodor and Man in this caſe would be as improper as it would be to call the biſhopric of Durham the biſhopric of Holy Iſland and Durham, or the biſhopric of Darlington and Durham; the former being a ſmall iſland and the latter a town belonging to the county and dioceſe of Durham. Neither of theſe accounts, therefore, gives a ſatiſfactory account of the original conjunction of Sodor and Man.

The iſland of Iona was the place where the biſhop of the Iſles reſided, the cathedral church of which, it is ſaid, was dedicated to our Saviour, in Greek *Soter*, hence *Sotorenſes*, which might be corrupted into *Sodorenſes*, a name frequently given by Daniſh writers to the weſtern iſles of Scotland. That we may be the more diſpoſed to accede to this Grecian etymology, the advocates for this opinion tell us, that the name *Icolumkill*, which is often applied to this iſland, is alſo of Greek extraction, being derived from *Columba*, "a pigeon;" a meaning that exactly correſponds to the Celtic word *Colum* and the Hebrew word *Iona*. We muſt confeſs, however, that we have very little faith in the conjectures of etymologiſts, and think that upon no occaſion they alone can eſtabliſh any fact, though when concurring with facts they certainly tend to confirm and explain them. It is only from hiſtorical facts that we can know to what Sodor was applied.

It appears from the hiſtory of the Orkneys, compiled by an old Icelandic writer, tranſlated and enlarged by Torfæus, that the Æbudæ or Weſtern iſles of Scotland were divided into two cluſters, Nordureys and Sudereys. The Nordureys, which were ſeparated from the Sudereys by the point of Ardnamurchan, a promontory in Argyleſhire, conſiſted of Muck, Egg, Rum, Canna, Skye, Raſay, Barra, South Uiſt, North Uiſt, Benbecula, and Lewis, including Harris, with a great number of ſmall iſles. The Sudereys were, Man, Arran, Bute, Cumra, Avon, Gid, Ila, Colonſay, Jura, Scarba, Mull, Iona, Tiree, Coll, Ulva, and other ſmall iſlands. All theſe, when joined together, and ſubject to the ſame prince, made up the kingdom of Man and the Iſles. In the Norwegian language, *Suder* and *Norder* ſignify ſouthern and northern, and *ey* or *ay* an iſland. When the Æbudæ were under one monarch, the ſeat of empire was fixed in the Sudereys, and the Nordureys were governed by deputies; hence the former are much oftener mentioned in hiſtory than the latter; hence, too, the Sudereys often comprehend the Nordureys, as in our days Scotland is ſometimes comprehended under England. Sudereys, or Suder, when angliciſed, became Sodor; and all the Weſtern iſles of Scotland being included in one dioceſe under the Norwegian princes, the biſhop appointed to ſuperintend them was called the biſhop of Man and the Iſles, or the biſhop of Sodor and Man. Since Man was conquered by Edward III. it has been ſeparated from the other iſles, and its biſhops have exerciſed no juriſdiction over them. Should it now be aſked, why then is the biſhop of Man ſtill called the biſhop of Sodor and Man? we reply, that we have been able to diſcover no reaſon; but ſuppoſe the appellation to be continued in the ſame way, as the title king of France has been kept up by the kings of Great Britain, for ſeveral centuries after the Engliſh were entirely expelled from France.

SOFA, in the eaſt, a kind of alcove raiſed half a foot above the floor of a chamber or other apartment; and uſed as the place of ſtate, where viſitors of diſtinction are received. Among the Turks the whole floor of their ſtate-rooms is covered with a kind of tapeſtry, and on the window-ſide is raiſed a ſofa or ſopha, laid with a kind of mattreſs, covered with a carpet much richer than the other. On this carpet the Turks are ſeated, both men and women, like the tailors in England, croſs-legged, leaning againſt the wall, which is bolſtered with velvet, ſatin, or other ſtuff ſuitable to the ſeaſon. Here they eat their meals; only laying a ſkin over the carpet to ſerve as a tablecloth, and a round wooden board over all, covered with plates, &c.

SOFALA, or CEFALA, a kingdom of Africa, lying on the coaſt of Moſambique, near Zanguebar. It is bounded on the north by Monomotapa; on the eaſt by the Moſambique ſea; on the ſouth by the kingdom of Sabia; and on the weſt by that of Manica. It contains mines of gold and iron, and a great number of elephants. It is governed by a king, tributary to the Portugueſe, who built a fort at the principal town, which is of the ſame name, and of great importance for their trade to the Eaſt Indies. It is ſeated in a ſmall iſland near the mouth of a river. E. Long. 35. 40. S. Lat. 20. 20.

SOFFITA, or SOFFIT, in *Architecture*, any timber ceiling formed of croſs beams of flying corniches, the ſquare compartiments or pannels of which are enriched with ſculpture, painting, or gilding; ſuch are thoſe in the palaces of Italy, and in the apartments of Luxembourg at Paris.

SOFFITA, or *Soffit*, is alſo uſed for the underſide or face of an architrave; and more particularly for that of the corona or larmier, which the ancients called *lacunar*, the French *plafond*, and we uſually the *drip*. It is enriched with compartiments of roſes; and in the Doric order has 18 drops, diſpoſed in three ranks, ſix in each, placed to the right of the guttæ, at the bottom of the triglyphs.

SOFI, or SOPHI. See SOPHI.

SOFTENING, in *Painting*, the mixing and diluting of colours with the bruſh or pencil.

SOHO, the name of a ſet of works, or manufactory of a variety of hardwares, belonging to the late Mr Boulton, ſituated on the borders of Staffordſhire, within two miles of Birmingham; now ſo juſtly celebrated as to deſerve a ſhort hiſtorical detail.

About 30 years ago the premiſes conſiſted of a ſmall mill and a few obſcure dwellings. Mr Boulton, in conjunction with Mr Fothergill, then his partner, at an expence of 9000l. erected a handſome and extenſive edifice, with a view of manufacturing metallic toys. The firſt productions conſiſted of buttons, buckles, watch-chains, trinkets, and ſuch other articles as were peculiar to Birmingham. Novelty, taſte, and variety, were however always conſpicuous; and plated wares, known by the name of Sheffield plate, compriſing a great variety of uſeful and ornamental articles, became another permanent ſubject of manufacture.

To open channels for the conſumption of theſe commodities, all the northern part of Europe was explored by the mercantile partner Mr Fothergill. A wide and extenſive correſpondence was thus eſtabliſhed, the undertaking became well known, and the manufacturer, by becoming his own merchant, eventually enjoyed a double profit.

Impelled by an ardent attachment to the arts, and by the patriotic ambition of forming his favourite Soho into a fruitful ſeminary of artiſts, the proprietor extended his views; and men of taſte and talents were now ſought for, and liberally patroniſed. A ſucceſsful imitation of the French or *mouliſe* ornaments, conſiſting of vaſes, tripods, candelabra, &c. &c. extended the celebrity of the works. Services of plate and other works in ſilver, both maſſive and airy, were added, and an aſſay office was eſtabliſhed in Birmingham.

Mr Watt, the ingenious improver of the ſteam-engine, was afterwards taken into partnerſhip with Mr Boulton; and they carried on at Soho a manufactory of ſteam-engines, not leſs beneficial to the public than lucrative to themſelves. This valuable machine, the nature and excellencies of which are deſcribed in another place (ſee *STEAM-Engine*), Mr Boulton propoſed to apply to the operation of coining, and ſuitable apparatus was erected at a great expence, for the purpoſe of being employed by government to make a new copper-coinage for the kingdom. Artiſts of merit were engaged, and ſpecimens of exquiſite delicacy were exhibited; the works were alſo employed upon highly finiſhed medals and private coins. To enumerate all the productions of this manufactory would be tedious (A).

In a national view, Mr Boulton's undertakings are highly valuable and important. By collecting around him artiſts of various deſcriptions, rival talents have been called forth, and by ſucceſſive competition have been multiplied to an extent highly beneficial to the public. The manual arts partook of the benefit, and became proportionably improved.

A barren heath has been covered with plenty and population; and Mr Boulton's works, which in their infancy were little known and attended to, now cover ſeveral acres, give employment to more than 600 perſons, and are ſaid to be the firſt of their kind in Europe.

SOIL, the mould covering the ſurface of the earth, in which vegetables grow. It ſerves as a ſupport for vegetables, and as a reſervoir for receiving and communicating nouriſhment.

Soils are commonly double or triple compounds of the ſeveral reputed primitive earths, except the barytic. The magneſian likewiſe ſparingly occurs. The more fertile ſoils afford alſo a ſmall proportion of coally ſubſtance ariſing from putrefaction, and ſome traces of marine acid and gypſum. The vulgar diviſion into clay, chalk, ſand, and gravel, is well underſtood. Loam denotes any ſoil moderately adheſive; and, according to the ingredient that predominates, it receives the epithets of clayey, chalky, ſandy, or gravelly. The intimate mixture of clay with the oxydes of iron is called *till*, and is of a hard conſiſtence and a dark reddiſh colour. Soils are found by analyſis to contain their earthy ingredients in very different proportions. According to M. Giobert, fertile mould in the vicinity of Turin, where the fall of rain amounts yearly to 40 inches, affords for each 100 parts, from 77 to 79 of ſilex, from 8 to 14 of argill, and from 5 to 12 of lime; beſides about one-half of carbonic matter, and nearly an equal weight of gas, partly carbonic and partly hydrocarbonic. The ſame experimenter repreſents the compoſition of barren ſoils in ſimilar ſituations to be from 42 to 88 per cent. of ſilex,

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(A) It was at this place, in the year 1772, that Mr Eginton invented an expeditious method of copying pictures in oil; but we do not know how far this method has ſucceeded.

lex, from 20 to 30 of argill, and from 4 to 20 of lime. The celebrated Bergman found rich ſoils in the valleys of Sweden, where the annual quantity of rain is 24 inches, to contain, for each 100 parts, 56 of ſiliceous ſand, 14 of argill, and 30 of lime. In the climate of Paris, where the average fall of rain is 20 inches, fertile mixtures, according to M. Tillet, vary from 46 to 52 per cent. of ſilex, and from 11 to 17 of argill, with 37 of lime. Hence it appears that in dry countries rich earths are of a cloſer texture, and contain more of the calcareous ingredient, with leſs of the ſiliceous. Mr Arthur Young has diſcovered, that the value of fertile lands is nearly proportioned to the quantities of gas which equal weights of their ſoil afford by diſtillation. See AGRICULTURE *Index*.

SOISSONS, an ancient, large, and conſiderable city of France, in the department of Aiſne and late province of Soiſſonnois. It was the capital of a kingdom of the ſame name, under the firſt race of the French monarchs. It contains about 12,000 inhabitants, and is a biſhop's ſee. The environs are charming, but the ſtreets are narrow, and the houſes ill-built. The fine cathedral has one of the moſt conſiderable chapters in the kingdom; and the biſhop, when the archbiſhop of Rheims was abſent, had a right to crown the king. The caſtle, though ancient, is not that in which the kings of the firſt race reſided. Soiſſons is ſeated in a very pleaſant and fertile valley, on the river Aiſne, 30 miles weſt by north of Rheims, and 60 north-eaſt of Paris. E. Long. 3. 24. N. Lat. 49. 23.

SOKE, or SOK. See SOCAGE.

SOKEMANS. See SOC and SOCAGE.

SOL, in *Muſic*, the fifth note of the gamut, *ut, re, mi, fa, ſol, la*. See GAMUT.

SOL, or *Sou*, a French coin made up of copper mixed with a little ſilver, and is worth upwards of an Engliſh halfpenny, or the 23d part of an Engliſh ſhilling. The ſol when firſt ſtruck was equal in value to 12 deniers Tournois, whence it was alſo called *douzain*, a name it ſtill retains, though its ancient value be changed; the ſol having been ſince augmented by three deniers, and ſtruck with a puncheon of a fleur-de-lis, to make it current for 15 deniers. Soon after the old ſols were coined over again, and both old and new were indifferently made current for 15 deniers. In 1709, the value of the ſame ſols was raiſed to 18 deniers. Towards the latter end of the reign of Louis XIV. the ſol of 18 deniers was again lowered to 15; and by the late king it was reduced to the original value of 12. What it is at preſent poſterity may perhaps diſcover.

The Dutch have alſo two kinds of ſols: the one of ſilver, called *ſols de gros*, and likewiſe *ſchelling*; the other of copper, called alſo the *ſtuyver*.

SOL, the *Sun*, in *Aſtronomy*, *Aſtrology*, &c. See ASTRONOMY, *paſſim*.

SOL, in *Chemiſtry*, is gold; thus called from an opinion that this metal is in a particular manner under the influence of the ſun.

SOL, in *Heraldry*, denotes Or, the golden colour in the arms of ſovereign princes.

SOLÆUS, or SOLEUS, in *Anatomy*, one of the extenſor muſcles of the foot, riſing from the upper and hinder parts of the tibia and fibula.

SOLAN-GOOSE. See PELICANUS, ORNITHOLOGY *Index*.

SOLANDRA, a genus of plants belonging to the claſs of monadelphia, and to the order of polyandria; and in the natural ſyſtem arranged under the 38th order, *Tricoccæ*. See BOTANY *Index*.

SOLANUM, a genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 28th order, *Luridæ*. See BOTANY *Index*.

SOLAR, ſomething belonging to the SUN.

SOLAR-*Spots*. See ASTRONOMY *Index*.

SOLDAN. See SULTAN.

SOLDANELLA, a genus of plants belonging to the claſs of pentandria, and order of monogynia; and in the natural ſyſtem arranged under the 21ſt order, *Preciæ*. See BOTANY *Index*.

SOLDER, SODDER, or *Soder*, a metallic or mineral compoſition uſed in ſoldering or joining together other metals.

Solders are made of gold, ſilver, copper, tin, biſmuth, and lead; uſually obſerving, that in the compoſition there be ſome of the metal that is to be ſoldered mixed with ſome higher and finer metals. Goldſmiths uſually make four kinds of ſolder, viz. ſolder of eight, where to ſeven parts of ſilver there is one of braſs or copper; ſolder of ſix, where only a ſixth part is copper; ſolder of four, and ſolder of three. It is the mixture of copper in the ſolder that makes raiſed plate come always cheaper than flat.

As mixtures of gold with a little copper are found to melt with leſs heat than pure gold itſelf, theſe mixtures ſerve as ſolders for gold: two pieces of fine gold are ſoldered by gold that has a ſmall admixture of copper; and gold alloyed with copper is ſoldered by ſuch as is alloyed with more copper: the workmen add a little ſilver as well as copper, and vary the proportions of the two to one another, ſo as to make the colour of the ſolder correſpond as nearly as may be to that of the piece. A mixture of gold and copper is alſo a ſolder for fine copper as well as for fine gold. Gold being particularly diſpoſed to unite with iron, proves an excellent ſolder for the finer kinds of iron and ſteel inſtruments.

The ſolder uſed by plumbers is made of two pounds of lead to one of block-tin. Its goodneſs is tried by melting it, and pouring the bigneſs of a crown-piece on a table; for, if good, there will ariſe little bright ſhining ſtars therein. The ſolder for *copper* is made like that of the plumbers; only with copper and tin; and for very nice works, inſtead of tin, they ſometimes uſe a quantity of ſilver. Solder for *tin* is made of two-thirds of tin and one of lead, or of equal parts of each; but where the work is any thing delicate, as in organ-pipes, where the juncture is ſcarce diſcernible, it is made of one part of biſmuth and three parts of pewter. The pewterers uſe a kind of ſolder made with two parts of tin and one of biſmuth; this compoſition melts with the leaſt heat of any of the ſolders.

Silver ſolder is that which is made of two parts of ſilver and one of braſs, and uſed in ſoldering thoſe metals. Spelter ſolder is made of one part of braſs and two of ſpelter or zinc, and is uſed by the braziers and copperſmiths for ſoldering braſs, copper, and iron. This ſolder is improved by adding to each ounce of it one pennyweight of ſilver; but as it does not melt without a conſiderable degree of heat, it cannot be uſed when it it is inconvenient to heat the work red hot; in which caſe copper and braſs are ſoldered with ſilver.

Though ſpelter ſolder be much cheaper than ſilver-ſolder, yet workmen in many caſes prefer the latter. And Mr Boyle informs us, that he has found it to run with ſo moderate a heat, as not much to endanger the melting of the delicate parts of the work to be ſoldered; and if well made, this ſilver ſolder will lie even upon the ordinary kind itſelf; and ſo fill up thoſe little cavities that may chance to be left in the firſt operation, which is not eaſily done without a ſolder more eaſily fuſible than the firſt made uſe of. As to iron, it is ſufficient that it be heated to a white heat, and the two extremities, in this ſtate, be hammered together; by which means they become incorporated one with the other.

SOLDERING, the joining and faſtening together of two pieces of the ſame metal, or of two different metals, by the fuſion and application of ſome metallic compoſition on the extremities of the metals to be joined.

To ſolder upon ſilver, braſs, or iron: Take ſilver, five pennyweights; braſs, four pennyweights: melt them together for ſoft ſolder, which runs ſooneſt. Take ſilver, five pennyweights; copper, three pennyweights: melt them together for hard ſolder. Beat the ſolder thin, and lay it on the place to be ſoldered, which muſt be firſt fitted and bound together with wire as occaſion requires; then take borax in powder, and temper it like pap, and lay it upon the ſolder, letting it dry; then cover it with live coals, and blow, and it will run immediately; take it preſently out of the fire, and it is done. It is to be obſerved, that if any thing is to be ſoldered in two places, which cannot well be done at one time, you muſt firſt ſolder with the harder ſolder, and then with the ſoft; for if it be firſt done with the ſoft, it will unſolder again before the other is faſtened. Let it be obſerved, that if you would not have your ſolder run about the piece that is to be ſoldered, you muſt rub ſuch places over with chalk.—In the ſoldering either of gold, ſilver, copper, or either of the metals above mentioned, there is generally uſed borax in powder, and ſometimes roſin. As to iron, it is ſufficient that it be heated red hot, and the two extremities thus hammered together, by which means they will become incorporated with each other. For the finer kinds of iron and ſteel inſtruments, however, gold proves an excellent ſolder. This metal will diſſolve twice or thrice its weight of iron in a degree of heat very far leſs than that in which iron itſelf melts; hence if a ſmall plate of gold is warpped round the parts to be joined, and afterwards melted by a blow-pipe, it ſtrongly unites the pieces together without any injury to the inſtrument, however delicate.

SOLDIER, a military man liſted to ſerve a prince or ſtate in conſideration of a certain daily pay.

Soldier-Crab. See Cancer, Entomology *Index.*

Freſh-Water Soldier. See Stratiotes, Botany *Index.*

SOLE, in the manege, ſort of a horn under a horſe's foot, which is much more tender than the other horn that encompaſſes the foot, and by reaſon of its hardneſs is properly called the *horn* or *hoof.*

Sole. See Pleuronectes, Ichthyology *Index.*

SOLEA. See Sandal and Shoe.

SOLECISM, in *Grammar*, a falſe manner of ſpeaking, contrary to the rules of grammar, either in reſpect of declenſion, conjugation, or ſyntax.—The word is Greek, σολοικισμος, derived from the *Soli*, a people of Attica, who being tranſplanted to Cilicia, loſt the purity of their ancient tongue, and became ridiculous to the Athenians for the improprieties into which they fell.

SOLEMN, ſomething performed with much pomp, ceremony, and expence. Thus we ſay, ſolemn feaſts, ſolemn funerals, ſolemn games, &c.—In law, *ſolemn* ſignifies ſomething authentic, or what is clothed in all its formalities.

SOLEN, Razor-sheath, or *Knife-handle Shell;* a genus belonging to the claſs of *vermes*, and order of *teſtacea.* See Conchology *Index.*

SOLEURE, a canton of Swiſſerland, the 11th in rank in the Helvetic confederacy, into which it was admitted in the year 1481. It ſtretches partly through the plain, and partly along the chains of the Jura, about 35 miles ſquare, and containing 50,000 inhabitants. The ſoil for the moſt part is exceedingly fertile in corn; and the diſtricts within the Jura abound in excellent paſtures. The trade of the town and canton is of little value, although they are commodiouſly ſituated for commerce. It is divided into 11 bailiwicks, the inhabitants of which are all Roman Catholics except thoſe of the bailiwick of Buckegberg, who profeſs the reformed religion. The ſovereign power reſides in the great council, which, compriſing the ſenate or little council of 36, conſiſts of 102 members, choſen by the ſenate in equal proportions from the 11 tribes or companies into which the ancient burghers are diſtributed.

A melancholy cataſtrophe took place in this canton on the 13th July 1813. The river Birſe, ſwelled by the rains, overflowed its banks at Dornach, and undermined a houſe, which was thrown down and buried a number of perſons in its ruins. An ancient tower, which was occupied as the priſon, experienced a ſimilar fate, fell on the bridge, broke it in the centre, and precipitated a great crowd of perſons collected upon it into the torrent. By this accident 150 of the inhabitants loſt their lives.

Soleure, an ancient and extremely neat town of Swiſſerland, capital of the canton of the ſame name. It contains about 4000 inhabitants, and is pleaſantly ſeated on the Aar, which here expands into a noble river. Among the moſt remarkable objects of curioſity in this town is the new church of St Urs, which was begun in 1762 and finiſhed in 1772; a noble edifice of a whitiſh grey ſtone or coarſe marble, which admits a poliſh. This building coſt at leaſt 80,000l. a conſiderable ſum for ſuch a ſmall republic, whoſe revenue ſcarcely exceeds 12,000l. a-year. Soleure is ſurrounded by regular ſtone fortifications, and is 20 miles north-north-eaſt of Bern, 27 ſouth-ſouth-weſt of Baſle, and 45 weſt of Zurich. E. Long. 7. 20. N. Lat. 47. 15.

SOLFAING, in *Muſic*, the naming or pronouncing the ſeveral notes of a ſong by the ſyllables *ut, re, mi, fa, ſol,* &c. in learning to ſing it.

Of the ſeven notes in the French ſcale *ut, re, mi, fa, ſol, la, ſi,* only four are uſed among us in ſinging, as *mi, fa, ſol, la:* their office is principally, in ſinging, that by applying them to every note of the ſcale, it may not only be pronounced with more eaſe, but chiefly that by them the tones and ſemitones of the natural ſcale may be better marked out and diſtinguiſhed. This deſign is obtained by the four ſyllables *fa, ſol, la, mi.*

Thus

Thus from *fa* to *ſol* is a tone, alſo from *ſol* to *la*, and from *la* to *mi*, without diſtinguiſhing the greater or leſs tone; but from *la* to *fa*, alſo from *mi* to *fa*, is only a ſemitone. If then theſe be applied in this order, *fa, ſol, la, fa, ſol, la, mi, fa*, &c. they expreſs the natural ſeries from C; and if that be repeated to a ſecond or third octave, we ſee by them how to expreſs all the different orders of tones and ſemitones in the diatonic ſcale; and ſtill above *mi* will ſtand *fa, ſol, la*, and below it the ſame inverted *la, ſol, fa*, and one *mi* is always diſtant from another an octave; which cannot be ſaid of any of the reſt, becauſe after *mi* aſcending come always *fa, ſol, la*, which are repeated invertedly deſcending.

To conceive the uſe of this, it is to be remembered, that the firſt thing in learning to ſing, is to make one raiſe a ſcale of notes by tones and ſemitones to an octave, and deſcend again by the ſame; and then to riſe and fall by greater intervals at a leap, as thirds and fourths, &c. and to do all this by beginning at notes of different pitch. Then thoſe notes are repreſented by lines and ſpaces, to which theſe ſyllables are applied, and the learners taught to name each line and ſpace thereby, which makes what we call *ſolfaing*; the uſe whereof is, that while they are learning to tune the degrees and intervals of ſound expreſſed by notes on a line or ſpace, or learning a ſong to which no words are applied, they may not only do it the better by means of articulate ſounds, but chiefly that by knowing the degrees and intervals expreſſed by thoſe ſyllables, they may more readily know the places of the ſemitones, and the true diſtance of the notes. See the article SINGING.

SOLFATERRA, a mountain of Italy in the kingdom of Naples, and Terra di Lavoro. This mountain appears evidently to have been a volcano in ancient times; and the ſoil is yet ſo hot, that the workmen employed there in making alum need nothing elſe beſides the heat of the ground for evaporating their liquids. Of this mountain we have the following account by Sir William Hamilton. "Near Aſtruni (another mountain, formerly a volcano likewiſe) riſes the Solfaterra, which not only retains its cone and crater, but much of its former heat. In the plain within the crater, ſmoke iſſues from many parts, as alſo from its ſides: here, by means of ſtones and tiles heaped over the crevices, through which the ſmoke paſſes, they collect in an awkward manner what they call *ſale armoniaco*; and from the ſand of the plain they extract ſulphur and alum. This ſpot, well attended to, might certainly produce a good revenue, whereas I doubt if they have hitherto ever cleared 200l. a-year by it. The hollow ſound produced by throwing a heavy ſtone on the plain of the crater of the Solfaterra, ſeems to indicate that it is ſupported by a ſort of arched natural vault; and one is induced to think that there is a pool of water beneath this vault (which boils by the heat of a ſubterraneous fire ſtill deeper), by the very moiſt ſteam that iſſues from the cracks in the plain of the Solfaterra, which, like that of boiling water, runs off a ſword or knife, preſented to it, in great drops. On the outſide, and at the foot of the cone of the Solfaterra, towards the lake of Agnano, water ruſhes out of the rocks ſo hot as to raiſe the quickſilver in Fahrenheit's thermometer to the degree of boiling water (A); a fact of which I was myſelf an eye-witneſs. This place, well worthy the obſervation of the curious, has been taken little notice of; it is called the *Piſciarelli*. The common people of Naples have great faith in the efficacy of this water; and make much uſe of it in all cutaneous diſorders, as well as for another diſorder that prevails here. It ſeems to be impregnated chiefly with ſulphur and alum. When you approach your ear to the rocks of the Piſciarelli, from whence this water oozes, you hear a horrid boiling noiſe, which ſeems to proceed from the huge cauldron that may be ſuppoſed to be under the plain of the Solfaterra. On the other ſide of the Solfaterra, next the ſea, there is a rock which has communicated with the ſea, till part of it was cut away to make the road to Puzzole; this was undoubtedly a conſiderable lava, that ran from the Solfaterra when it was an active volcano. Under this rock of lava, which is more than 70 feet high, there is a ſtratum of pumice and aſhes. This ancient lava is about a quarter of a mile broad; you meet with it abruptly before you come in ſight of Puzzole, and it finiſhes as abruptly within about 100 paces of the town. The ancient name of the Solfaterra was *Forum Vulcani*; a ſtrong proof of its origin from ſubterraneous fire. The degree of heat that the Solfaterra has preſerved for ſo many ages, ſeems to have calcined the ſtones upon its cone and in its crater, as they are very white and crumble eaſily in the hotteſt parts.

SOLICITOR, a perſon employed to take care of and manage ſuits depending in the courts of law or equity. Solicitors are within the ſtatute to be ſworn, and admitted by the judges, before they are allowed to practiſe in our courts, in like manner as attorneys.

There is alſo a great officer of the law, next to the attorney-general, who is ſtyled the king's ſolicitor-general; who holds his office by patent during the king's pleaſure, has the care and concern of managing the king's affairs, and has fees for pleading, beſides other fees ariſing by patents, &c. He attends on the privy-council; and the attorney-general and he were anciently reckoned among the officers of the exchequer; they have their audience, and come within the bar in all other courts.

SOLID, in *Philoſophy*, a body whoſe parts are ſo firmly connected together, as not eaſily to give way or ſlip from each other; in which ſenſe *ſolid* ſtands oppoſed to *fluid*.

Geometricians define a ſolid to be the third ſpecies of magnitude, or that which has three dimenſions, viz. length, breadth, and thickneſs or depth.

Solids are commonly divided into regular and irregular. The regular ſolids are thoſe terminated by regular and

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(A) "I have remarked, that after a great fall of rain, the degree of heat in this water is much leſs; which will account for what Padre Torre ſays (in his book, intitled *Hiſtoire et Phenomenes du Veſuve*), that when he tried it in company with Monſieur de la Condamine, the degree of heat, upon Reaumur's thermometer, was 68°.

and equal planes, and are only five in number, viz. the tetrahedron, which conſiſts of four equal triangles; the cube or hexahedron, of ſix equal ſquares; the octahedron, of eight equal triangles; the dodecahedron, of twelve; and the icoſahedron, of twenty equal triangles.

The irregular ſolids are almoſt infinite, comprehending all ſuch as do not come under the definition of regular ſolids; as the ſphere, cylinder, cone, parallelogram, priſm, parallelopiped, &c.

SOLIDS, in *Anatomy*, are the bones, ligaments, membranes, muſcles, nerves and veſſels, &c.

The ſolid parts of the body, though equally compoſed of veſſels, are different with regard to their conſiſtence; ſome being hard and others ſoft. The hard, as the bones and cartilages, give firmneſs and attitude to the body, and ſuſtain the other parts: the ſoft parts, either alone or together with the hard, ſerve to execute the animal functions. See ANATOMY.

SOLIDAGO, a genus of plants belonging to the claſs of ſyngeneſia, and to the order of polygamia ſuperflua; and in the natural ſyſtem ranging under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SOLIDITY, that property of matter, or body, by which it excludes all other bodies from the place which itſelf poſſeſſes; and as it would be abſurd to ſuppoſe that two bodies could poſſeſs one and the ſame place at the ſame time, it follows, that the ſofteſt bodies are equally ſolid with the hardeſt. See METAPHYSICS, Nº 44, 173, &c.

Among geometricians, the ſolidity of a body denotes the quantity or ſpace contained in it, and is called alſo its ſolid content.

The ſolidity of a cube, priſm, cylinder, or parallelopiped, is had by multiplying its baſis into its height. The ſolidity of a pyramid or cone is had by multiplying either the whole baſe into a third part of the height, or the whole height into a third part of the baſe.

SOLILOQUY, a reaſoning or diſcourſe which a man holds with himſelf; or, more properly, according to Papias, it is a diſcourſe by way of anſwer to a queſtion that a man propoſes to himſelf.

Soliloquies are become very common on the modern ſtage; yet nothing can be more inartificial, or more unnatural, than an actor's making long ſpeeches to himſelf, to convey his intentions to the audience. Where ſuch diſcoveries are neceſſary to be made, the poets ſhould rather take care to give the dramatic perſons ſuch confidants as may neceſſarily ſhare their inmoſt thoughts; by which means they will be more naturally conveyed to the audience; yet even this is a ſhift which an accurate poet would not have occaſion for. The following lines of the duke of Buckingham concerning the uſe and abuſe of ſoliloquies deſerve attention:

Soliloquies had need be very few,
Extremely ſhort, and ſpoke in paſſion too.
Our lovers talking to themſelves, for want
Of others, make the pit their confidant:
Nor is the matter mended yet, if thus
They truſt a friend, only to tell it us.

SOLIMAN II. emperor of the Turks, ſurnamed the *Magnificent*, was the only ſon of Selim I. whom he ſucceeded in 1520. He was educated in a manner very different from the Ottoman princes in general; for he was inſtructed in the maxims of politics and the ſecrets of government. He began his reign by reſtoring thoſe perſons their poſſeſſions whom his father had unjuſtly plundered. He re-eſtabliſhed the authority of the tribunals, which was almoſt annihilated, and beſtowed the government of provinces upon none but perſons of wealth and probity: "I would have my viceroys (he uſed to ſay) reſemble thoſe rivers that fertilize the fields through which they paſs, not thoſe torrents which ſweep every thing before them."

After concluding a truce with Iſmael Sophy of Perſia, and ſubduing Gozeli Bey, who had raiſed a rebellion in Syria, he turned his arms againſt Europe. Belgrade was taken in 1521, and Rhodes fell into his hands the year following, after an obſtinate and enthuſiaſtic defence. In 1526 he defeated and ſlew the king of Hungary in the famous battle of Mohatz. Three years after he conquered Buda, and immediately laid ſiege to Vienna itſelf. But after continuing 20 days before that city, and aſſaulting it 20 times, he was obliged to retreat with the loſs of 80,000 men. Some time after he was defeated by the Perſians, and diſappointed in his hopes of taking Malta. He ſucceeded, however, in diſpoſſeſſing the Genoeſe of Chio, an iſland which had belonged to that republic for more than 200 years.

He died at the age of 76, while he was beſieging Sigeth, a town in Hungary, on the 30th Auguſt 1566.

He was a prince of the ſtricteſt probity, a lover of juſtice, and vigorous in the execution of it; but he tarniſhed all his glory by the cruelty of his diſpoſition. After the battle of Mohatz he ordered 1500 priſoners, moſt of them gentlemen, to be ranged in a circle, and beheaded in preſence of his whole army.

Soliman thought nothing impoſſible which he commanded: A general having received orders to throw a bridge over the Drave, wrote him, that it was impoſſible. The ſultan ſent him a long band of linen with theſe words written on it: "The emperor Soliman, thy maſter, orders thee to build a bridge over the Drave in ſpite of the difficulties thou mayeſt meet with. He informs thee at the ſame time, that if the bridge be not finiſhed upon his arrival, he will hang thee with the very linen which informs thee of his will."

SOLIPUGA, or SOLIFUGA, in *Natural Hiſtory*, the name given by the Romans to a ſmall venomous inſect of the ſpider-kind, called by the Greeks *heliocentros*; both words ſignifying an animal which ſtings moſt in the country and ſeaſons where the ſun is moſt hot. Solinus makes this creature peculiar to Sardinia; but this is contrary to all the accounts given us by the ancients. It is common in Africa and ſome parts of Europe. Almoſt all the hot countries produce this venomous little creature. It lies under the ſand to ſeize other inſects as they go by; and if it meet with any uncovered part of a man, produces a wound which proves very painful; it is ſaid that the bite is abſolutely mortal, but probably this is not true. Solinus writes the word *ſolifuga*, and ſo do many others, erroneouſly deriving the name from the notion that this animal flies from the ſun's rays, and buries itſelf in the ſand.

SOLIS, ANTONIO DE, an ingenious Spaniſh writer, of an ancient and illuſtrious family, born at Placenza in Old Caſtile, in 1610. He was intended for the law; but his inclination toward poetry prevailed, and he cultivated it with great ſucceſs. Philip IV. of Spain made him one of his ſecretaries ; and after his death the queen-regent appointed him hiſtoriographer of the Indies, a place of great profit and honour : his Hiſtory of the Conqueſt of Mexico ſhows that ſhe could not have named a fitter perſon. He is better known by this hiſtory at leaſt abroad, than by his poetry and dramatic writings, though in theſe he was alſo diſtinguiſhed. He turned prieſt at 57 years of age, and died in 1686.

SOLITARY, that which is remote from the company or commerce of others of the ſame ſpecies.

SOLITARIES, a denomination of nuns of St Peter of Alcantara, inſtituted in 1676, the deſign of which was to imitate the ſevere penitent life of that ſaint. Thus they are to keep a continual ſilence, never to open their mouths to a ſtranger ; to employ their time wholly in ſpiritual exerciſes, and leave their temporal concerns to a number of maids, who have a particular ſuperior in a ſeparate part of the monaſtery : they always go bare-footed, without ſandals ; gird themſelves with a thick cord, and wear no linen.

SOLO, in the Italian muſic, is frequently uſed in pieces conſiſting of ſeveral parts, to mark thoſe that are to perform alone ; as *fiauto ſolo, violino ſolo*. It is alſo uſed for ſonatas compoſed for one violin, one German flute, or other inſtrument, and a baſs ; thus we ſay, *Corelli's ſolos, Geminiani's ſolos*, &c. When two or three parts play or ſing ſeparately from the grand chorus, they are called a *doi ſoli*, a *tre ſoli*, &c. Solo is ſometimes denoted by *S*.

SOLOMON, the ſon of David king of Iſrael, renowned in Scripture for his wiſdom, riches, and magnificent temple and other buildings. Towards the end of his life he ſullied all his former glory by his apoſtaſy from God ; from which cauſe vengeance was denounced againſt his houſe and nation. He died about 975 B. C.

SOLOMON's Seal, a ſpecies of CONVALLARIA, which ſee, BOTANY *Index*.

SOLON, one of the ſeven wiſe men of Greece, was born at Salamis, of Athenian parents, who were deſcended from Codrus. His father leaving little patrimony, he had recourſe to merchandiſe for his ſubſiſtence. He had, however, a greater thirſt after knowledge and fame than after riches, and made his mercantile voyages ſubſervient to the increaſe of his intellectual treaſures. He very early cultivated the art of poetry, and applied himſelf to the ſtudy of moral and civil wiſdom. When the Athenians, tired out with a long and troubleſome war with the Megarenſians, for the recovery of the iſle of Salamis, prohibited any one, under pain of death, to propoſe the renewal of their claim to that iſland, Solon thinking the prohibition diſhonourable to the ſtate, and finding many of the younger citizens deſirous to revive the war, feigned himſelf mad, and took care to have the report of his inſanity ſpread through the city. In the mean time he compoſed an elegy adapted to the ſtate of public affairs, which he committed to memory. Every thing being thus prepared, he ſallied forth into the market-place with the kind of cap on his head which was commonly worn by ſick perſons, and, aſcending the herald's ſtand, he delivered, to a numerous crowd, his lamentation for the deſertion of Salamis. The verſes were heard with general applauſe ; and Piſiſtratus ſeconded his advice, and urged the people to renew the war. The decree was immediately repealed ; the claim to Salamis was reſumed ; and the conduct of the war was committed to Solon and Piſiſtratus, who, by means of a ſtratagem, defeated the Megarenſians, and recovered Salamis.

His popularity was extended through Greece in conſequence of a ſucceſsful alliance which he formed among the ſtates in defence of the temple at Delphos againſt the Cirrhæans. When diſſenſions had ariſen at Athens between the rich creditors and their poor debtors, Solon was created archon, with the united powers of ſupreme legiſlator and magiſtrate. He ſoon reſtored harmony between the rich and poor : He cancelled the debts which had proved the occaſion of ſo much oppreſſion ; and ordained that in future no creditor ſhould be allowed to ſeize the body of the debtor for his ſecurity : He made a new diſtribution of the people, inſtituted new courts of judicature, and framed a judicious code of laws, which afterwards became the baſis of the laws of the twelve tables in Rome. Among his criminal laws are many wiſe and excellent regulations ; but the code is neceſſarily defective with reſpect to thoſe principles which muſt be derived from the knowledge of the true God, and of pure morality, as the certain foundations of national happineſs. Two of them in particular were very exceptionable ; the permiſſion of a voluntary exile to perſons that had been guilty of premeditated murder, and the appointment of a leſs ſevere puniſhment for a rape than for ſeduction. Thoſe who wiſh to ſee accurately ſtated the comparative excellence of the laws of Moſes, of Lycurgus, and Solon, may conſult Prize Diſſertations relative to Natural and Revealed Religion by Teyler's Theological Society, vol. ix.

The interview which Solon is ſaid to have had with Crœſus king of Lydia ; the ſolid remarks of the ſage after ſurveying the monarch's wealth ; the recollection of thoſe remarks by Crœſus when doomed to die, and the noble conduct of Cyrus on that occaſion, are known to every ſchoolboy. Solon died in the iſland of Cyprus, about the 80th year of his age. Statues were erected to his memory both at Athens and Salamis. His thirſt after knowledge continued to the laſt : "I grow old (ſaid he) learning many things." Among the apophthegms and precepts which have been aſcribed to Solon, are the following : Laws are like cobwebs, that entangle the weak, but are broken through by the ſtrong. He who has learned to obey, will know how to command. In all things let reaſon be your guide. Diligently contemplate excellent things. In every thing that you do, conſider the end.

SOLSTICE, in *Aſtronomy*, that time when the ſun is in one of the ſolſtitial points ; that is, when he is at his greateſt diſtance from the equator ; thus called becauſe he then appears to ſtand ſtill, and not to change his diſtance from the equator for ſome time ; an appearance owing to the obliquity of our ſphere, and which thoſe living under the equator are ſtrangers to.

The ſolſtices are two in each year ; the æſtival or ſummer ſolſtice, and the hyemal or winter ſolſtice. The ſummer ſolſtice is when the ſun ſeems to deſcribe the tropic of cancer, which is on June 22. when he makes the longeſt day : the winter ſolſtice is when the ſun enters the firſt degree, or ſeems to deſcribe the tropic of capricorn, which is on December 22. when he makes the ſhorteſt day. This is to be underſtood as in our northern hemiſphere ; for in the ſouthern, the ſun's entrance

trance into capricorn makes the ſummer ſolſtice, and that into cancer the winter ſolſtice. The two points of the ecliptic, wherein the ſun's greateſt 'aſcent above the equator, and his deſcent below it, are terminated, are called the *ſolſtitial points;* and a circle, ſuppoſed to paſs through the poles of the world and theſe points, is called the *ſolſtitial colure.* The ſummer ſolſtitial point is in the beginning of the firſt degree of cancer; and is called the *æſtival* or *ſummer point;* and the winter ſolſtitial point is in the beginning of the firſt degree of capricorn, and is called the *winter point.* Theſe two points are diametrically oppoſite to each other.

SOLUTION, in *Chemiſtry*, denotes an intimate union of ſolid with fluid bodies, ſo as to form a tranſparent liquor. See CHEMISTRY *paſſim.*

SOLVENT, that which diſſolves a ſolid body into a tranſparent fluid.

SOLWAY MOSS. See *Moving Moss.*

SOMBRERO, the name of an uninhabited iſland in the Weſt Indies in the form of a hat, whence the name is derived. It is alſo the name of one of the Nicobar iſlands in the Eaſt Indies.

Wonderful Plant of SOMBRERO, is a ſtrange kind of ſenſitive plant growing in the Eaſt Indies, in ſandy bays and in ſhallow water. It appears like a ſlender ſtraight ſtick; but when you attempt to touch it, immediately withdraws itſelf into the ſand. Mr Miller gives an account of it in his deſcription of Sumatra. He ſays, the Malays call it *lolan lout*, that is, ſea graſs. He never could obſerve any tentacula; but, after many unſucceſsful attempts, drew out a broken piece about a foot long. It was perfectly ſtraight and uniform, and reſembled a worm drawn over a knitting needle. When dry it appears like a coral.

Philoſophical tranſactions, vol. xviii. p. [illegible].

SOMERS, JOHN, lord high chancellor of England, was born at Worceſter in 1652. He was educated at Oxford, and afterwards entered himſelf at the Middle-Temple, where he ſtudied the law with great vigour. In 1688 he was one of the counſel for the ſeven biſhops at their trial, and argued with great learning and eloquence againſt the diſpenſing power. In the convention which met by the prince of Orange's ſummons, January 22. 1689, he repreſented Worceſter; and was one of the managers for the Houſe of Commons, at a conference with the Houſe of Lords upon the word *abdicated.* Soon after the acceſſion of King William and Queen Mary to the throne, he was appointed ſolicitor-general, and received the honour of knighthood. In 1692 he was made attorney general, and in 1693 advanced to the poſt of lord keeper of the great ſeal of England. In 1695 he propoſed an expedient to prevent the practice of clipping the coin. In 1697 he was created Lord Somers, baron of Eveſham, and made lord high chancellor of England. In the beginning of 1700 he was removed from his poſt of lord chancellor, and the year after was impeached of high crimes and miſdemeanors by the Houſe of Commons, of which he was acquitted upon trial by the Houſe of Lords. He then retired to a ſtudious courſe of life, and was choſen preſident of the Royal Society. In 1706 he propoſed a bill for the regulation of the law; and the ſame year was one of the principal managers for the union between England and Scotland. In 1708 he was made lord preſident of the council; from which poſt he was removed in 1710, upon the change of the miniſtry. In the latter end of Queen Anne's reign his lordſhip grew very infirm in his health; which is ſuppoſed to be the reaſon that he held no other poſt than a ſeat at the council-table, after the acceſſion of King George I. He died of an apoplectic fit in 1716. Mr Addiſon has drawn his character very beautifully in the Freeholder.

SOMERSETSHIRE, a county of England, taking its name from Somerton, once the capital, between 50° and 51° 27′ north latitude, and between 1° 25′ and 2° 59′ weſt longitude. It is bounded on the weſt by Devonſhire, on the ſouth by Dorſetſhire, on the north by Briſtol channel or the Severn ſea, on the north-eaſt by a ſmall part of Glouceſterſhire, and on the eaſt by Wiltſhire. It is one of the largeſt counties in England, extending in length from eaſt to weſt about 68 miles; in breadth, where broadeſt, from ſouth to north, about 47; and 240 in circumference. It is divided into 42 hundreds, in which are 3 cities, 32 market-towns, 1700 villages, 385 pariſhes, of which 132 are vicarages, containing more than 1,000,000 of acres, and about 273,750 ſouls. It ſends 18 members to parliament, viz. two for the county, two for Briſtol, two for Bath, two for Wells, two for Taunton, two for Bridgewater, two for Ilcheſter, two for Milbourn-port, and two for Minehead.

The air of this county is very mild and wholeſome, eſpecially that of the hilly part. The ſoil in general is exceeding rich, ſo that ſingle acres very commonly produce forty or fifty buſhels of wheat, and there have been inſtances of ſome producing ſixty of barley. As there is very fine paſture both for ſheep and black cattle, it abounds in both, which are as large as thoſe of Lincolnſhire, and their fleſh of a finer grain. In conſequence of this abundance of black cattle, great quantities of cheeſe are made in it, of which that of Cheddar is thought equal to Parmeſan. In the hilly parts are found coal, lead, copper, and lapis calaminaris. Wood thrives in it as well as in any county of the kingdom. It abounds alſo in peaſe, beans, beer, cyder, fruit, wild-fowl, and ſalmon; and its mineral waters are celebrated all over the world.

The riches of this county, both natural and acquired, exceed thoſe of any other in the kingdom, Middleſex and Yorkſhire excepted. The woollen manufacture in all its branches is carried on to a very great extent; and in ſome parts of the county great quantities of linen are made. If to theſe the produce of various other commodities in which it abounds is added, the amount of the whole muſt undoubtedly be very great. Its foreign trade muſt alſo be allowed to be very extenſive, when it is conſidered that it has a large trade for ſea-coal, and poſſeſſes, beſides other ports, that of Briſtol, a town of the greateſt trade in England, next to London.

Beſides ſmall ſtreams, it is well watered and ſupplied with fiſh by the rivers Severn, Avon, Parrel, Froome, Ax, Torre, and Tone. Its greateſt hills are Mendip, Pouldon, and Quantock, of which the firſt abounds in coal, lead, &c. The rivers Severn and Parrel breed very fine ſalmon. The chief town is Briſtol.

SOMERTON, an ancient town in Somerſetſhire, from whence the county derives its name. It is 123 miles from London; it has five ſtreets, containing 251 houſes, which are moſtly built of the blue ſtone from the quarries in the neighbourhood. It is governed by conſtables, and has a hall for petty ſeſſions. The market

ket for corn is conſiderable, and it has ſeveral fairs for cattle. The church has, what is not very frequent, an *octangular* tower with ſix bells. N. Lat. 51. 4. W. Long. 1. 53.

SOMNAMBULI, perſons who walk in their ſleep. See SLEEPWALKERS.

SOMNER, WILLIAM, an eminent Engliſh antiquary, was born at Canterbury in 1606. His firſt treatiſe was The Antiquities of Canterbury, which he dedicated to Archbiſhop Laud. He then applied himſelf to the ſtudy of the Saxon language; and having made himſelf maſter of it, he perceived that the old gloſſary prefixed to Sir Roger Twiſden's edition of the laws of King Henry I. printed in 1644, was faulty in many places; he therefore added to that edition notes and obſervations valuable for their learning, with a very uſeful gloſſary. His Treatiſe of Gavelkind was finiſhed about 1648, though not publiſhed till 1660. Our author was zealouſly attached to King Charles I. and in 1648 he publiſhed a poem on his ſufferings and death. His ſkill in the Saxon tongue led him to inquire into moſt of the European languages ancient and modern. He aſſiſted Dugdale and Dodſworth in compiling the *Monaſticon Anglicanum.* His Saxon Dictionary was printed at Oxford in 1659. He died in 1669.

SON, an appellation given to a male child conſidered in the relation he bears to his parents. See PARENT and FILIAL *Piety*.

SONATA, in *Muſic*, a piece or compoſition, intended to be performed by inſtruments only; in which ſenſe it ſtands oppoſed to *cantata*, or a piece deſigned for the voice. See CANTATA.

The ſonata then, is properly a grand, free, humorous compoſition, diverſified with a great variety of motions and expreſſions, extraordinary and bold ſtrokes, figures, &c. And all this purely according to the fancy of the compoſer; who, without confining himſelf to any general rules of counterpoint, or to any fixed number or meaſure, gives a looſe to his genius, and runs from one mode, meaſure, &c. to another, as he thinks fit. This ſpecies of compoſition had its riſe about the middle of the 17th century; thoſe who have moſt excelled in it were Baſſani and Corelli. We have ſonatas of 1, 2, 3, 4, 5, 6, 7, and even 8 parts, but uſually they are performed by a ſingle violin, or with two violins, and a thorough baſs for the harpſichord; and frequently a more figured baſs for the baſs viol, &c.

There are a thouſand different ſpecies of ſonatas; but the Italians uſually reduce them to two kinds. *Suonate de chieſa*, that is, ſonatas proper for church muſic, which uſually begin with a grave ſolemn motion, ſuitable to the dignity and ſanctity of the place and the ſervice, after which they ſtrike into a briſker, gayer, and richer manner. Theſe are what they more peculiarly call ſonatas. *Suonate de camera*, or ſonatas for the chamber, are properly ſerieſes of ſeveral little pieces, for dancing, only compoſed to the ſame tune. They uſually begin with a prelude or little ſonata, ſerving as an introduction to all the reſt: afterwards come the allemand, pavane, courant, and other ſerious dances; then jigs, gavots, minuets, chacons, paſſecailles, and other gayer airs: the whole compoſed in the ſame tune or mode.

SONCHUS, SOW-THISTLE, in *Botany*, a genus of plants belonging to the claſs of *ſyngeneſia*, and to the order of *polygamia æqualis*; and in the natural ſyſtem ranged under the 49th order, *Compoſitæ*. The receptacle is naked; the calyx is imbricated, bellying and conical; the down of the ſeed is ſimple, ſeſſile, and very ſoft; the ſeed is oval and pointed. There are 13 ſpecies; the maritimus, paluſtris, fruticoſus, arvenſis, oleraceus, tenerrimus, plumieri, alpinus, floridanus, ſibiricus, tataricus, tuberoſus, and canadenſis. Four of theſe are natives of Britain.—1. *Paluſtris*, marſh ſow-thiſtle. The ſtem is erect, from ſix to ten feet high, branched and hairy towards the top: the leaves are firm, broad, half pinnated, ſerrated, and ſharp-pointed; the lower ones ſagittate at the baſe: the flowers are of a deep yellow, large, and diſperſed on the tops of the branches: the calyx is rough. It is frequent in marſhes, and flowers in July or Auguſt.—2. *Arvenſis*, corn ſow-thiſtle. The leaves are alternate, runcinate, and heart ſhaped at the baſe; the root creeps under ground; the ſtem is three or four feet high, and branched at the top. It grows in corn-fields, and flowers in Auguſt —3. *Oleraceus*, common ſow-thiſtle. The ſtalk is ſucculent, piſtular, and a cubit high or more; the leaves are broad, embracing the ſtem, generally deeply ſinuated, ſmooth, or prickly at the edges; the flowers are of a pale yellow, numerous, in a kind of umbel, and terminal; the calyx is ſmooth. It is frequent in waſte places and cultivated grounds.—4. *Alpinus*, blue-flowered ſow-thiſtle. The ſtem is erect, purpliſh, branched, or ſimple, from three to ſix feet high: the leaves are large, ſmooth, and ſinuated; the extreme ſegment large and triangular: the flowers are blue, and grow on hairy viſcid pedicles, in long ſpikes: the calyx is brown. This ſpecies is found in Northumberland.

SONG, in *Poetry*, a little compoſition, conſiſting of eaſy and natural verſes, ſet to a tune in order to be ſung. See POETRY, N° 120.

SONG, in *Muſic*, is applied in general to a ſingle piece of muſic, whether contrived for the voice or an inſtrument. See AIR.

SONG of Birds, is defined by the honourable Daines Barrington to be a ſucceſſion of three or more different notes, which are continued without interruption, during the ſame interval, with a muſical bar of four crotchets in an adagio movement, or whilſt a pendulum ſwings four ſeconds.

It is affirmed, that the notes of birds are no more innate than language in man, and that they depend upon imitation, as far as their organs will enable them to imitate the ſounds which they have frequent opportunities of hearing: and their adhering ſo ſteadily, even in a wild ſtate, to the ſame ſong, is owing to the neſtlings attending only to the inſtruction of the parent bird, whilſt they diſregard the notes of all others that may perhaps be ſinging round them.

Birds in a wild ſtate do not commonly ſing above 10 weeks in the year, whereas birds that have plenty of food in a cage ſing the greateſt part of the year; and we may add, that the female of no ſpecies of birds ever ſings. This is a wiſe proviſion of nature, becauſe her ſong would diſcover her neſt. In the ſame manner, we may rationally account for her inferiority in plumage. The faculty of ſinging is confined to the cock birds; and accordingly Mr Hunter, in diſſecting birds of ſeveral ſpecies, found the muſcles of the larynx to be

ſtronger

ſtronger in the nightingale than in any other bird of the ſame ſize; and in all thoſe inſtances, where he diſſected both cock and hen, the ſame muſcles were ſtronger in the cock. To the ſame purpoſe, it is an obſervation as ancient as the time of Pliny, that a capon does not crow.

Some have aſcribed the ſinging of the cock-bird in the ſpring ſolely to the motive of pleaſing his mate during incubation; others, who allow that it is partly for this end, believe it is partly owing alſo to another cauſe, viz. the great abundance of plants and inſects in the ſpring, which, as well as ſeeds, are the proper food of ſinging birds at that time of the year.

Mr Barrington remarks, that there is no inſtance of any ſinging bird which exceeds our blackbird in ſize; and this, he ſuppoſes, may ariſe from the difficulty of its concealing itſelf, if it called the attention of its enemies, not only by its bulk, but by the proportionable loudneſs of its notes. This writer farther obſerves, that ſome paſſages of the ſong in a few kinds of birds correſpond with the intervals of our muſical ſcale, of which the cuckoo is a ſtriking and known inſtance; but the greater part of their ſong cannot be reduced to a muſical ſcale; partly, becauſe the rapidity is often ſo great, and it is alſo ſo uncertain when they may ſtop, that we cannot reduce the paſſages to form a muſical bar in any time whatſoever; partly alſo, becauſe the pitch of moſt birds is conſiderably higher than the moſt ſhrill notes of thoſe inſtruments which have the greateſt compaſs; and principally, becauſe the intervals uſed by birds are commonly ſo minute, that we cannot judge of them from the more groſs intervals into which we divide our muſical octave. This writer apprehends, that all birds ſing in the ſame key; and in order to diſcover this key, he informs us, that the following notes have been obſerved in different birds, A, B flat, C, D, F, and G; and therefore E only is wanting to complete the ſcale: now theſe intervals, he ſays, can only be found in the key of F with a ſharp third, or that of G with a flat third; and he ſuppoſes it to be the latter, becauſe admitting that the firſt muſical notes were learned from birds, thoſe of the cuckoo, which have been moſt attended to, form a flat third, and moſt of our compoſitions are in a flat third, where muſic is ſimple, and conſiſts merely of melody. As a farther evidence that birds ſing always in the ſame key, it has been found by attending to a nightingale, as well as a robin which was educated under him, that the notes reducible to our intervals of the octave were always preciſely the ſame.

Moſt people, who have not attended to the notes of birds, ſuppoſe, that every ſpecies ſing exactly the ſame notes and paſſages: but this is by no means true; though it is admitted that there is a general reſemblance. Thus the London bird-catchers prefer the ſong of the Kentiſh goldfinches, and Eſſex chaffinches; and ſome of the nightingale fanciers prefer a Surrey bird to thoſe of Middleſex.

Of all ſinging birds, the ſong of the nightingale has been moſt univerſally admired: and its ſuperiority (deduced from a cage-bird) conſiſts in the following particulars; its tone is much more mellow than that of any other bird, though at the ſame time, by a proper exertion of its muſical powers, it can be very brilliant. Another point of ſuperiority is its continuance of ſong without a pauſe, which is ſometimes no leſs than 20 ſeconds; and when reſpiration becomes neceſſary, it takes it with as much judgment as an opera-ſinger. The ſky-lark in this particular, as well as in compaſs and variety, is only ſecond to the nightingale. The nightingale alſo ſings (if the expreſſion may be allowed) with ſuperior judgement and taſte. Mr Barrington has obſerved, that his nightingale, which was a very capital bird, began ſoftly like the ancient orators, reſerving its breath to ſwell certain notes, which by theſe means had a moſt aſtoniſhing effect. This writer adds, that the notes of birds, which are annually imported from Aſia, Africa, and America, both ſingly and in concert, are not to be compared to thoſe of European birds.

The following table, formed by Mr Barrington, agreeably to the idea of M. de Piles in eſtimating the merits of painters, is deſigned to exhibit the comparative merit of the Britiſh ſinging birds; in which 20 is ſuppoſed to be the point of abſolute perfection.

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	Mellowneſs of tone.	Sprightly notes.	Plaintive notes.	Compaſs.	Execution.
Nightingale - -	19	14	19	19	19
Sky-lark - - -	4	19	4	18	18
Wood-lark - -	18	4	17	12	8
Tit-lark - -	12	12	12	12	12
Linnet - - -	12	16	12	16	18
Goldfinch - -	4	19	4	12	12
Chaffinch - -	4	12	4	8	8
Greenfinch - -	4	4	4	4	6
Hedge-ſparrow -	6	0	6	4	4
Aberdavine or ſiſkin	2	4	0	4	4
Red-poll - -	0	4	0	4	4
Thruſh - - -	4	4	4	4	4
Blackbird - -	4	4	0	2	2
Robin - - -	6	16	12	12	14
Wren . - -	0	12	0	4	2
Reed-ſparrow - -	0	4	0	2	2
Black cap, or Norfolk mock nightingale	14	12	12	14	14

SONNA, a book of Mahometan traditions, which the orthodox muſſulmans are required to believe.

SONNERATIA, a genus of plants belonging to the claſs of *icoſandria*, and to the order of *monogynia*. See BOTANY *Index*.

SONNET, in *Poetry*, a compoſition contained in 14 verſes, viz. two ſtanzas or meaſures of four verſes each, and two of three, the firſt eight verſes being all in three rhimes.

SONNITES, among the Mahometans, an appellation given to the orthodox muſſulmans or true believers; in oppoſition to the ſeveral heretical ſects, particularly the Shiites, or followers of Ali.

SOOJU, or SOY. See DOLICHOS.

SOONTABURDAR, in the Eaſt Indies; an attendant, who carries a ſilver bludgeon in his hand about two or three feet long, and runs before the palanquin. He is inferior to the chubdar; the propriety of an Indian newaury requiring two ſoontaburdars for every chubdar in the train. The chubdar proclaims the approach of viſitors, &c. He generally carries a large ſilver

ver ſtaff about five feet long in his hands; and among the Nabobs he proclaims their praiſes aloud as he runs before their palanquins.

SOOT, a volatile matter ariſing from wood and other fuel along with the ſmoke; or rather, it is the ſmoke itſelf condenſed and gathered to the ſides of the chimney. Though once volatile, however, ſoot cannot be again reſolved into vapour; but, if diſtilled by a ſtrong fire, yields a volatile alkali and empyreumatic oil, a conſiderable quantity of fixed matter remaining at the bottom of the diſtilling veſſel. If burnt in an open fire, it flames with a thick ſmoke, whence other ſoot is produced. It is uſed as a material for making ſal ammoniac, and as a manure. See AMMONIA, *muriate of*, CHEMISTRY *Index*.

SOOT-Black. See *COLOUR-Making*.

SOPHI, or SOFI, a title given to the emperor of Perſia, importing as much as wiſe, ſage, or philoſopher.

The title is by ſome ſaid to have taken its riſe from a young ſhepherd named *Sophi*, who attained to the crown of Perſia in 1370; others derive it from the *ſophoi* or ſages anciently called *magi*. Voſſius gives a different account of the word: ſophi in Arabic, he obſerves, ſignifies *wool*; and he adds, that it was applied by the Turks out of deriſion to the kings of Perſia ever ſince Iſhmael's time; becauſe, acording to their ſcheme of religion, he is to wear no other covering on his head but an ordinary red woollen ſtuff; whence the Perſians are alſo called *hezelbaſchs*, q. d. *red-heads*. But Bochart aſſures us, that ſophi in the original Perſian language, ſignifies one that is pure in his religion, and who prefers the ſervice of God in all things: and derives it from an order of religious called by the ſame name. The ſophis value themſelves on their illuſtrious extraction. They are deſcended in a right line from Houſſein, ſecond ſon of Ali, Mahomet's couſin, and Fatima, Mahomet's daughter.

SOPHIS, or *Sofees*, a kind of order of religious among the Mahometans in Perſia, anſwering to what are otherwiſe called *derviſes*, and among the Arabs and Indians *faquirs*. Some will have them called ſophis from a kind of coarſe camblet which they wear, called *ſouf*, from the city Souf in Syria, where it is principally manufactured. The more eminent of thoſe ſophis are complimented with the title *ſchiek*, that is, *reverend*, much as in Romiſh countries the religious are called *reverend fathers*. Schiek Sophi, who laid the foundation of the grandeur of the royal houſe of Perſia, was the founder, or rather the reſtorer of this order: Iſhmael, who conquered Perſia, was himſelf a ſophi, and greatly valued himſelf on his being ſo. He choſe all the guards of his perſon from among the religious of this order; and would have all the great lords of his court ſophis. The king of Perſia is ſtill grandmaſter of the order; and the lords continue to enter into it, though it be now fallen under ſome contempt.

SOPHISM, in *Logic*, a ſpecious argument having the appearance of truth, but leading to falſehood. Sophiſms are reduced by Ariſtotle into eight claſſes, an arrangement ſo juſt and comprehenſive, that it is equally proper in preſent as in former times. 1. *Ignoratio elenchi*, in which the ſophiſt ſeems to determine the queſtion, while he does it only in appearance. Thus the queſtion, “Whether the exceſs of wine be hurtful?” ſeems to be determined by proving, that wine revives the ſpirits and gives a man courage: but the principal point is here kept out of ſight; for ſtill it may be hurtful to health, to fortune, and reputation. 2. *Petitio principii*, a begging of the queſtion, or taking for granted that which remains to be proved, as if any one ſhould undertake to prove that the ſoul is extended through all the parts of the body, becauſe it reſides in every member. This is affirming the ſame thing in different words. 3. Reaſoning in a circle; as when the Roman Catholics prove the Scriptures to be the word of God by the authority of the church, and the authority of the church from the Scriptures. 4. *Non cauſa pro cauſa*, or the aſſigning of a falſe cauſe to any effect. Thus the ſuppoſed principle, that nature abhors a vacuum, was applied to explain the riſing of water in a pump before Galileo diſcovered that it was owing to the preſſure of the atmoſphere. In this way the vulgar aſcribe accidents to divine vengeance, and the hereſies and infidelity of modern times are ſaid to be owing to learning. 5. *Fallacia accidentis*, in which the ſophiſt repreſents what is merely accidental as eſſential to the nature of the ſubject. This is nearly allied to the former, and is committed by the Mahometans and Roman Catholics. The Mahometans forbid wine, becauſe it is ſometimes the occaſion of drunkenneſs and quarrels; and the Roman Catholics prohibit the reading of the Bible, becauſe it has ſometimes promoted hereſies. 6. By deducing an univerſal aſſertion from what is true only in particular circumſtances, and the reverſe: thus ſome men argue, “tranſcribers have committed many errors in copying the Scriptures, therefore they are not to be depended on.” 7. By aſſerting any thing in a compound ſenſe which is only true in a divided ſenſe; ſo when the Scriptures aſſure us, that the worſt of ſinners may be ſaved, it does not mean that they ſhall be ſaved while they remain ſinners, but that if they repent they may be ſaved. 8. By an abuſe of the ambiguity of words. Thus Mr Hume reaſons in his Eſſay on Miracles: “Experience is our only guide in reaſoning concerning matters of fact; now we know from experience, that the laws of nature are fixed and invariable. On the other hand, teſtimony is variable and often falſe; therefore ſince our evidence for the reality of miracles reſts ſolely on teſtimony which is variable, and our evidence for the uniformity of the laws of nature is invariable, miracles are not to be believed.” The ſophiſtry of this reaſoning depends on the ambiguity of the word *experience*, which in the firſt propoſition ſignifies the maxims which we form from our own obſervation and reflection; in the ſecond it is confounded with teſtimony; for it is by the teſtimony of others, as well as our own obſervation, that we learn whether the laws of nature are variable or invariable. The Eſſay on Miracles may be recommended to thoſe who wiſh to ſee more examples of ſophiſtry; as we believe moſt of the eight ſpecies of ſophiſms which we have mentioned are well illuſtrated by examples in that eſſay.

SOPHIST, an appellation aſſumed in the early periods of Grecian hiſtory by thoſe who devoted their time to the ſtudy of ſcience. This appellation appearing too arrogant to Pythagoras, he declined it, and wiſhed to be called a *philoſopher*; declaring that, though he could not conſider himſelf as a wiſe man, he was indeed a lover of wiſdom. True wiſdom and modeſty are generally

generally united. The example of Pythagoras was followed by every man of eminence; while the name *ſophiſt* was retained only by thoſe who with a pomp of words made a magnificent diſplay of wiſdom upon a very ſlight foundation of knowledge. Thoſe men taught an artificial ſtructure of language, and a falſe method of reaſoning, by which, in argument, the worſe might be made to appear the better reaſon (ſee SOPHISM). In Athens they were long held in high repute, and ſupported, not only by contributions from their pupils, but by a regular ſalary from the ſtate. They were among the bittereſt enemies of the illuſtrious Socrates, becauſe he embraced every opportunity of expoſing to contempt and ridicule their vain pretenſions to ſuperior knowledge, and the pernicious influence of their doctrines upon the taſte and morals of the Athenian youth.

SOPHISTICATION, the mixing of any thing with what is not genuine; a practice too common in the making up of medicines for ſale; as alſo among vintners, diſtillers, and others, who are accuſed of ſophiſticating their wines, ſpirits, oils, &c. by mixing with them cheaper and coarſer materials; and in many caſes the cheat is carried on ſo artfully as to deceive the beſt judges.

SOPHOCLES, the celebrated Greek tragic poet, the ſon of Sophilus an Athenian, was born at Colonn, and educated with great attention. Superior vigour and addreſs in the exerciſes of the paleſtra, and ſkill in muſic, were the great accompliſhments of young men in the ſtates of Greece. In theſe, Sophocles excelled; nor was he leſs diſtinguiſhed by the beauty of his perſon. He was alſo inſtructed in the nobleſt of all ſciences, civil polity and religion: from the firſt of theſe he derived an unſhaken love of his country, which he ſerved in ſome embaſſies, and in high military command with Pericles; from the latter he was impreſſed with a pious reverence for the gods, manifeſted by the inviolable integrity of his life. But his ſtudies were early devoted to the tragic muſe; the ſpirit of Eſchylus lent a fire to his genius, and excited that noble emulation which led him to contend with, and ſometimes to bear away the prize from, his great maſter. He wrote 43 tragedies, of which 7 only have eſcaped the ravages of time: and having teſtified his love of his country by refuſing to leave it, though invited by many kings; and having enjoyed the uninterrupted eſteem and affection of his fellow citizens, which neither the gallant actions and ſublime genius of Eſchylus, nor the tender ſpirit and philoſophic virtue of Euripides, could ſecure to them, he died in the 91ſt year of his age, about 406 years before Chriſt. The burial-place of his anceſtors was at Decelia, which the Lacedæmonians had at that time ſeized and fortified; but Lyſander, the Spartan chief, permitted the Athenians to inter their deceaſed poet; and they paid him all the honours due to his love of his country, integrity of life, and high poetic excellence. Eſchylus had at once ſeized the higheſt poſt of honour in the field of poetry, the true ſublime; to that eminence his claim could not be diſputed. Sophocles had a noble elevation of mind, but tempered with ſo fine a taſte, and ſo chaſtened a judgment, that he never paſſed the bounds of propriety. Under his conduct the tragic muſe appeared with the chaſte dignity of ſome noble matron at a religious ſolemnity; harmony is in her voice, and grace in all her motions. From him the theatre received ſome additional embelliſhments; and the drama the introduction of a third ſpeaker, which made it more active and intereſting: but his diſtinguiſhed excellence is in the judicious diſpoſition of the fable, and ſo nice a connection and dependence of the parts on each other, that they all agree to make the event not only probable, but even neceſſary. This is peculiarly admirable in his "Oedipus King of Thebes;" and in this important point he is far ſuperior to every other dramatic writer.

The ingratitude of the children of Sophocles is well known. They wiſhed to become immediate maſters of their father's poſſeſſions; and therefore tired of his long life, they accuſed him before the Areopagus of inſanity. The only defence the poet made was to read his tragedy of Oedipus at Colonos, which he had lately finiſhed; and then he aſked his judges, whether the author of ſuch a performance could be taxed with inſanity! The father upon this was acquitted, and the children returned home covered with ſhame and confuſion. The ſeven tragedies of Sophocles which ſtill remain, together with the Greek Scholia which accompany them, have been tranſlated into Latin by Johnſon, and into Engliſh by Dr Franklin and Mr Potter.

SOPHORA, a genus of plants belonging to the claſs of decandria, and to the order of monogynia; and in the natural ſyſtem arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

SOPORIFIC, or SOPORIFEROUS, a medicine that produces ſleep. Such are opium, laudanum, the ſeed of poppies, &c. The word is formed from the Latin *ſopor*, "ſleep." The Greeks in place of it uſe the word *hypnotic*.

SORBONNE, or SORBON, the houſe or college of the faculty of theology eſtabliſhed in the univerſity of Paris. It was founded in 1252 by St Louis, or rather by Robert de Sorbon his confeſſor and almoner, firſt canon of Cambray, and afterwards of the church of Paris; who gave his own name to it, which he himſelf took from the village of Sorbon or Serbon, near Sens, where he was born. The foundation was laid in 1250; Queen Blanche, in the abſence of her huſband, furniſhing him with a houſe which had formerly been the palace of Julian the apoſtate, of which ſome remains are ſtill ſeen. Afterwards the king gave him all the houſes he had in the ſame place, in exchange for ſome others. The college has been ſince magnificently rebuilt by the cardinal de Richelieu. The deſign of its inſtitution was for the uſe of poor ſtudents in divinity. There are lodgings in it for 36 doctors, who are ſaid to be of the *ſociety of the Sorbonne*; thoſe admitted into it without being doctors, are ſaid to be of the *hoſpitality of the Sorbonne*. Six regent doctors formerly held lectures every day for an hour and a half each; three in the morning, and three in the afternoon.

SORBONNE, is alſo uſed in general for the whole faculty of theology at Paris; as the aſſemblies of the whole body are held in the houſe of the Sorbonne; and the bachelors of the other houſes of the faculty, as the houſe of Navarre, &c. come hither to hold their *ſorbonnique*, or act for being admitted doctor in divinity.

SORBUS, SERVICE-TREE, a genus of plants belonging to the claſs of icoſandria, and to the order of trigynia. See BOTANY *Index*.—The *aucuparia*, mountain-aſh, quicken-tree, quick-beam, or roan-tree, riſes with a ſtraight upright ſtem and regular branching head, twenty or thirty feet high or more, covered with a ſmooth grayiſh brown bark; pinnated leaves of eight or ten pair of long, narrow, ſerrated folioles, and an odd one, ſmooth on both ſides; and large umbellate cluſters of white flowers at the ſides and ends of the branches, ſucceeded by cluſters of fine red berries, ripe in autumn and winter. There is a variety with yellow ſtriped leaves. This ſpecies grows wild in many parts of this iſland, in mountainous places, woods, and hedge-rows, often growing to the ſize of timber; and is admitted into moſt ornamental plantations, for the beauty of its growth, foliage, flowers, and fruit; the latter, in particular, being produced in numerous red large bunches all over the tree, exhibit a fine appearance in autumn and winter, till devoured by the birds, eſpecially the blackbird and thruſh, which are ſo allured by this fruit as to flock from all parts and feed on it voraciouſly.—In the iſland of Jura the juice of the berries is employed as an acid for punch. It is probable that this tree was in high eſteem with the Druids; for it is more abundant than any other tree in the neighbourhood of thoſe Druidical circles of ſtones, ſo common in North Britain. It is ſtill believed by ſome perſons, that a branch of this tree can defend them from enchantment or witchcraft. Even the cattle are ſuppoſed to be preſerved by it from danger. The dairy-maid drives them to the ſummer paſtures with a rod of the roan-tree, and drives them home again with the ſame. In Strathſpey, we are told, a hoop is made of the wood of this tree on the 1ſt of May, and all the ſheep and lambs are made to paſs through it.

The *domeſtica*, or cultivated ſervice-tree, with eatable fruit, grows with an upright ſtem, branching 30 or 40 feet high or more, having a browniſh bark, and the young ſhoots in ſummer covered with a mealy down; pinnated leaves of eight or ten pair of broadiſh deeply ſerrated lobes and an odd one, downy underneath; and large umbellate cluſters of white flowers at the ſides and ends of the branches, ſucceeded by bunches of large, fleſhy, edible red fruit, of various ſhapes and ſizes. This tree is a native of the ſouthern warm parts of Europe, where its fruit is uſed at table as a deſſert, and it is cultivated here in many of our gardens, both as a fruit-tree and as an ornament to diverſify hardy plantations.

SORCERY, or MAGIC; the power which ſome perſons were formerly ſuppoſed to poſſeſs of commanding the devil and the infernal ſpirits by ſkill in charms and invocations, and of ſoothing them by fumigations. Sorcery is therefore to be diſtinguiſhed from witchcraft; an art which was ſuppoſed to be practiſed, not by commanding evil ſpirits, but by compact with the devil. As an inſtance of the power of bad ſmells over dæmons or evil ſpirits, we may mention the flight of the evil ſpirit mentioned in Tobit into the remote parts of Egypt, produced, it is ſaid, by the ſmell of the burnt liver of a fiſh. Lilly informs us, that one Evans having raiſed a ſpirit at the requeſt of Lord Bothwell and Sir Kenelm Digby, and forgetting a fumigation, the ſpirit, vexed at the diſappointment, pulled him without the circle, and carried him from his houſe in the Minories into a field near Batterſea Cauſeway.

King James, in his *Dæmonologia*, has given a very full account of the art of ſorcery. "Two principal things (ſays he) cannot well in that errand be wanted: holy water (whereby the devill mockes the papiſts), and ſome preſent of a living thing unto him. There are likewiſe certaine daies and houres that they obſerve in this purpoſe. Theſe things being all ready and prepared, circles are made, triangular, quadrangular, round, double, or ſingle, according to the forme of the apparition they crave. When the conjured ſpirit appeares, which will not be while after many circumſtances, long prayers, and much muttering and murmurings of the conjurors, like a papiſt prieſt diſpatching a hunting maſſe—how ſoone, I ſay, he appeares, if they have miſſed one jote of all their rites; or if any of their feete once ſlyd over the circle, through terror of his fearfull apparition, he paies himſelf at that time, in his owne hand, of that due debt which they ought him, and otherwiſe would have delaied longer to have paied him: I mean, he carries them with him, body and ſoule." How the conjurors made triangular or quadrangular circles, his majeſty has not informed us, nor does he ſeem to imagine there was any difficulty in the matter. We are therefore led to ſuppoſe, that he learned his mathematics from the ſame ſyſtem as Dr Sacheverell, who, in one of his ſpeeches or ſermons, made uſe of the following ſimile: "They concur like parallel lines, meeting in one common centre."

Another mode of conſulting ſpirits was by the beryl, by means of a ſpeculator or ſeer; who, to have a complete ſight, ought to be a pure virgin, a youth who had not known woman, or at leaſt a perſon of irreproachable life and purity of manners. The method of ſuch conſultation is this: The conjuror having repeated the neceſſary charms and adjurations, with the litany or invocation peculiar to the ſpirits or angels he wiſhes to call (for every one has his particular form), the ſeer looks into a cryſtal or beryl, wherein he will ſee the anſwer, repreſented either by types or figures; and ſometimes, though very rarely, will hear the angels or ſpirits ſpeak articulately. Their pronunciation is, as Lilly ſays, like the Iriſh, much in the throat. Lilly deſcribes one of theſe beryls or cryſtals. It was, he ſays, as large as an orange, ſet in ſilver, with a croſs at the top, and round about engraved the names of the angels Raphael, Gabriel, and Uriel. A delineation of another is engraved in the frontiſpiece to Aubery's Miſcellanies.

Theſe ſorcerers or magicians do not always employ their art to do miſchief; but, on the contrary, frequently exert it to cure diſeaſes inflicted by witches; to diſcover thieves; recover ſtolen goods; to foretel future events, and the ſtate of abſent friends. On this account they are frequently called *white witches*. See MAGIC, WITCHCRAFT, &c.

Our forefathers were ſtrong believers when they enacted, by ſtatute 33 Hen. VIII. c. 8. all witchcraft and ſorcery to be felony without benefit of clergy; and again, by ſtatute 1 Jac. I. c. 12. that all perſons invoking any evil ſpirit, or conſulting, covenanting with, entertaining, employing, feeding, or rewarding any evil ſpirit; or taking up dead bodies from their graves to be uſed in any witchcraft, ſorcery, charm, or enchantment; or killing or otherwiſe hurting any perſon by ſuch infernal arts; ſhould be guilty of felony without benefit of clergy, and ſuffer death. And if any perſon ſhould attempt by ſorcery to diſcover hidden treaſure,

or

or to reſtore ſtolen goods, or to provoke unlawful love, or to hurt any man or beaſt, though the ſame were not effected, he or ſhe ſhould ſuffer impriſonment and pillory for the firſt offence, and death for the ſecond. Theſe acts continued in force till lately, to the terror of all ancient females in the kingdom; and many poor wretches were ſacrificed thereby to the prejudice of their neighbours and their own illuſions, not a few having by ſome means or other confeſſed the fact at the gallows. But all executions for this dubious crime are now at an end; our legiſlature having at length followed the wiſe example of Louis XIV. in France, who thought proper by an edict to reſtrain the tribunals of juſtice from receiving informations of witchcraft. And accordingly it is with us enacted, by ſtatute 9 Geo. II. c. 5. that no proſecution ſhall for the future be carried on againſt any perſon for conjuration, witchcraft, ſorcery, or inchantment: But the miſdemeanor of perſons pretending to uſe witchcraft, tell fortunes, or diſcover ſtolen goods, by ſkill in the occult ſciences, is ſtill deſervedly puniſhed with a year's impriſonment, and ſtanding four times in the pillory.

SOREX, the SHREW, a genus of animals belonging to the claſs of *mammalia*, and order of *feræ*. See MAMMALIA *Index*.

SORITES, in *Logic*, a ſpecies of reaſoning in which a great number of propoſitions are ſo linked together, that the predicate of the one becomes continually the ſubject of the next following, till at laſt a concluſion is formed by bringing together the ſubject of the firſt propoſition and the predicate of the laſt. Such was that merry argument of Themiſtocles, to prove that his little ſon under ten years old governed the whole world. Thus: *My ſon governs his mother; his mother me; I the Athenians; the Athenians the Greeks; Greece commands Europe; Europe the whole world: therefore my ſon commands the whole world.* See LOGIC, N° 96, 97.

SORNING, in *Scots Law*. See LAW, N° clxxxvi. 30.

SORREL, in *Botany*, a ſpecies of the RUMEX, which grows in paſtures and meadows, and is well known. The natives of Lapland boil large quantities of the leaves in water, and mix the juice when cold with the milk of the rein-deer, which they eſteem an agreeable and wholeſome food. The Dutch are ſaid to cultivate this plant for its uſefulneſs in the dyeing of woollen cloths black; and we know that by means of the common broad-leaved ſorrel an excellent black colour is, in many places of Scotland, given to woollen ſtuffs without the aid of copperas. As this mode of dyeing does not in the ſmalleſt degree injure the texture of the cloth, which continues to the laſt ſoft and ſilky, without that hardneſs to the touch which it acquires when dyed black by means of copperas, our readers will probably thank us for the following receipt, with which we have been favoured by a learned phyſician:

Let the ſtuff to be dyed be well waſhed with ſoap and water, and afterwards completely dried. Then of the common broad-leaved ſorrel boil as much as ſhall make an acid decoction of ſufficient quantity to let the ſtuff to be dyed lie in it open and eaſy to be ſtirred. The greater quantity of ſorrel that is uſed, the better will the colour be; and therefore if the pot or cauldron will not hold enough at once, when part has been ſufficiently boiled, it muſt be taken out and wrung, and a freſh quantity be boiled in the ſame juice or decoction. When the liquor is made ſufficiently acid, ſtrain it from the ſorrel through a ſieve, put the cloth or yarn into it, and let it boil for two hours, ſtirring it frequently. If ſtockings be among the ſtuff to be dyed, it will be expedient, after they have been an hour in the boiling liquor, to turn them inſide out, and at the end of the ſecond hour let the whole be poured into a tub or any other veſſel. The pot or cauldron muſt then be waſhed, and water put into it, with half a pound of logwood chips for every pound of dry yarn or cloth. The logwood and water ſhould boil ſlowly for four hours; and then the cloth or yarn being wrung from the ſour liquor, and put into the logwood decoction, the whole muſt be ſuffered to boil ſlowly for four hours, ſtockings, if there be any, being turned inſide out at the end of two hours. Of this laſt decoction there muſt, as of the former, be enough to let the cloth lie open and eaſy to be ſtirred while boiling. At the end of the four hours the cloth muſt be taken out, and among the boiling liquor, firſt removed from the fire, muſt be poured a Scotch pint or half an Engliſh gallon of ſtale urine for every pound of dry cloth or other ſtuff to be dyed. When this compound liquor has been ſtirred and become cold, the cloth muſt be put into it and ſuffered to remain well covered for 12 hours, and then dried in the ſhade; it is then waſhed in cold water, and dried for uſe.

Wood-SORREL. See OXALIS, BOTANY *Index*.

SORREL-Colour, in the manege, is a reddiſh colour, generally thought to be a ſign of a good horſe.

SORRENTO, a ſea-port town of Naples; ſeated in a peninſula, on the bay of Naples, at the foot of a mountain of the ſame name, and 15 miles ſouth-eaſt of Naples. Sorrentum was famous in ancient times for its beautiful earthen veſſels, particularly goblets and drinking cups; and claims the honour of being the birth-place of Torquato Taſſo. E. Long. 14. 24. N. Lat. 40. 40.

SORTILEGE, (*Sortilegium*) a ſpecies of divination performed by means of *ſortes* or lots.

The *ſortes Preneſtinæ*, famous in antiquity, conſiſted in putting a number of letters, or even whole words, into an urn; and then, after ſhaking them together, they were thrown on the ground; and whatever ſentences could be made out of them, conſtituted the anſwer of the oracle. To this method of divination ſucceeded that which has been called the *ſortes Homerianæ* and *ſortes Virgilianæ*, a mode of inquiring into futurity, which undoubtedly took its riſe from a general cuſtom of the oracular prieſts of delivering their anſwers in verſe; it ſubſiſted a long time among the Greeks and Romans; and being from them adopted by the Chriſtians, it was not till after a long ſucceſſion of centuries that it became exploded. Among the Romans it conſiſted in opening ſome celebrated poet at random, and among the Chriſtians the Scriptures, and drawing, from the firſt paſſage which preſented itſelf to the eye, a prognoſtic of what would befal one's ſelf or others, or direction for conduct when under any exigency. There is good evidence that this was none of the vulgar errors; the greateſt perſons, philoſophers of the beſt repute, admitted this ſuperſtition. Socrates, when in priſon, hearing this line of Homer,

> Within three days I Phthia's ſhore ſhall ſee,

immediately ſaid, within three days I ſhall be out of the world; gathering it from the double meaning of the word *Phthia*, which in Greek is both the name of a country and ſignifies corruption or death. This prediction, addreſſed to Æſchines, was not eaſily forgotten, as it was verified.

When this ſuperſtition paſſed from Paganiſm into Chriſtianity, the Chriſtians had two methods of conſulting the divine will from the Scriptures; the one, caſually, to open the divine writings, and take their direction, as above mentioned; the other, to go to church with a purpoſe of receiving, as a declaration of the will of heaven, the words of the Scripture, which were ſinging at the inſtant of one's entrance.

This unwarrantable practice of inquiring into futurity prevailed very generally in England till the beginning of the 18th century; and ſometimes the books of Scripture, and ſometimes the poems of Virgil, were conſulted for oracular reſponſes. One remarkable inſtance is that of King Charles I. who being at Oxford during the civil wars, went one day to ſee the public library, where he was ſhown, among other books, a Virgil nobly printed and exquiſitely bound. The lord Falkland, to divert the king, would have his majeſty make a trial of his fortune by the *Sortes Virgilianæ*. Whereupon the king opening the book, the paſſage which happened to come up was this:

At, bello audacis populi vexatus et armis,
Finibus extorris, complexu avulſus Iuli,
Auxilium imploret; videatque indigna ſuorum
Funera: nec, cum ſe ſub leges pacis iniquæ
Tradiderat, regno aut optata luce fruatur;
Sed cadat ante diem, mediaque inhumatus arena.
Æneid, lib. iv.

Yet let a race, untamed and haughty foes,
His peaceful entrance with dire arms oppoſe;
Oppreſſed with numbers in the unequal field,
His men diſcouraged, and himſelf expelled,
Let him for ſuccour ſue from place to place,
Torn from his ſubjects, and his ſon's embrace:
Firſt let him ſee his friends in battle ſlain,
And their untimely fate lament in vain;
And when at length the cruel war ſhall ceaſe,
On hard conditions may he buy his peace.
Nor let him then enjoy ſupreme command,
But fall untimely by ſome hoſtile hand,
And lie unburied on the barren ſand.

Lord Falkland obſerving that the king was concerned at this accident, would likewiſe try his own fortune in the ſame manner, hoping he might fall upon ſome paſſage that would have no relation to his caſe, and thereby divert the king's thoughts from any impreſſion which the other might have upon him; but the place he ſtumbled upon was as much ſuited to his deſtiny as the other had been to the king's; being the lamentation of Evander for the untimely death of his ſon Pallas*: for this lord's eldeſt ſon, a young man of an amiable character, had been ſlain in the firſt battle of Newbury.

We have ourſelves known ſeveral whoſe devotion has not always been regulated by judgment purſue this method of divination; and have generally obſerved, that the conſequence has been deſpair or preſumption. To ſuch we beg leave to recommend one paſſage in Scripture which will never diſappoint them: *Thou ſhalt not tempt the Lord thy God.*

SOTERIA, in antiquity, ſacrifices offered to the gods for delivering a perſon from danger; as alſo poetical pieces compoſed for the ſame purpoſe.

SOUBISE, a town of France, in the department of Lower Charente, and late territory of Saintonge. It is ſeated on the river Charente, 22 miles ſouth of Rochelle, in W. Long. 1. 2. N. Lat. 45. 57.

SOUDAN, a kingdom of Africa, ſituated between 11° and 16° N. Lat. and 26° and 30° E. Long. See DAR FUR.

SOUGH, among miners, denotes a paſſage dug under ground, to convey off waters from mines. See MINE.

SOVEREIGN, in matters of government, is applied to the ſupreme magiſtrate or magiſtrates of an independent government or ſtate; becauſe their authority is only bounded by the laws of God and the laws of the ſtate: ſuch are kings, princes, &c. See PREROGATIVE, &c.

SOVEREIGN Power, or *Sovereignty*, is the power of making laws; for wherever that power reſides, all others muſt conform to it, and be directed by it, whatever appearance the outward form and adminiſtration of the government may put on. For it is at any time in the option of the legiſlature to alter that form and adminiſtration by a new edict or rule, and to put the execution of the laws into whatever hands it pleaſes: and all the other powers of the ſtate muſt obey the legiſlative power in the execution of their ſeveral functions, or elſe the conſtitution is at an end. In our conſtitution the law aſcribes to the king the attribute of ſovereignty: but that is to be underſtood in a qualified ſenſe, i. e. as ſupreme magiſtrate, not as ſole legiſlator; as the legiſlative power is veſted in the king, lords, and commons, not in any of the three eſtates alone.

SOU. See SOL.

SOUFFRIERE, a ſmall town, ſituated at the bottom of a bay, near the leeward extremity of the iſland of St Lucia. Of itſelf it is not entitled to much notice, but the adjacent ground is very remarkable. The declivities of the ſurrounding hills are cultivated, and afford ſugar-cane of a good quality.

The extremity of the ſouth ſide of Souffriere bay runs into two ſteep hills of a conical ſhape, and nearly perpendicular, reckoned the higheſt on the iſland, and known by the appellation of the *Sugar-Loaf Hills*. It is impoſſible to aſcend them; for although it was once attempted by two negroes, it is ſaid that they never returned. Paſſing the hills to the windward of Souffriere, a fine level country preſents itſelf, extending from 15 to 20 miles from the back of the Sugar-Loaf Hills along the ſea coaſt, being wholly cultivated, and divided into rich eſtates. It is interſected by numerous rivers of very clear water, which, by art, are made ſubſervient to the purpoſe of ſugar-making. The rains here are leſs frequent than on any other part of the iſland, and the wind blows from the ſea, or nearly ſo.

There is a volcano in the vicinity of this town. After paſſing one or two ſmall hills, the ſmell of ſulphur is ſenſibly felt before any veſtige of the place is perceived. The firſt thing diſcerned is a rivulet of black running water, ſending forth ſtreams nearly in a ſtate of ebullition, from which the volcano ſoon comes into view, ſituated

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* Æneid, lib. xi.

tuated in a hollow, and ſurrounded by hills on every ſide. There are many pits in the hollow, of a black and thick boiling matter, which appears to work with great force. Lava is ejected by ſlow degrees, and there is a large maſs of it in the centre of the hollow, forming a ſort of hill. The lava is ſaid to be a ſulphur mixed with calcareous earth and ſome ſaline body. Small quantities of alum have been found in a perfect ſtate; and there is a rivulet of good water in the opening, at the north ſide of the hollow. When the bottom of it is ſtirred, the water is very hot, ſo much ſo as not to be touched. The liquid running from the pits is ſtrongly impregnated with ſulphur, and very much reſembles the preparation ſold in the ſhops, called *aqua ſulphurata*.

SOUL, the principle of perception, memory, intelligence, and volition, in man; which, ſince the earlieſt era of philoſophy, has furniſhed queſtions of difficult inveſtigation, and materials of keen and important controverſy (ſee METAPHYSICS, Part III. chap. ii. iii. iv. v.; and RESURRECTION, N° 42—48.). In the 4th volume of the memoirs of the Literary and Philoſophical Society of Mancheſter, the reader will find a very valuable paper by Dr Ferrier, proving by evidence apparently complete, that every part of the brain has been injured without affecting the act of thought. An abridgement of that memoir would weaken its reaſoning; which, built on matters of fact and experience, appears to us to have ſhaken the modern theory of the Materialiſts from its very foundation.

SOUL of Brutes. See BRUTES.

SOUND, in *Phyſics*, a term which expreſſes a ſimple idea; it is that primary information which we obtain of external things by means of the ſenſe of hearing. See ACOUSTICS.

SOUND, in *Geography*, denotes in general any ſtrait or inlet of the ſea between two headlands. It is given by way of eminence to the ſtrait between Sweden and Denmark, joining the German ocean to the Baltic, being about three miles over. See DENMARK, N° 32. and ELSINORE.

SOUND-Board, the principal part of an organ, and that which makes the whole machine play. It is a reſervoir into which the wind, drawn in by the bellows, is conducted by a port-vent, and thence diſtributed into the pipes placed over the holes of its upper part. The wind enters them by valves, which open by preſſing on the keys, after the regiſters are drawn, by which the air is prevented from going into any of the other pipes, beſides thoſe in which it is required.

SOUND-Board alſo denotes a thin broad board placed over the head of a public ſpeaker, to enlarge or extend and ſtrengthen his voice.

Sound-boards are found by experience to be of no uſe in theatres, as their diſtance from the ſpeaker is too great to be impreſſed with ſufficient force. But ſound-boards over a pulpit have frequently a good effect, when the caſe is conſtructed of a proper thickneſs, and according to particular principles.

SOUND-Poſt, is a poſt placed in the inſide of a violin, &c. as a prop between the back and belly of the inſtrument, and nearly under the bridge.

SOUNDING, the operation of trying the depth of the ſea, and the nature of the bottom, by means of a plummet ſunk from a ſhip to the bottom.

There are two plummets uſed for this purpoſe in navigation; one of which is called the *hand-lead*, weighing about 8 or 9 pounds; and the other the *deep ſea-lead*, which weighs from 25 to 30 pounds; and both are ſhaped like the fruſtum of a cone or pyramid. The former is uſed in ſhallow waters, and the latter at a great diſtance from the ſhore; particularly on approaching the land after a ſea voyage. Accordingly the lines employed for this purpoſe are called the *deep-ſea lead-line*, and the *hand lead-line*.

The hand lead-line, which is uſually 20 fathoms in length, is marked at every two or three fathoms; ſo that the depth of the water may be aſcertained either in the day or night. At the depth of two or three fathoms, there are marks of black leather; at 5 fathoms, there is a white rag; at 7, a red rag; at 10, black leather; at 13, black leather; at 15, a white rag; and at 17, a red ditto.

Sounding with the hand lead, which is called *heaving the lead* by ſeamen, is generally performed by a man who ſtands in the main-chains to windward. Having the line quite ready to run out without interruption, he holds it nearly at the diſtance of a fathom from the plummet; and having ſwung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he ſwings it round his head, and thence as far forward as is neceſſary; ſo that by the lead's ſinking whilſt the ſhip advances, the line may be almoſt perpendicular when it reaches the bottom. The perſon ſounding then proclaims the depth of the water in a kind of ſong reſembling the cries of hawkers in a city. Thus if the mark of five fathoms is cloſe to the ſurface of the water, he calls, 'By the mark five!' and as there is no mark at four, ſix, eight, &c. he eſtimates thoſe numbers, and calls, 'By the dip four,' &c. If he judges it to be a quarter or an half more than any particular number, he calls, 'And a quarter five! and a half four,' &c. If he conceives the depth to be three quarters more than a particular number, he calls it a quarter leſs than the next: thus, at four fathoms and three fourths he calls, 'A quarter leſs five!' and ſo on.

The deep ſea-lead is marked with two knots at 20 fathoms, three at 30, four at 40, and ſo on to the end. It is alſo marked with a ſingle knot in the middle of each interval, as at 25, 35, 45 fathoms, &c. To uſe this lead more effectually at ſea, or in deep water on the ſea-coaſt, it is uſual previouſly to bring to the ſhip, in order to retard her courſe: the lead is then thrown as far as poſſible from the ſhip on the line of her drift, ſo that, as it ſinks, the ſhip drives more perpendicularly over it. The pilot, feeling the lead ſtrike the bottom, readily diſcovers the depth of the water by the mark on the line neareſt its ſurface. The bottom of the lead being alſo well rubbed over with tallow, retains the diſtinguiſhing marks of the bottom, as ſhells, ooze, gravel, &c. which naturally adhere to it.

The depth of the water, and the nature of the ground, which is called the *ſoundings*, are carefully marked in the log-book, as well to determine the diſtance of the place from the ſhore, as to correct the obſervations of former pilots.

A machine for the ſame purpoſe has been invented by Mr Maſſey, of which the following deſcription is given:

"The importance of obtaining true ſoundings at ſea muſt be be admitted by every ſeaman; and it is rather ſingular, that no other method than the common lead has hitherto been brought into uſe; as its imperfections are very generally acknowledged.

"Many veſſels have been loſt, by depending upon the ſoundings taken in the uſual way. The difficulty of obtaining the true perpendicular, and the uncertainty as to the exact moment when the lead ſtrikes the bottom, upon which the accuracy of the reſult depends, muſt always prevent the poſſibility of obtaining the true depth, while the ſhip has any conſiderable way upon her. Indeed, it has been acknowledged by experienced ſeamen, during ſome experiments, made at various times, in the river Merſey, that they could not depend upon the common lead, when going five or ſix knots in the hour, in ten or twelve fathoms of water. When the depth is conſiderable, the veſſel muſt be hove to, which is an operation attended with great loſs of time, and ſometimes conſiderable injury to the ſails; and during a chaſe, this inconvenience muſt be particularly felt.

"True ſoundings may be taken with this machine in thirty fathoms water, without the trouble of heaving the veſſel to, although ſhe may be going at the rate of ſix miles in the hour. True ſoundings may alſo thus be obtained in very deep water, where it is not poſſible to take them by the common lead.

Plate CCCCXCVII. fig. 1.

"Fig. 1. repreſents the ſounding machine. *a* is the ſounding weight, containing a regiſter, 1, 2, with two dials: the hand of the dial 1 makes one revolution when the weight has deſcended twenty fathoms, the other revolves once when the deſcent amounts to five hundred fathoms. A rotator, *b*, ſimilar to that attached to the log, communicates with the wheel work of the dials 1, 2, by means of the rod *c*, on which there are three univerſal joints, 3, 4, and 5. This rod is ſupported during the deſcent of the weight, by the drop, *d*, at the end of which is a fork, 6, and a friction wheel, 7.

"When the machine is to be uſed, a ſounding line is faſtened to the ring, *e*; and one of the vanes of the rotator is ſlipped into the ſpring 8: the rotator will then be in the poſition indicated by the dotted lines, *x*. The indices muſt be ſet at 0, and the cover or lid, *f*, be ſhut. The machine muſt then be projected perpendicularly into the ſea. As ſoon as it reaches the ſurface, the reſiſtance of the water forces the dotted rotator, *x*, out of the ſpring 8, and it aſſumes its perpendicular direction as repreſented by the rotator *b*. As the machine deſcends, it is evident the rotator will revolve, and its motion be communicated freely paſt the friction wheel 7, and the univerſal joint 5, to the wheel work of the dials 1, 2, and thus indicate the ſpace paſſed through in fathoms. When the machine has arrived at the bottom, the rotator, as it is no longer buoyed up by the reaction of the water, will fall to the bottom, quitting the fork of the drop *d*, which will alſo fall from its horizontal poſition, and in its deſcent, by means of the locking rod 9, prevent the rotator from revolving as the machine is drawn up. When at the bottom, the rotator will be in the poſition of the dotted lines *y*.

"This machine, ſimple in its conſtruction, and ſcarcely more liable to accident than the common lead, aſcertains, with the utmoſt preciſion, the perpendicular depth, by the mere act of deſcent through the water. No miſtake can ariſe from that common ſource of error, the drift or lee-way of the ſhip during the time of deſcent; nor does an operation of ſuch importance depend upon the uncertain ſenſation cauſed by the lead ſtriking the bottom, on which the accuracy of the common log altogether depends, and which, it is well known, frequently and materially miſleads the beſt ſeaman: for though a thouſand fathoms of line were laid out, in the ſmalleſt depth of water, no inaccuracy could ariſe, as the perpendicular depth, at the point of heaving, would be regiſtered on the index. The only inconvenience experienced would be the additional labour neceſſary for hauling in the exceſs of line. The moſt inexperienced perſon may uſe this machine, without riſk of error, in the moſt turbulent ſea, and during the night.

"The advantages already enumerated would render the ſounding machine of great importance; but there are other properties of ſtill more conſequence.

"To heave a ſhip to, in order to obtain ſoundings, on a lee ſhore, in ſtormy weather, is a very diſagreeable operation, attended with much trouble, and loſs of way; alſo with conſiderable danger to the ſhip's ſails; indeed, it would often, under ſuch circumſtances, be attended with great hazard to the ſafety of the ſhip. To avoid theſe unpleaſant conſequences, the maſter ſometimes adopts a meaſure, which he conceives to be the leſs exceptionable alternative, by running on without ſounding at all.

"To prove how much inconvenience and danger are avoided by Maſſey's lead, it is enough to ſtate, that ſoundings may be taken in depth from 60 to 80 fathoms, while the ſhip is under way, at the rate of three miles an hour; and as the rate of ſailing may be ſtill materially reduced, without entirely ſtopping the veſſel, or altering her courſe, ſo may ſoundings be had, to any depth required, while ſhe is under way.

"In order more clearly to ſhow the ſuperiority of this machine, and make it apparent, that the quantity of ſtray-line veered out does not at all affect the truth of the reſult: ſuppoſe the common lead thrown from the mizen chains of the ſhip, which may be repreſented by the point *a* of the triangle *a b c*, (fig. 2.), and that the ſhip has moved forwards through the ſpace equal to the line *b c*, while the lead has deſcended through the line *a c*; it is evident, that it is impoſſible, in this caſe, to aſcertain the exact depth, as a quantity of line, equal to *a b*, would be paid out, whereas the true depth is equal only to the line *a c*, which is much leſs. But the caſe is very different when the patent ſounding machine is uſed, as the operation ceaſes when it has reached the bottom; nor is the ſtray-line, *a b*, whatever its length, at all taken into the account.

Fig. 2.

"It has been extremely difficult, and ſometimes impoſſible, to obtain ſoundings in very deep water with the common lead, which may perhaps be thus accounted for. The common line which is uſed for ſounding, though, if left to itſelf, it would ſink in water, yet its deſcent would be much ſlower than that of the lead, ſeparately; it conſequently follows, that the lead muſt be ſo much impeded by carrying the line with it, that when it does reach the bottom, there will be ſcarcely any ſenſible check to enable the ſeaman to know the preciſe moment. Indeed, if he can aſcertain even this to a certainty, he ſtill cannot depend upon the truth of his ſoundings; for if there be the leaſt drift or current, the line itſelf will aſſume a curve, ſimilar to that of the line of a kite in the air. Theſe two cauſes will always operate

rate againſt the perfection of the common mode of ſounding.

"After ſo fully deſcribing the principle of the patent ſounding machine, it is ſcarcely neceſſary to prove, that is liable to neither of the foregoing objections; and it may be ſufficient to ſay, that, as it will certainly find its way to the bottom, if a ſufficient portion of ſtray-line be allowed to guard againſt its being checked in its progreſs, and the certainty of its having reached the bottom may be aſcertained by the arming, there can be no doubt of the practicability of its obtaining ſoundings, in any depth, and no reaſonable doubt of their correctneſs when obtained.

"From the conſtruction of this machine, it might be imagined, that the rotator would impede its motion through the water, and that it could not deſcend ſo rapidly as the common lead; but during repeated trials, in thirteen fathoms water, in which the rotator was frequently detached, and the lead ſuffered to deſcend alone, there was no difference perceptible in the time of their deſcent, though an excellent quarter-ſecond ſtop watch was uſed during the experiment, to detect any change. The following table ſhows how very uniformly the times of deſcent correſponded with the depths in fathoms, during a ſeries of trials made on the river Merſey, with the patent lead, weighing 14 pounds.

"The manner of conducting theſe experiments was ſuch as is deſerving of perfect reliance. Two pilots, of well-known ability and experience, were employed: one threw the lead, and the other, the moment he found, by the ſlackening of the rope, that the weight had arrived at the bottom, cried 'ſtop,' to a third perſon who held the watch.

Time of deſcent.	Fathoms.	Time of deſcent.	Fathoms.
2 ſeconds	2½	7¼ ſeconds	11½
2½ ———	3	7¼ ———	11½
3 ———	4	7¼ ———	11½
5 ———	8	7½ ———	12
5½ ———	8½	7¾ ———	12¾
6 ———	10	8 ———	13
6 ———	10	8¼ ———	13½
7 ———	11¼	6 ———	10

"Taken when under ſail, at upwards of five knots in the hour.

"Several captains and maſters in the navy have made trial of the log and ſounding machine, and given very favourable reports of their performance; and it has been adopted by order of the Navy Board in the British navy *."

SOUP, a ſtrong decoction of fleſh or other ſubſtances.

Portable or dry ſoup is a kind of cake formed by boiling the gelatinous parts of animal ſubſtances till the watery parts are evaporated. This ſpecies of ſoup is chiefly uſed at ſea, and has been found of great advantage. The following receipt will ſhow how it is prepared.

Of calves feet take 4; leg of beef 12 lbs.; knuckle of veal 3 lbs; and leg of mutton 10 lbs. Theſe are to be boiled in a ſufficient quantity of water, and the ſcum taken off as uſual; after which the ſoup is to be ſeparated from the meat by ſtraining and preſſure. The meat is then to be boiled a ſecond time in other water; and the two decoctions, being added together, muſt be left to cool, in order that the fat may be exactly ſeparated. The ſoup muſt then be clarified with five or ſix whites of eggs, and a ſufficient quantity of common ſalt added. The liquor is then ſtrained through flannel, and evaporated on the water-bath to the conſiſtence of a very thick paſte; after which it is ſpread rather thin upon a ſmooth ſtone, then cut into cakes, and laſtly dried in a ſtove until it becomes brittle; theſe cakes are kept in well cloſed bottles. The ſame proceſs may be uſed to make a portable ſoup of the fleſh of poultry; and aromatic herbs may be uſed as a ſeaſoning, if thought proper.

Theſe tablets or cakes may be kept four or five years. When intended to be uſed, the quantity of half an ounce is put into a large glaſs of boiling water, which is to be covered, and ſet upon hot aſhes for a quarter of an hour, or until the whole is entirely diſſolved. It forms an excellent ſoup, and requires no addition but a ſmall quantity of ſalt.

SOUR-CROUTE. See CROUTE.

SOUR-Gourd, or *African Calabaſh-tree*. See ADANSONIA, BOTANY *Index*.

SOUTH, DR ROBERT, an eminent divine, was the ſon of Mr William South a merchant of London, and was born at Hackney near that city in 1633. He ſtudied at Weſtminſter ſchool, and afterwards in Chriſt-church college, Oxford. In 1654, he wrote a copy of Latin verſes to congratulate Cromwell upon the peace concluded with the Dutch; and the next year a Latin poem, entitled *Muſica Incantans*. In 1660 he was elected public orator of the univerſity; and the next year became domeſtic chaplain to Edward earl of Clarendon, lord-high chancellor of England. In 1663 he was inſtalled prebendary of Weſtminſter, admitted to the degree of doctor of divinity, and had a finecure beſtowed on him in Wales by his patron the earl of Clarendon; after whoſe retirement into France in 1667 he became chaplain to the duke of York. In 1670 he was inſtalled canon of Chriſt church in Oxford; and in 1676 attended as chaplain to Laurence Hyde, Eſq. ambaſſador extraordinary to the king of Poland. In 1678 he was preſented to the rectory of Iſlip in Oxfordſhire; and in 1680 rebuilt the chancel of that church, as he afterwards did the rectory-houſe belonging to it. After the revolution he took the oath of allegiance to King William and Queen Mary, though he excuſed himſelf from accepting a great dignity in the church, vacated by the perſonal refuſal of that oath. His health began to decline ſeveral years before his death, which happened in 1716. He was interred in Weſtminſter Abbey, where a monument is erected to his memory. He publiſhed, 1. Animadverſions on Dr Sherlock's Vindication of the Holy and Ever Bleſſed Trinity. 2. A Defence of his Animadverſions. 3. Sermons, 8 vols 8vo. And after his deceaſe were publiſhed his *Opera Poſthuma Latina*, and his poſthumous Engliſh works. Dr South was remarkable for his wit, which abounds in all his writings, and particularly in his ſermons; but at the ſame time they equally abound in ill-humour, ſpleen, and ſatire. He was remarkable for being a time ſerver. During the life of Cromwell he was a ſtaunch Preſbyterian, and then railed againſt the Independents: at the Reſtoration

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[*] *Ni l. ourn*, xi. 2 .

South ‖ Southern.

tion he exerted his pulpit-eloquence againſt the Preſbyterians; and in the reign of Queen Anne, was a warm advocate for Sacheverel.

SOUTH, one of the four cardinal points from which the winds blow.

SOUTH Sea, or *Pacific Ocean*, is that vaſt body of water interpoſed between Aſia and America. It does not, however, ſtrictly ſpeaking, reach quite to the continent of Aſia, excepting to the northward of the peninſula of Malacca: for the water interpoſed between the eaſtern coaſt of Africa and the peninſula juſt mentioned has the name of the *Indian ocean*. The South ſea then is bounded on one ſide by the weſtern coaſt of America, through its whole extent, from the unknown regions in the north to the ſtraits of Magellan and Terra del Fuego, where it communicates with the ſouthern part of the Atlantic. On the other ſide, it is bounded by the coaſt of Aſia, from the northern promontory of Tſchukotſkoi Noſs, to the peninſula of Malacca already mentioned. Thence it is bounded to the ſouthward by the northern coaſts of Borneo, Celebes, Macaſſar, New Guinea, New Holland, and the other iſlands in that quarter, which divide it from the Indian ocean. Then, waſhing the eaſtern coaſt of the great iſland of New Holland, it communicates with that vaſt body of water encompaſſing the whole ſouthern part of the globe, and which has the general name of the *Southern ocean* all round. Thus does this vaſt ocean occupy almoſt the ſemicircumference of the globe, extending almoſt from one pole to the other, and about the equatorial parts extending almoſt 180° in longitude, or 12,500 of our miles.

The northern parts of the Pacific ocean are entirely deſtitute of land; not a ſingle iſland having yet been diſcovered in it from the latitude of 40° north and upwards, excepting ſuch as are very near the coaſt either of Aſia or America; but in the ſouthern part there are a great number.

Till very lately the South ſea was in a great meaſure unknown. From the great extent of ice which covers the ſouthern part of the globe, it was imagined that much more land exiſted there than in the northern regions: but that this could not be juſtly inferred merely from that circumſtance, is plain from what has been advanced under the article AMERICA, N° 3—24.; and the ſouthern continent, long known by the name of *Terra Auſtralis*, has eluded the ſearch of the moſt expert navigators ſent out from Britain and France by royal authority. See TERRA AUSTRALIS.

SOUTH Sea Company. See COMPANY.

SOUTHAMPTON, a ſea-port town of Hampſhire in England; is ſeated on an arm of the ſea; is a place of good trade, and in 1801 contained nearly 8000 inhabitants. It is ſurrounded by walls and ſeveral watch-towers, and had a ſtrong caſtle to defend the harbour, now in ruins. It is a corporation and a county of itſelf, with the title of an earldom, and ſends two members to parliament. W. Long. 1. 24. N. Lat. 50. 54.

SOUTHERN, THOMAS, an eminent dramatic writer, was born at Dublin in 1660, and received his education in the univerſity there. He came young to London to ſtudy law; but inſtead of that devoted himſelf to poetry and the writing of plays. His Perſian Prince, or Loyal Brother, was introduced in 1682, when the Tory intereſt was triumphant in England; and the character of the Loyal Brother being intended to compliment James duke of York, he rewarded the author when he came to the throne with a commiſſion in the army. On the Revolution taking place, he retired to his ſtudies, and wrote ſeveral plays, from which he is ſuppoſed to have derived a very handſome ſubſiſtence, being the firſt who raiſed the advantage of play-writing to a ſecond and third night. The moſt finiſhed of all his plays is Oroonoko, or the Royal Slave, which is built on a true ſtory related in one of Mrs Behn's novels. Mr Southern died in 1746, in the 86th year of his age; the latter part of which he ſpent in a peaceful ſerenity, having by his commiſſion as a ſoldier, and the profits of his dramatic works, acquired a handſome fortune; and being an exact economiſt, he improved what fortune he gained to the beſt advantage. He enjoyed the longeſt life of all our poets; and died the richeſt of them, a very few excepted. His plays are printed in two volumes 12mo.

South ‖ Spa

SOUTHERN Continent. See AMERICA, N° 3—24. and *TERRA Auſtralis*.

SOUTHERNWOOD. See ARTEMISIA, BOTANY *Index*.

SOUTHWARK, a town of Surrey, and a ſuburb of the city of London, being ſeparated from that metropolis only by the Thames. See LONDON, N° 96.

SOW. See SUS, MAMMALIA *Index*.

SOW, in the iron works, the name of the block or lump of metal they work at once in the iron furnace.

SOW-Thiſtle. See SONCHUS, BOTANY *Index*.

SOWING, in *Agriculture* and *Gardening*, the depoſiting any kind of ſeed in the earth for a future crop. See AGRICULTURE.

Drill-SOWING. See *DRILL-Sowing*.

SOY. See DOLICHOS.

SOZOMENUS, HERMIAS, an eccleſiaſtical hiſtorian of the 5th century, was born in Bethelia, a town of Paleſtine. He was educated for the law, and became a pleader at Conſtantinople. He wrote an Abridgement of Eccleſiaſtical Hiſtory, in two books, from the aſcenſion of our Saviour to the year 323. This compendium is loſt; but a continuation of it in nine books, written at greater length, down to the year 440, is ſtill extant. He ſeems to have copied Socrates, who wrote a hiſtory of the ſame period. The ſtyle of Sozomenus is perhaps more elegant; but in other reſpects he falls far ſhort of that writer, diſplaying throughout his whole book an amazing credulity and a ſuperſtitious attachment to monks and the monaſtic life. The beſt edition of Sozomenus is that of Robert Stephen in 1544. He has been tranſlated and publiſhed by Valeſius, and republiſhed with additional notes by Reading at London, 1720, in 3 vols folio.

SPA, a town of Germany, in the circle of Weſtphalia and biſhopric of Liege, famous for its mineral water, lies in E. Long. 5. 50. N. Lat. 50. 30. about 21 miles ſouth-eaſt from Liege, and 7 ſouth-weſt from Lomburg. It is ſituated at one end of a deep valley on the banks of a ſmall rivulet, and is ſurrounded on all ſides by high mountains. The ſides of theſe mountains next to Spa are rude and uncultivated, preſenting a rugged appearance as if ſhattered by the convulſions of earthquakes; but as they are ſtrewed with tall oaks and abundance of ſhrubs, the country around forms a wild, romantic, and beautiful landſcape. The acceſs to the town is very beautiful. The road winds over the mountains till it deſcends to their bottom, when it runs along a ſmooth valley for a mile or a mile and a half.

The town conſiſts of four ſtreets in form of a croſs, and contains about 400 inhabitants. Spa has no wealth to boaſt of. It can ſcarcely furniſh the neceſſaries of life to its own inhabitants during the winter, and almoſt all the luxuries which are requiſite for the great concourſe of affluent viſitors during the ſummer are carried from Liege by women. Its only ſource of wealth is its mineral waters. No ſooner does the warm ſeaſon commence, than crowds of valetudinarians arrive, as well as many other perſons who are attracted ſolely by the love of amuſement, and ſome from leſs honourable motives. The inhabitants, who ſpend ſeven or eight months of the year without ſeeing the face of a ſtranger, wait for the return of this period with impatience. The welcome ſound of the carriages brings multitudes from the town, either to gratify their curioſity, or to offer their ſervices in the hopes of ſecuring your employment while you remain at Spa. Immediately after your arrival, your name and deſignation is added to the printed liſt of the annual viſitors; for which you pay a ſtated ſum to the bookſellers, who have a patent for this purpoſe from the prince biſhop of Liege. This liſt not only enables one to know at a glance whether any friends or acquaintances are reſiding there, but alſo to diſtinguiſh perſons of rank and faſhion from adventurers, who ſeldom have the effrontery to inſert their names.

There are two different ways of accommodating the viſitors at Spa with lodging and neceſſaries. People may either lodge at a hotel, where every thing is furniſhed them in a ſplendid and expenſive ſtyle; or they may take up their reſidence in private lodgings, from which they may ſend for proviſions to a cook's ſhop.

Among the people who viſit Spa, there are many perſons of the firſt rank and faſhion in Europe. Perhaps indeed there is no place in Europe to which ſo many kings and princes reſort; but it is alſo viſited by many ſelf-created nobility, who, under the titles of counts, barons, marquiſes, and knights, contrive by their addreſs, and artifices, to prey upon the rich and unexperienced.

The manners eſtabliſhed at Spa are conducive both to health and amuſement. Every body riſes early in the morning, at ſix o'clock or before it, when a great many horſes ſtand ready ſaddled for thoſe who chooſe to drink the Sauveniere or Geronſtere waters at a little diſtance from Spa. After this healthy exerciſe a part of the company generally breakfaſt together at Vauxhall, a magnificent and ſpacious building. At this place a number of card-tables are opened every forenoon, round which many perſons aſſemble and play for ſtakes to a very conſiderable amount. A ball too is generally held once a week at Vauxhall, beſides two balls at the aſſembly rooms near the Pouhon in the middle of the town.

The moſt remarkable waters at Spa are, 1. The Pouhon, ſituated in the middle of the town; 2. The Sauveniere, a mile and a half eaſt from it; 3. Groiſbeck, near to the Sauveniere; 4. Tonnelet, ſituated a little to the left of the road which leads to the Sauveniere; 5. Geronſtere, two miles ſouth from Spa; 6. Wartroz, near to the Tonnelet; 7. Sarts or Niveſet, in the diſtrict of Sarts; 8. Chevron or Bru, in the principality of Slavelot; 9. Couve; 10. Beverſe; 11. Sige; 12. Geremont. Theſe four laſt are near Malmedy.

Dr Brownrigg was the firſt perſon who diſcovered that fixed air, or, as it is now generally called, *carbonic acid gas*, forms a principal ingredient in the compoſition of the Spa waters, and actually ſeparated a quantity of this elaſtic fluid, by expoſing it to different degrees of heat from 110° to 170° of Fahrenheit. From 20 ounces 7 drams and 14 grains apothecaries weight of the Pouhon water, he obtained 8 ounces 2 drams and 50 grains. Since June 1765, when Dr Brownrigg read a paper on this ſubject before the Royal Society of London, the waters of Spa have been often analyſed, but perhaps by none with more accuracy than by Dr Aſh, who publiſhed a book on the chemical and medicinal properties of theſe waters in 1788. We ſhall preſent the reſult of his analyſis of the five principal ſprings in the following table.

Fountains.	Quantity of Water.	Ounce meaſures of Gas.	Solid contents.	Aerated Lime.	Aerated Magneſia.	Aerated Mineral Alkali.	Aerated Iron.	Selenite.	Aerated Vegetab. Alkali.
	Ounces.		Grains.						
Pouhon	33.	35.75	16.25	2.75	9.50	2.25	1.75	—	—
Geronſtere	32.75	24.75	5.50	2.50	—	1.75	0.75	0.50	
Sauveniere	32.50	33.50	3.75	1.50	—	0.75	0.50	—	1.
Groiſbeck	32.25	35.50	5.25	1.50	—	1.	0.75	—	2.
Tonnelet	32.	40.75	2.00	0.25	—	0.75	1.	—	—

The Pouhon ſpring riſes from the hill to the north of Spa, which conſiſts of argillaceous ſchiſtus and ferrugineous ſlate. The other fountains riſe from the ſurrounding hills to the ſouth-eaſt, ſouth, weſt, and north-weſt of the town; and this ridge of mountains is formed of calcareous earths mixed with ſiliceous ſubſtances. The ſurface of the mountains is covered with woods, interſperſed with large boggy ſwamps filled with mud and water. The Pouhon is conſidered as the principal ſpring at Spa, being impregnated with a greater quantity of iron than any of the reſt, and containing more fixed air than any except the Tonnelet. It is from this ſpring that the Spa water for exportation is bottled; for which the demand is ſo great, that, according to the beſt information that Mr Thickneſſe could obtain, the quantity exported amounts to 200,000 or 250,000 bottles annually. This exported water is inferior in its virtue to that which is drunk on the ſpot; for the veſſels into which it is collected are injudiciouſly expoſed to the ſun, rain, wind, and duſt, for ſeveral hours before they are corked, by which means a conſiderable part of its volatile ingredients muſt be evaporated; for it has been

Thickneſſe's Journey through the Pais Bas.

been found by experiment, that by expoſing it to a gentle heat, air-bubbles aſcend in great numbers. It is in its greateſt perfection when collected in cold dry weather; it is then pellucid, colourleſs, and without ſmell, and almoſt as light as diſtilled water. It varies in its heat from 52° or 53° to 67° of Fahrenheit's thermometer.

The Geronſtere is a much weaker chalybeate water than the Pouhon; and as it is exceedingly nauſeous, and taſtes and ſmells like rotten eggs, it certainly contains ſome hepatic gas. This is a circumſtance which Dr Aſh ſeems not to have attended to ſufficiently. The Sauveniere water alſo, when newly taken from the well, ſmells a little of ſulphur. The Groiſbeck contains more alkali, and almoſt as much gas as the Pouhon, and has been celebrated for its good effects in the caſe of calculous concretions. The Tonnelet contains more gas than any of the reſt. So ſmall is the quantity of any foſſil body held in ſuſpenſion by the aerial acid in it, and ſo volatile is the gas, that it begins to paſs off very rapidly the moment it is taken out of the well, and in a ſhort time is entirely gone. Dr Aſh informs us, that in the neighbourhood of this well, the cellars, on any approaching change of weather, are found to contain much fixed air; and the beſt prognoſtic which they have of rain is the averſion which cats ſhow to be carried into theſe cellars.

The Spa waters are diuretic, and ſometimes purgative. They exhilarate the ſpirits with an influence much more benign than wine or ſpirituous liquors; and they are more cooling, and allay thirſt more effectually, than common water. They are found beneficial in caſes of weakneſs and relaxation, either partial or univerſal; in nervous diſorders; in obſtructions of the liver and ſpleen; in caſes where the blood is too thin and putreſcent; in caſes of exceſſive diſcharges proceeding from weakneſs; in the gravel and ſtone; and in moſt caſes where a ſtrengthening remedy is wanted. But they are hurtful in confirmed obſtructions attended with fever, where there is no free outlet to the matter, as in ulcerations of the lungs. They are alſo injurious to bilious and plethoric conſtitutions, when uſed before the body is cooled by proper evacutions.

SPACE. See METAPHYSICS, Part II. Chap. iv.

SPACE, in *Geometry*, denotes the area of any figure, or that which fills the interval or diſtance between the lines that terminate it.

SPADIX, in *Botany*, anciently ſignified the receptacle of the palms. It is now uſed to expreſs every flower-ſtalk that is protruded out of a ſpatha or ſheath.

The ſpadix of the palms is branched; that of all other plants ſimple. This laſt caſe admits of ſome variety; in *calla*, *dracontium*, and *pothos*, the florets cover it on all ſides; in *arum*, they are diſpoſed on the lower part only: and in *zoſtera* on one ſide. See BOTANY.

SPAGIRIC ART, a name given by old authors to that ſpecies of chemiſtry which works on metals, and is employed in the ſearch of the philoſopher's ſtone.

SPAHIS, horſemen in the Ottoman army, chiefly raiſed in Aſia. The great ſtrength of the grand ſeignior's army conſiſts in the janiſaries, who are the foot; and the ſpahis, who are the horſe.

1
Situatio
and bou
dary.

SPAIN. The kingdom of Spain, which occupies by far the greater portion of the ſouth-weſtern peninſula of Europe, is bounded on the north by the bay of Biſcay and Pyrenean mountains, which ſeparate it from France; on the eaſt by the Mediterranean ſea; on the ſouth by the ſtraits of Gibraltar, which divide it from the African kingdom of Morocco; and on the weſt, partly by the Atlantic ocean, but chiefly by the narrow kingdom of Portugal. This laſt is the only artificial boundary of the Spaniſh territory, and conſiſts of ideal lines, except in three parts, where the river Minho to the north, and the Douro and the Chanca, till its junction with the Guadiana to the eaſt, form rather more natural limits.

2
Extent.

From Cape Ortegal in N. Lat. 43° 44′, to the rock of Gibraltar, in N. Lat. 35° 57′, the continent of Spain extends through nearly 8° of latitude, while its extent from weſt to eaſt, viz. from Cape Finiſterre in Long. 9° 17′ W. from Greenwich to Cape Creus, or Croix, in Long. 3° 30′ E. from the ſame meridian, comprehends nearly 13° of longitude. In Britiſh miles, its length from north to ſouth, viz. from Cape Penas to Gibraltar, may be eſtimated at 550 miles, while its medium breadth may be computed at 440. According to De Laborde, its ſuperficial extent, excluſive of Portugal, is 25,137 ſquare French leagues, or about 21,000 ſquare Engliſh leagues.

Beſides the continental part of Spain, this monarchy comprehends ſeveral iſlands in the Mediterranean, eſpecially Majorca, Minorca, and Iviça; the Canary iſlands, and ſeveral places on the north-weſtern coaſt of Africa; the Philippine and Ladrone iſlands; together with an immenſe territory both in North and South America, comprehending Mexico or New Spain, New Mexico, the iſland of Cuba, Porto Rico, &c. in North America, and in the ſouthern part of that continent, the greateſt portion of *Terra Firma*, Peru, Chili, almoſt the whole of Paraguay, with an extenſive territory lying on the banks of the river Plate.

3
Diviſion

The uſual diviſion of the Spaniſh continent is into fourteen provinces, viz. thoſe of CATALONIA, ARAGON, and NAVARRE, on the confines of France; BISCAY, ASTURIAS, and GALLICIA, on the ſhores of the Atlantic; LEON and ESTREMADURA, on the ſide of Portugal; ANDALUSIA chiefly on the ſtraits of Gibraltar; GRANADA, MURCIA, and VALENCIA, on the ſhores of the Mediterranean; OLD and NEW CASTILE in the centre.

The lateſt writer on the geography of Spain, De Laborde, reckons only 13 provinces, as he includes Granada under Andaluſia. In the following table we have brought together the moſt important circumſtances reſpecting each of theſe provinces, viz. the ſubdiviſions, extent in ſquare Britiſh miles, population at the end of the 18th century, and chief towns; and we have arranged the provinces in the order followed by Laborde.


SPAIN
AND
PORTUGAL.
W. Train Sculpt
BAY of BISCAY
ATLANTIC OCEAN
MEDITERRANEAN SEA
AFRICA
FRANCE
Pyrenean Mountains
GALICIA
ASTURIAS
BISCAY
NAVARRA
ALAVA
ARAGON
CATALONIA
OLD CASTILE
NEW CASTILE
LEON
ESTREMADURA
VALENCIA
MURCIA
ANDALUSIA
GRANADA
PORTUGAL
ENTRE DOURO E MINHO
TRAS OS MONTES
BEIRA
ALENTEJO
ALGARVE
MADRID
LISBON
Toledo
Salamanca
Valladolid
Burgos
Zaragoza
Barcelona
Valencia
Cordova
Sevilla
Granada
Cadiz
Gibraltar
STRAIT of GIBRALTAR
Oporto
Coimbra
MAJORCA
MINORCA
IVIZA
Fromentera
ALGIER
Oran
Ceuta
Tangier
The Coast 5 from Tofiño 4 The interior 3 part from 2 Lopez 1 0 Longitude East 1 from Greenwich 2 3

Provinces.	*Subdiviſions.*	*Extent in ſquare miles.*	*Population.*	*Chief Towns.*
Province of CATALONIA.	County of Rouſſillon ——— Cerdagne	10,400	814,412	BARCELONA, Tarragona, Urgel, Lerida, Gerona, Salſona, Vich, Tortoſa, Figueras, &c.
Kingdom of VALENCIA.		7,800	932,150	VALENCIA, Alicant, Elche, Orihuela, Caſtellan, Alzira, Carcaxente, Gandia, Xaciva, Otiniente, Alcoy, Segorbe, &c.
Province of ESTREMADURA.		16,000	416,922	BADAJOZ, Placencia, Coria, Merida, Truxillo, Xera de los Cavalleros, Llerina, Almatona, Zafra, &c.
Province of ANDALUSIA.	Kingdom of Seville	12,600	754,293	SEVILLE, Xeres de la Frontera, Arcos, Cadiz, Real Ejo, Ayamonte, Nivela, &c.
	——— Granada	4,500	661,661	GRANADA, Malaga, Loxa, Santa Fé, *Antiquera*, Ronda, Guadix, Baza, &c.
	——— Cordova	1,080	236,016	CORDOVA, and Archidona, &c.
	——— Jaen	2,400	177,136	JAEN, Ubeda, Baeza, Anduxar, &c.
Kingdom of MURCIA.		8,812	337,686	MURCIA, Carthagena, Lorca, Chinchilla, Alba Cete, Villena, Almanza, &c.
Kingdom of ARAGON.		16,500	623,308	ZARAGOZA, Iaca, Barbaſtro, Hueſca, Tarazona, Albarrazin, Teruel, &c.
Kingdom of NAVARRE.		2,287	287,382	PAMPELUNA, Tudela, &c.
Province of BISCAY.	Biſcay Proper	4,000	116,042	BILBOA, Vermijo, &c.
	Alava		74,000	VITTORIA, Trevino, Onate, &c.
	Guipuzcoa		12,076	ST SEBASTIAN, Fuenaraba, Toloſa, Placentia, &c.
Principality of the ASTURIAS.	Oviedo	3,375	350,000	OVIEDO, Aviles, Luarca, Gijon, &c.
	Santillana	1,200		SANTILLANA, San Vincente, Riva de Sella, &c.
Kingdom of GALLICIA.		11,500	1,350,000	SAN JAGO DE COMPOSTELLA, Bayona, Lugo, Orenſe, Mondonedo, Corunna, Vigo, &c.
Kingdom of LEON.	Leon Palencia Zamora Salamanca	10,750	665,432	LEON, Duero, Aſtorga, Salamanca, Zamora, &c.
Kingdom of OLD CASTILE.	Burgos Avila Segovia	10,800	1,190,180	BURGOS, Oſma, Siguenza, Avila, Valladolid, Segovia, Calahorra, Soria, &c.
Kingdom of NEW CASTILE.	Toledo	22,000	1,146,809	MADRID, Toledo, Aranjuez, Talavera della Reyna, &c.
	Cuença			CUENÇA, Guete, Alacon, &c.
	Lamanca			OCANA, Hucles, Laguardia, Tarrazona, &c.
Kingdom of MAJORCA.	Iſlands of Majorca	1,440	136,000	PALMA, Alcudia, &c.
	——— Cabrera			
	——— Iviça	100		IVIÇA.
Iſland of MINORCA.		360	27,000	MAHON, Cittadella.
			10,308,505	

Some account of theſe provinces will be found under the articles ANDALUSIA, ARAGON, ASTURIAS, BISCAY, CASTILE, CATALONIA, ESTREMADURA, GALLICIA, GRANADA, LEON, MURCIA, NAVARRE, VALENCIA, IVICA, MAJORCA, and MINORCA; but, for the beſt view of their preſent ſtate, we muſt refer our readers to De Laborde's *View of Spain*, vols i. ii. and iii. or to Playfair's *Geography*, vol. i.

4 Face of the country.

In its general appearance, Spain preſents a pleaſing variety of hill and dale, mountain and valley. It muſt be regarded as a mountainous country, its plains being few in number and of ſmall extent. The moſt remarkable of theſe occupies the centre of the kingdom, eſpecially New Caſtile, which forms the moſt elevated tract of level country to be found in Europe, having a mean elevation of more than 300 fathoms above the level of the ſea. The country is well wooded, and abounds with rivers; but theſe are often very deficient in water, and

Spain, eſpecially on its eaſtern coaſt, is remarkable for the dryneſs of its ſoil. Notwithſtanding this aridity, however, moſt parts of the kingdom teem with fertility, and native verdure and high cultivation render the ſcenery delightful. Here and there, indeed, occurs a tract of deſert utterly incapable of cultivation; but, in general, nature has done much more for the country than the labour of its inhabitants.

5 **Soil.** The ſoil is ſaid to be in general light, and eaſily wrought; but on many parts of the eaſtern coaſt it is compoſed chiefly of a ſtiff loam or clay. The moſt fertile parts of the kingdom are in Valencia, on the coaſt of Granada, in the kingdom of Old Caſtile, and in ſeveral parts of thoſe of New Caſtile and Leon. The ſoil of Catalonia is very diſcouraging, except in the valleys, and the ſame may be ſaid of all the provinces bordering on the Pyrennees; the ſoil of Eſtremadura, though naturally good, has been ſo long abandoned to itſelf, that it has almoſt ceaſed to produce, and that of Andaluſia has a very mixed character. The ſoil of Murcia is uncommonly arid; that of the Aſturias cold; that of Gallicia extremely wet. In the neighbourhood of Carthagena there is an extenſive tract, which is ſo covered with ſtones as to form a deſert as ſterile and untameable as any on the ſandy plains of Africa or Arabia.

6 **Mountains.** We have ſaid that Spain is a mountainous country. The chain of the Pyrenees, common to it and France, is by no means the moſt conſiderable in point either of elevation or extent; though that chain may be regarded as the common root or origin of all the reſt. From the weſtern corner of the Pyrenees a vaſt ridge branches off through Navarre, Biſcay, Aſturias, and Gallicia, terminating only at Cape Finiſterre, and Cape Ortegal. This ridge is the *Cantabrian* mountains, and is diſtinguiſhed into ſeveral ſubordinate groups, denominated from the principal towns ſituated in their vicinity. Thus we have the mountains of Mondonedo in Gallicia. In general, theſe groups are called *Sierras*, from the jagged or *ſerrated* appearance of their tops; as the *Sierra de la Aſturias*, *Sierra d'Avila*, &c. The ſubordinate mountains that extend from the Sierra of the Aſturias in the north, to the Alpuxaras in the ſouth, run in parallel lines; and the ſame direction prevails in the mountains of Saint Andero, which join the Pyrenees.

From the mountains of Biſcay ariſes a main ridge, which, after proceeding a little to the ſouth, divides into three or four branches. Of theſe the moſt northerly chain ſeparates the provinces of Old Caſtile and New Caſtile, extending to the confines of Portugal, and called the mountains of Guadarama. A ſecond branch divides the principal part of New Caſtile from the province of La Mancha, running from the north eaſt to the ſouth-weſt, as far as Badajos in Eſtremadura. The moſt remarkable part of this chain is the Sierra of Guadalupe. South of theſe runs the Sierra Morena, or Sable mountains, rendered claſſical by the inimitable pen of Cervantes. This is the laſt chain till we reach the Alpuxaras, that extend through the provinces of Granada and Andaluſia.

Of theſe mountains there are two points, which, in elevation, exceed Mont Perdu, the higheſt of the Pyrenees, viz. the Pico de Venleta, in the Sierra Nevada, or ſnowy mountains of Granada, which is elevated more than 1781 fathoms above the level of the ocean, and the peak of Mulahaſen, in the ſame chain, raiſed above 1824 fathoms, which is within 76 fathoms of the peak of Teneriffe.

7 **Capes and promontories.** The principal capes and promontories of the Spaniſh continent are, Cape Creus, Cape St Antoine, oppoſite the iſland of Iviça; Cape Palas, near Carthagena; Cape de Gatte, near Almeria, and the promontory on which ſtands the town of Gibraltar, all on the coaſt of the Mediterranean; and Cape Machicaco, Cape Penas, Cape Ortegal, the promontory of Ferrol, Cape Finiſterre, and Cape Trafalgar, on the coaſts of the Atlantic.

8 **Bays and gulfs.** The principal bays and gulfs on the coaſt of Spain, purſuing the ſame courſe, are the following; the bay of Valencia, the bay of Alicant, the gulf of Carthagena, the bay of Almeria, the bay of Gibraltar, the harbour of Cadiz, the bay of Corunna, commonly called the Groyne, and the bay of Biſcay.

9 **Rivers.** The rivers of Spain are intimately connected with the mountains from which they derive their ſource, and between the chains of which they generally flow. The moſt important are, the Ebro, riſing in the mountains of Santillana in the Aſturias, and running in a ſouth-eaſtern direction between the Caſtiles and Valencia on the one hand, and the provinces of Navarre, Aragon, and Catalonia, on the other, till it reaches the Mediterranean, at a ſmall diſtance from Tortoſa; the Xacar, riſing in the Sierra of Cuença in New Caſtile, and flowing into the Mediterranean conſiderably to the ſouthward of Valencia; the Segura, riſing in a mountain of the ſame name, traverſing the province of Murcia, and meeting the Mediterranean about midway between the capital of that province and Alicant. Theſe flow into the Mediterranean, and there are ſeveral other rivers of leſs note, which pour their waters into the ſame ſea, and which we can merely enumerate. Theſe are the Ter at Gerona, the Lobregate at Barcelona, and the Mijares, paſſing by Segorbe. The rivers which flow into the Atlantic are, the Guadalquiver, riſing at the foot of Mount Segura, from the oppoſite ſide of which originates the river of the ſame name, flowing with a ſluggiſh courſe through the province of Andaluſia, and meeting the Atlantic a little to the north-weſt of Xeres; the Guadiana, riſing among ſome lakes to the north-weſt of Alcaraz in New Caſtile, and paſſing between the Sierra Morena and the Sierra de Guadalupe, till, near Badajos, it enters the kingdom of Portugal, and runs nearly in a ſoutherly direction, till it meets the Atlantic at Ayamonte; the Tagus, riſing among the mountains of Albaraçin in New Caſtile, and running weſterly till, at Alcantara, it becomes a river of Portugal; the Douro, riſing in Old Caſtile near Soria, and paſſing by Valladolid and Zamora, near which it forms a part of the boundary of Portugal; the Minho, riſing in the mountains of Gallicia, and running to the ſouth-weſt, till it meets the Atlantic to the north of Camina. The only other river of any importance in this direction is the Lima, ſuppoſed to be the Lethe of the poets, which riſes in Gallicia, and flows into the ſea below Viara.

10 **Lakes.** If we except the ſeries of ſmall lakes from which we have ſaid the river Guadiana takes its riſe, there are, in Spain, few lakes that merit particular notice. The moſt remarkable of theſe is the lake of Abulfera, in the province of Valencia. This lake begins near the village of Catarroija, about a league ſouth of the city of Valencia, and extends nearly four leagues as far as Cullera. When

it is full, it is about four leagues long, two in breadth, and ſix in circumference; but it is ſo ſhallow, that ſmall boats can ſcarcely float in it. To ſupply the deficiency of water, an engine is employed, by which the neighbouring waters are drawn into the bed of the lake; and any ſuperabundant water occaſioned by heavy rains, is carried off into the ſea by means of an artificial opening. This lake contains a great many fiſh, and numerous aquatic birds make it their haunt. On certain days in the year the inhabitants of Valencia make excurſions hither to ſhoot the birds, and the ſurface of the lake is at theſe times covered with boats.

11 Foreſts. Many parts of the kingdom of Spain abound in large tracts of wood. Extenſive foreſts are found in Catalonia, the Aſturias, Gallicia, and in the Sierra Morena. It is in the mountainous chains that the foreſts of Spain are moſt remarkable; and there are few of theſe heights, except in the ſnowy regions of the Sierra Nevada, but what are covered with wood almoſt to their ſummits.

12 Climates and ſeaſons. The climate of Spain is as delightful as that of any part of Europe; and though at certain ſeaſons of the year the eaſtern coaſt is ſubject to exceſſive heat and drought, and the north-weſtern to almoſt perpetual rains, the temperature is in general mild, and the air ſalubrious.

The climate of Spain has been admirably depicted by M. A. de Humboldt; and we ſhall here preſent to our readers the ſubſtance of his remarks, as they are related by De Laborde, in his view of Spain.

No country of Europe preſents a configuration ſo ſingular as Spain. It is this extraordinary form which accounts for the dryneſs of the ſoil in the interior of the Caſtiles, for the power of evaporation, the want of rivers, and that difference of temperature which is obſervable between Madrid and Naples, two towns ſituated under the ſame degree of latitude.

The interior of Spain is, as we have ſeen, an elevated plane, which is higher than any of the ſame kind in Europe, occupying ſo large an extent of country. The mean height of the barometer at Madrid is 26 inches $2\frac{2}{5}$ lines. It is therefore $\frac{1}{14}$ lower than the mean height of the mercury at the level of the ocean. This is the difference of the preſſure of the atmoſphere that is experienced by all bodies expoſed to the air at Madrid, and at Cadiz and Bourdeaux. At Madrid the barometer falls as low as 25 inches 6 lines, and ſometimes even lower.

The following is a table of the variations in the height of the barometer during the firſt nine months of the year 1793.

Months.	Maximum.		Minimum.		Mean Height of the Mercury.	
1793.	Inches.	Lines.	Inches.	Lines.	Inches.	Lines.
January,	26	5.8	25	9.8	26	2.6
February,	26	5.3	25	6.2	26	1.6
March,	26	4.7	25	6.	25	11.6
April,	26	2.4	25	6.9	25	11.6
May,	26	4.6	25	10.5	26	0.8
June,	26	4.	25	11.8	26	1.6
July,	26	4.3	26	0.7	26	2.4
Auguſt,	26	3.2	25	11.5	26	1.4
September,	26	4.3	25	11.	26	1.7

From the mean height of the barometer at Madrid, we find that capital to be elevated $309\frac{6}{10}$ fathoms above the level of the ocean. Madrid, conſequently, ſtands as high as the town of Inſpruck, ſituated on one of the higheſt defiles of the Tyrol, while its elevation is 15 times greater than that of Paris, and three times greater than that of Geneva.

According to M. Thalacker, the mineralogiſt, who has taken ſeveral heights with the barometer in the environs of Madrid, the elevation of the king's palace at San Ildefonſo is 593 fathoms, which is higher than the edge of the crater of Mount Veſuvius, and is, ſtrictly ſpeaking, in the regions of the clouds, which generally float from 550 to 600 fathoms high.

The height of the plain of the Caſtiles has an evident effect on its temperature. We are aſtoniſhed at not finding oranges in the open air under the ſame latitude as that of Tarentum, part of Calabria, Theſſaly, and Aſia Minor; but the mean temperature of Madrid is very little ſuperior to that of Marſeilles, Paris, and Berlin, and is nearly the ſame with that of Genoa and Rome. The following table ſhews the mean temperature at Madrid and at Rome, during the firſt nine months of the years 1793 and 1807.

At Madrid.				At Rome.		
Months.	Deg. of Fahrenheit.			Deg. of Fahrenheit.		
January,	39°	3		40°	11′	15″
February,	43	24		47	49	30
March,	47	54		50	15	45
April,	52	19	30″	54	34	30
May,	59	4	30	65	56	15
June,	72	32	15	72	30	
July,	77	13	30	79	15	
Auguſt,	81	34	30	79	15	
September,	65	45		72	34	30

Thus, the mean temperature at Madrid appears to be 59° of Fahrenheit, while that of the coaſts of Spain, from the 41° to the 36° of Lat. is between $63\frac{1}{2}°$ and 68° of Fahrenheit. In the former climate we find that orange trees will not flouriſh in perfection, while in the latter we ſee banana trees, heliconias, and even ſugarcanes, growing in ſituations that are ſheltered from the cold winds.

13 Animals. Spain preſents few ſpecies of animals that are not found in the other parts of ſouthern Europe. Among the quadrupeds, we may remark, as peculiar to Spain, the genet, (*viverra genetta.*) The bear is found in ſeveral parts of the great Pyrenean chain, eſpecially on ſome of the mountains of Aragon, as well as thoſe of Oecar and Reynoſa in Old Caſtile. Wolves are met with in all the higher and mountainous parts of the country, and wild boars on the mountains of Navarre, on the Pinar, and the Sierra de Caraſcoy, in the kingdom of Valencia. The roebuck is found on ſome of the mountains of Navarre, and the lynx and the ibex on thoſe of Cuença in New Caſtile, in the valleys of Aure and Giſtau, as well as in the Pyrenees. The glory of Spaniſh zoology is the horſe, for which this kingdom has been famous in all ages. The Spaniſh

horſes have probably originated from the Barbs of the north of Africa, ſuppoſed to be the immediate offſpring of the Arabian breed. The Spaniſh mules are alſo excellent, and the aſs is here no ignoble animal, though not equal to thoſe of Arabia. There is little remarkable in the breed of cattle; but the Merino ſheep have long been diſtinguiſhed, and are perhaps ſuperior to any in the world for the beauty of the fleece, if not for the delicacy of the mutton. The flocks of Merino ſheep are ſometimes extremely large, and Mr Townſend mentions one nobleman who poſſeſſed not fewer than 40,000. The whole number in the kingdom may be eſtimated at about 5,000,000. Theſe animals were, by a ſpecial code, called the *Meſta*, authoriſed to travel from one province to another, according as the ſeaſon preſented the beſt paſturage in the mountains or the plains. The fleece of the Merino ſheep is eſteemed double in value to that of any other breed.

Of the birds more peculiarly found in Spain, the *vultur percnopterus*, the *cuculus glandarius*, *cuculus tridactyla*, *motacilla hiſpanica*, *hirundo mellia*, and *hirundo rupeſtris*, are the moſt remarkable.

Freſh-water fiſhes are very plentiful in the Spaniſh rivers; but thoſe in moſt eſteem are from the ſmall river Tormes in Old Caſtile, where have been taken trout of 20 lbs. weight. The tench of the lakes near Tobar in New Caſtile, are remarkably fine and delicate, and are taken in great abundance every year, during the months of May and June. The fiſh taken on the coaſts are much the ſame as thoſe of the other countries bordering on the Mediterranean and the Atlantic. The tunny was formerly taken on the eaſtern coaſt, where it formed a particular branch of the fiſhery, but is now, we believe, little regarded.

Among the Spaniſh inſects, the moſt remarkable are, the cantharides, (*meloë veſicatorius*), and the kermes inſect (*coccus ilicis*). The latter inſect is much cultivated as an article of dyeing, eſpecially in the territory of Bujalance, and of Fernan Nunes in the kingdom of Cordova, as alſo in the vicinity of the town of De las Aguas, four leagues from Alicant, and near the river Henares, in New Caſtile. The evergreen oaks on which theſe animals feed, preſent in the ſpring, a moſt ſingular appearance, from the red *nidi* of the kermes, with which their leaves are covered.

14
Vegetables.

No country of Europe of the ſame extent, furniſhes ſuch an ample field for the reſearches of the botaniſt, as Spain; and indeed its botany conſtitutes a very important part of its natural hiſtory. The mountainous diſtricts are clothed with the evergreen oak, the common oak, the cheſnut, and in ſome places various ſpecies of pine; but their moſt uſeful production is the cork tree. The ſmaller heights produce the wild olive, the almond, the ſhumac, the laurel, the bay, the cypreſs, Canary and Portugal broom, the yellow jeſſamine, and the Provence roſe. The vine, the palm tree, the orange, the lemon and the olive, are ſo nearly naturalized as to require but little cultivation; and the ſame may be ſaid of the kali (*ſalſola ſoda*), which is produced in large quantities on the coaſts, and furniſhes the beſt kind of kelp, commonly called *barilla*, uſed in the manufacture of ſoap and glaſs. The plains and valleys are covered with many of thoſe plants which form ſome of the greateſt ornaments of our flower gardens, as the tulip, ſeveral ſpecies of iris, the pæony, the paſſion flower, the orange and martagon lily, the jonquil, ſeveral ſpecies of narciſſus and hyacinth, and above all the rhododendron. The mountains, however, exhibit the greateſt variety of botanical riches. Thoſe moſt worthy of the viſits and reſearches of the enterpriſing botaniſt, are, the Sierra de Guadalupe in Eſtremadura; the mountains of Moncayo in Aragon; of Pineda, Guadarama, and Cuença, in New Caſtile; of Caroſcoy, in the kingdom of Murcia; of Pena-Coloſa, Mongi, Aytona, and Mariola, in the kingdom of Valencia, and the Pyrenees.

The ſugar-cane, was, before the diſcovery of the Weſt India iſlands, one of the moſt important objects of Spaniſh cultivation, and numerous ſugar mills were eſtabliſhed along the coaſt of the Mediterranean, eſpecially in the kingdom of Granada. At the conqueſt of that Mooriſh kingdom, not fewer than fourteen ſugar plantations and two mills, were found within the province. Some ſugar canes are ſtill cultivated in the kingdom of Valencia, but the manufacture of ſugar is diſcontinued, and the canes are uſed only for diſtillation. There is, we believe, ſtill a manufactory for ſugar from Spaniſh canes in Granada.

15
Minerals.

Spain has long been celebrated for the riches of its mineral kingdom, and it may ſtill be conſidered as the Mexico and Peru of Europe. There are few metals which may not be found in this kingdom; and, till the diſcovery of America put the Spaniards in poſſeſſion of mines which far ſurpaſs their own in produce, the gold and ſilver mines of Spain were thought to be nearly the richeſt in the world. At preſent, no gold mines are wrought, but grains of that metal are found diſſeminated in ferruginous quartz, forming a vein that paſſes through a mountain near the village of San Ildefonſo in Old Caſtile. Spangles of gold are found intermixed with emery, in a mine near Alocer in Eſtremadura, and in the territory of Molena in Aragon; and this metal is occaſionally found in the ſand of two rivers; the Agneda, in the kingdom of Leon, which riſes from the mountains of Xalamo, and the Tagus in New Caſtile, eſpecially in the vicinity of Toledo.

Silver is much more abundant, but moſt of its mines have alſo been abandoned. We believe the only ſilver mine now in work is that of the Sierra de Guadalupe, near the village of Logrozen, where the ſilver is found mixed with micaceous ſchiſtus. The moſt remarkable ſilver mines formerly worked are thoſe of Alrodoval del Campo; of Zalamea on the road to Alocer in Eſtremadura; of Almazaron near Carthagena; three in the Sierra Morena, about a league from Guadalcanal, in the kingdom of Seville, and another about two leagues from Linarez, in the kingdom of Jaen. This laſt mine was well known both to the Carthaginians and the Romans; while Spain was under the dominion of the former it belonged to Himilca, the wife of Aſdrubal. After having been long abandoned, it was again wrought in the 17th century, when a vein of ore five feet in diameter was diſcovered; at preſent, however, it is no longer in a ſtate of activity.

Mines of copper are found near Pampeluna in Navarre, near Salva Tierra in Alava; near Eſcarray, and at the foot of the mountains of Guadarama in Old Caſtile; near Lorea in Murcia; near the Chartreuſe of the Val de Chriſto in Valencia; in the Sierra de Guadalupe in Eſtremadura; in the mountains near Cordova; near Riotinto, and at la Canada de los Conejos in Seville;

in the diſtrict of Albuladui in Granada, and near Lenarez in the kingdom of Jaen.

There are numerous lead mines, eſpecially near Tortoſa in Catalonia; at Zoma, Benaſques, and Plan in Aragon; near Logroſen and Alcoſer in Eſtremadura; in the mountain Guadarrama in Old Caſtile; near los Alumbres and Lorca in Murcia; at Alcaniz and Conſtantina in Seville, and at the diſtrict of Linarez in Jaen.

The mines of iron are abundant, and need not be enumerated. Of antimony there are two mines, both in the diſtrict of La Mancha. One of theſe is at Alendia, near Almodovar; the other at the foot of the Sierra Morena. There is only one mine of cobalt, viz. in the province of Aragon, found in the valley of Geſton. There are two mines of cinnabar in Valencia; one about two leagues from Alicant in the limeſtone mountains of Alcoray; the other between Valencia and San Felipe; and two others in the ſame province, that produce native mercury, but none of theſe are worked. The moſt abundant mine of mercury and cinnabar united is in the diſtrict of La Mancha, on the borders of Cordova. It is ſituated in a hill of ſandſtone which reſts on ſlate. The whole length of the hill is traverſed by two principal veins, both of which were wrought by the Romans. The whole of this mine was lately wrought by the agents of the king, and its produce was very abundant.

Plumbago is found in a thick vein intermixed with feldſpar, about a league from the village of Real Monaſterio, in the kingdom of Seville. Mines of ſulphur occur, both in Aragon and Murcia; jet has been found in the diſtrict of Old Colmenar, in Old Caſtile; and there is good evidence of the preſence of coal at ſeveral places in Catalonia, in the Aſturias, New Caſtile, and Aragon; but it is ſaid that no coal mines have as yet been opened.

The marbles of Spain are very numerous and valuable. A black marble, veined with white, is procured near Barcelona; many dendritic marbles occur near Tortoſa. Near the town of Molina, in Aragon, is found a granular marble ſpotted with red, yellow, and white. At the village of Salinos, in the diſtrict of Guipuzcoa, is a beautiful blue pyritical marble, containing marine ſhells. From Monte Segarra, near Segorbia, in the province of Valencia, are procured ſeveral fine marbles, which were held in great eſtimation even by the Romans. The province of Granada, however, contains more valuable varieties of this beautiful mineral than all the reſt of Spain; of theſe ſome of the principal are the following. A pure white ſtatuary marble, of which the whole mountain of Filabra, near Almeria, is compoſed; a fleſh-coloured marble from a mountain near Antiquera; an exquiſitely beautiful wax-coloured alabaſter, from the vicinity of the city of Granada; and a finely veined marble from the Sierra Nevada.

16 Mineral Waters.

Of the Spaniſh mineral waters the following are the moſt celebrated. The principal cold ſprings are, a hepatic water in the town of Buron, in Valencia; a carbonated water at Gerona, in Catalonia; a ſaline purgative water at Vacia-Madrid, three leagues from the capital, and another of a ſimilar nature near Toledo.

The principal hot ſprings are, the baths of Abu-Zulena, at Javal-Cohol, near Bæza; a hepatic ſpring uſed for bathing near Alhama de Granada; another near Almeria, in the province of Granada, to which are attached both bathing and vapour baths: all theſe were diſcovered, or at leaſt brought into general uſe, by the Moors. A very copious hot ſpring near Merida, in Eſtremadura, made uſe of by the Romans. The Calda de Bonar, in the neighbourhood of Leon, a ſpring of tepid water frequented by the Romans, and ſtill exhibiting the ruins of baths and ancient inſcriptions. A very hot ſpring near Orenſe, in Gallicia. A ſpring at Alhama, near Calatayud, in Aragon, formerly much frequented, but now in a ſtate of neglect. The Fuente de Buzot, near Alicant, a ſaline ſpring of the temperature of 104° Fahrenheit. A very copious and hot ſpring at Archena, near Murcia, where ſtill remain the ruins of Roman and Mooriſh baths. A hepatic ſpring near Arnedillo, in Old Caſtile.

17 Natural curioſities.

Among the natural curioſities of Spain, we may particularize the mountain of Montſerrat in Catalonia (ſee MONTSERRAT); the inſulated hill of rock ſalt near the town of Cardona, in Catalonia (ſee GEOLOGY, N° 102); the ſubterranean lake contained within a cave, in the neighbourhood of the Cava Perella, in the iſland of Minorca; the ſtalactitic cave called St Michael's, on the weſt ſide of the rock of Gibraltar, and the river Guadiana, which appears and diſappears ſeveral times in the courſe of its progreſs to the ſea.

18 Spaniſh iſlands.

The various groups of iſlands that are ſubject to Spain have long been diſtinguiſhed by particular names. Thus *Majorca, Minorca, Cabrera* and *Dragonera*, were called by the ancients *Inſulæ Baleares*, and are ſtill named the *Balearic Iſles*; while Iviça and *Feromentura* form a leſſer group, denominated the *Pityuſe Iſles*. Of theſe iſlands, the latter were taken poſſeſſion of by the Carthaginians nearly 700 years before the Chriſtian era; and about 200 years after that enterpriſing people made themſelves maſters of the Balearic iſles. After the fall of Carthage, all theſe iſlands long maintained a ſtate of piratical independence, and only Majorca was ever completely ſubject to the Romans. In the time of Auguſtus we are told that the Balearic iſles were ſo infeſted with rabbits, that the inhabitants ſent deputies to Rome for aſſiſtance to deſtroy theſe formidable invaders of their plantations. In the year 426 of the Chriſtian era, theſe iſlands came into the poſſeſſion of the Vandals, from whom they were taken at the end of the 8th century by the African Moors. At the beginning of the 9th century they were ſeized on by a fleet ſent into the Mediterranean by Charlemagne; but they were ſoon after reconquered by the Moors, who maintained the ſovereignty in theſe iſlands till, in 1228, they were finally diſpoſſeſſed by Don James grandſon of Alphonſo II. king of Aragon.

19 Names of Spain.

Though Spain appears to have been known to the Phœnicians nearly 1000 years before the birth of Chriſt, it ſeems to have been little regarded by the Greeks till after the period when Herodotus compoſed his hiſtory. Some part of this country was probably the Tarſhiſh of Scripture, from which the Phœnicians imported gold, ſilver, and other precious commodities into Judea. When the Greeks had eſtabliſhed a colony at Marſeilles, they muſt have been well acquainted with at leaſt the northern part of this peninſula, to which they gave the names of Iberia and Celtiberia, from two nations who then inhabited the country. and of Heſperia, from its extreme ſituation in the weſt of the then known world. The name Hiſpania, from which its modern appellation is derived, was beſtowed on it by the Romans; but the etymology of this name is uncertain.

20
Original population.

The Aborigines of Spain were doubtleſs a Celtic tribe, which probably paſſed into this peninſula from the adjoining continent of Gaul, though at a very early period they appear to have been mixed with a colony of Mauritani, or Moors from the coaſt of Africa. The Celtic inhabitants, or Celtiberi, ſeem to have poſſeſſed the north-eaſt of the peninſula, while the Mauritani occupied the ſouthern and ſouth-weſtern diſtricts.

21
Spain invaded by the Carthaginians.
An. 240. B. C.

Nothing certain is known reſpecting the early ſtate of Spain, till the commencement of the firſt Punic war between the Romans and the Carthaginians, in the middle of the third century before Chriſt. Not long before this date, probably at the beginning of the century, the latter people had poſſeſſed themſelves of Catalonia, when their general Hamilcar Barcas is ſaid to have founded the city of Barceno, the modern Barcelona. The Carthaginian colony, however, ſeems to have been rather a mercantile than a warlike ſettlement, and the Celtiberi were more the allies than the ſubjects of their African neighbours. Of the conteſts carried on between the Carthaginians and the Romans, till the final ſubjugation of the former, and the conſequent occupation of all their territories by the Roman republic, we have given an account under the articles CARTHAGE and ROME. We ſhall here briefly conſider the ſtate of Spain at the time of its occupation by the Romans, and relate the events to which that occupation gave riſe, and which are leſs connected with the more immediate tranſactions of the Punic wars.

22
State of Spain at the Roman conqueſt.

At the time of the Roman conqueſt, Spain, though prodigious quantities of ſilver had been carried out of it by the Carthaginians and Tyrians, was yet a very rich country. In the moſt ancient times, indeed, its riches are ſaid to have exceeded what is related of the moſt wealthy country in America. Ariſtotle aſſures us, that when the Phenicians firſt arrived in Spain, they exchanged their naval commodities for ſuch immenſe quantities of ſilver, that their ſhips could neither contain nor ſuſtain its load, though they uſed it for ballaſt, and made their anchors and other implements of ſilver. When the Carthaginians firſt came to Spain, they found the quantity of ſilver nothing leſſened, ſince the inhabitants at that time made all their utenſils, and even mangers, of that precious metal. In the time of the Romans this amazing plenty was very much diminiſhed; however, their gleanings were by no means deſpicable, ſince in the ſpace of nine years they carried off 111,542 pounds of ſilver, and 4095 of gold, beſides an immenſe quantity of coin and other things of value (A). The Spaniards were always remarkable for their bravery, and ſome of Hannibal's beſt troops were brought from thence; but as the Romans penetrated farther into the country than the Carthaginians had done, they met with nations whoſe love of liberty was equal to their valour, and whom the whole ſtrength of their empire was ſcarcely able to ſubdue. Of theſe the moſt formidable were the Numantines, Cantabrians, and Aſturians.

23
Succeſſe of Vi athus a gainſt t Romans

In the time of the third Punic war, one Viriathus, a celebrated hunter, and afterwards the captain of a gang of banditti, took upon him the command of ſome nations who had been in alliance with Carthage, and ventured to oppoſe the Roman power in that part of Spain called *Luſitania*, now Portugal. The prætor, named *Vetilius*, who commanded in thoſe parts, marched againſt him with 10,000 men; but was defeated and killed, with the loſs of 4000 of his troops. The Romans immediately diſpatched another prætor with 10,000 foot and 1300 horſe: but Viriathus having firſt cut off a detachment of 4000 of them, engaged the reſt in a pitched battle; and having entirely defeated them, reduced great part of the country. Another prætor, who was ſent with a new army, met with the ſame fate; ſo that, after the deſtruction of Carthage, the Romans thought proper to ſend a conſul named *Quintus Fabius*, who defeated the Luſitanians in ſeveral battles, and regained two important places which had long been in the hands of the rebels. After the expiration of Fabius's conſulate, Viriathus continued the war with his uſual ſucceſs, till the ſenate thought proper to ſend againſt him the conſul Q. Cæcilius Metellus, an officer of great valour and experience. With him Viriathus did not chooſe to venture a pitched battle, but contented himſelf with acting on the defenſive; in conſequence of which the Romans recovered a great many cities, and the whole of Tarraconian Spain was obliged to ſubmit to their yoke. The other conſul, named *Servilianus*, did not meet with the ſame ſucceſs; his army was defeated in the field, and his camp was nearly taken by Viriathus. Notwithſtanding the good fortune of Metellus, however, he could not withſtand the intrigues of his countrymen againſt him, and he was not allowed to finiſh the war he had begun with ſo much ſucceſs. In reſentment for this he took all imaginable pains to weaken the army under his command: he diſbanded the flower of his troops, exhauſted the magazines, let the elephants die, broke in pieces the arrows which had been provided for the Cretan archers, and threw them into a river. Yet, after all, the army which he gave up to his ſucceſſor Q. Pompeius, conſiſting of 30,000 foot and 2000 horſe, was ſufficient to have cruſhed Viriathus if the general had known how to uſe it. But, inſtead of oppoſing Viriathus with ſucceſs, the imprudent conſul procured much more formidable enemies. The Termantians and Numantines, who had hitherto kept themſelves independent, offered very advantageous terms of peace and alliance with Rome; but Pompeius inſiſted on their delivering up their arms. Upon this war was immediately commenced. The conſul with great confidence inveſted Numantia; but being repulſed with conſiderable loſs, he ſat down before Termantia, where he was attended with ſtill worſe ſucceſs. The very firſt day, the Termantines killed 700 of his legionaries; took a great convoy which was coming to

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(A) In this account we muſt allow ſomething for the exaggerations of fabulous hiſtorians. There is no doubt, however, that Spain was at this time immenſely rich, and if we may believe Strabo, there was then a mine near Carthage which yielded every day 25,000 drams of ſilver, or about 300,000l. per annum.

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the Roman camp: and having defeated a conſiderable body of their horſe, puſhed them from poſt to poſt till they came to the edge of a precipice, where they all tumbled down, and were daſhed to pieces. In the mean time Servilius, who had been continued in his command with the title of *proconſul*, managed matters ſo ill, that Viriathus ſurrounded him on all ſides, and obliged him to ſue for peace. The terms offered to the Romans were very moderate; being only that Viriathus ſhould keep the country he at that time poſſeſſed, and the Romans remain maſters of all the reſt. This peace the proconſul was very glad to ſign, and afterwards procured its ratification by the ſenate and people of Rome.

The next year Q. Pompeius was continued in his command againſt the Numantines in Farther Spain, while Q. Servilius Cæpio, the new conſul, had for his province Hither Spain, where Viriathus had eſtabliſhed his new ſtate. Pompeius undertook to reduce Numantia by turning aſide the ſtream of the Durius, now the Douro, by which it was ſupplied with water; but, in attempting this, ſuch numbers of his men were cut off, that, finding himſelf unable to contend with the enemy, he was glad to make peace with them on much worſe terms than they had offered of their own accord. The peace, however, was ratified at Rome; but in the mean time Cæpio, deſirous of ſhowing his prowefs againſt the renowned Viriathus, prevailed on the Romans to declare war againſt him without any provocation. As Cæpio commanded an army greatly ſuperior to the Luſitanians, Viriathus thought proper to ſue for peace; but finding that Cæpio would be ſatisfied with nothing leſs than a ſurrender at diſcretion, he reſolved to ſtand his ground. In the mean time, the latter having bribed ſome of the intimate companions of Viriathus to murder him in his ſleep, he by that infamous method put an end to a war which had laſted 14 years, very little to the honour of the republic.

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After the death of Viriathus, the Romans with like treachery ordered their new conſul Popilius to break the treaty with the Numantines. His infamous conduct met with the reward it deſerved; the Numantines ſallying out, put the whole Roman army to flight with ſuch ſlaughter, that they were in no condition to act during the whole campaign. Mancinus, who ſucceeded Popilius, met with ſtill worſe ſucceſs; his great army, conſiſting of 30,000 men, was utterly defeated by 4000 Numantines, and 20,000 of them killed in the purſuit. The remaining 10,000, with their general, were pent up by the Numantines in ſuch a manner that they could neither advance nor retreat, and would certainly have been all put to the ſword or made priſoners, had not the Numantines, with a generoſity which their enemies never poſſeſſed, offered to let them depart upon condition that a treaty ſhould be concluded with them upon very moderate terms. This the conſul very willingly promiſed, but found himſelf unable to perform. On the contrary, the people not ſatisfied with declaring his treaty null and void, ordered him to be delivered up to the Numantines. The latter refuſed to accept him, unleſs he had along with him the 10,000 men whom they had relieved as before related. At laſt, after the conſul had remained a whole day before the city, his ſucceſſor Furius, thinking this a ſufficient recompenſe to the Numantines for breaking the treaty, ordered him to be received again into the camp. However, Furius did not choose to engage with ſuch a deſperate and reſolute enemy as the Numantines had ſhowed themſelves; and the war with them was diſcontinued till the year 133 B. C. when Scipio Æmilianus, the deſtroyer of Carthage, was ſent againſt them. Againſt this renowned commander the Numantines with all their valour were not able to contend. Scipio, having with the utmoſt care introduced ſtrict diſcipline among his troops, and reformed the abuſes which his predeceſſors had ſuffered in their armies, by degrees brought the Romans to face their enemies, which at his arrival they had abſolutely refuſed to do. Having then ravaged all the country round the town, it was ſoon blocked up on all ſides, and the inhabitants began to feel the want of proviſions. At laſt they reſolved to make one deſperate attempt for their liberty, and either to break through their enemies, or periſh in the attempt. With this view they marched out in good order by two gates, and fell upon the works of the Romans with the utmoſt fury. The Romans, unable to ſtand this deſperate ſhock, were on the point of yielding, when Scipio, haſtening to the places attacked, with no fewer than 20,000 men, the unhappy Numantines were at laſt driven into the city, where they ſuſtained for a little longer the miſeries of famine. Finding at laſt, however, that it was altogether impoſſible to hold out, it was reſolved by the majority to ſubmit to the pleaſure of the Roman commander. But this reſolution was not univerſally approved. Many ſhut themſelves up in their houſes, and died of hunger, while even thoſe who had agreed to ſurrender repented their offer, and ſetting fire to their houſes, periſhed in the flames with their wives and children, ſo that not a ſingle Numantine was left alive to grace the triumph of the conqueror of Carthage.

27
Scipio Æmilianus ſent againſt them.
An. 133. B. C.

28
Miſerable end of the people.

After the deſtruction of Numantia, the whole of Spain ſubmitted to the Roman yoke; and nothing remarkable happened till the times of the Cimbri, when a prætorian army was cut off in Spain by the Luſitanians. From this time nothing remarkable occurs in the hiſtory of Spain till the civil war between Marius and Sylla. The latter having cruſhed the Marian faction, as related under the article Rome, proſcribed all thoſe that had ſided againſt him, whom he could not immediately deſtroy. Among theſe was Sertorius, a man of conſummate valour and experience in war. He had been appointed prætor of Spain by Marius; and upon the overthrow of Marius, retired to that province. Sylla no ſooner heard of his arrival in that country, than he ſent thither one Caius Annius with a powerful army to drive him out. As Sertorius had but few troops along with him, he diſpatched one Julius Salinator with a body of 6000 men to guard the paſſes of the Pyrenees, and to prevent Annius from entering the country. But Salinator having been treacherouſly murdered by aſſaſſins hired by Annius for that purpoſe, he no longer met with any obſtacle; and Sertorius was obliged to embark for the coaſt of Africa with 3000 men, being all he had now remaining. With theſe he landed in Mauritania; but as his men were ſtraggling careleſly about, great numbers of them were cut off by the Barbarians. This new misfortune obliged Sertorius to re-embark for Spain; but finding the whole coaſt lined with the troops of Annius, he put to ſea again, not knowing what courſe to ſteer. In this new voyage he met with a ſmall fleet of Cilician pirates; and having prevailed with

29
Sertorius ſupports the Marian faction in Spain.

30
Is driven out, and undergoes many hardſhips.

with them to join him, he made a deſcent on the coaſt of Iviça, overpowered the garriſon left there by Annius, and gained a conſiderable booty. On the news of this victory Annius ſet ſail for Iviça, with a conſiderable ſquadron, having 5000 land forces on board. Sertorius, not intimidated by the ſuperiority of the enemy, prepared to give them battle. But a violent ſtorm ariſing, moſt of the ſhips were driven on ſhore and daſhed to pieces, Sertorius himſelf with great difficulty eſcaping with the ſmall remains of his fleet. For ſome time he continued in great danger, being prevented from putting to ſea by the fury of the waves, and from landing, by the enemy; at laſt, the ſtorm abating, he paſſed the ſtraits of Gades, now Gibraltar, and landed near the mouth of the river Bætis. Here he met with ſome ſeamen newly arrived from the Atlantic or Fortunate iſlands; and was ſo charmed with the account which they gave him of thoſe happy regions, that he reſolved to retire thither to ſpend the reſt of his life in quiet and happineſs. But having communicated this deſign to the Cilician pirates, they immediately abandoned him, and ſet ſail for Africa, with an intention to aſſiſt one of the barbarous kings againſt his ſubjects who had rebelled. Upon this Sertorius ſailed thither alſo, but took the oppoſite ſide; and having defeated the king named *Aſcalis*, obliged him to ſhut himſelf up in the city of Tingis, now Tangier, which he cloſely beſieged. But in the mean time Pacianus, who had been ſent by Sylla to aſſiſt the king, advanced with a conſiderable army againſt Sertorius. Upon this the latter, leaving part of his forces before the city, marched with the reſt to meet Pacianus, whoſe army, though greatly ſuperior to his own in number, he entirely defeated; killed the general, and took all his forces priſoners.—The fame of this victory ſoon reached Spain; and the Luſitanians, being threatened with a new war from Annius, invited Sertorius to head their armies. With this requeſt he very readily complied, and ſoon became very formidable to the Romans. Titus Didius, governor of that part of Spain called *Bætica*, firſt entered the liſts with him; but he being defeated, Sylla next diſpatched Metellus, reckoned one of the beſt commanders in Rome, to ſtop the progreſs of this new enemy. But Metellus, notwithſtanding all his experience, knew not how to act againſt Sertorius, who was continually changing his ſtation, putting his army into new forms, and contriving new ſtratagems. On his firſt arrival he ſent for L. Domitius, then prætor of Hither Spain, to his aſſiſtance; but Sertorius being informed of his march, detached Hirtuleius, or Herculeius, his quæſtor, againſt him, who gave him a total overthrow. Metellus then diſpatched Lucius Lollius prætor of Narbonne Gaul againſt Hirtuleius; but he met with no better ſucceſs, being utterly defeated, and his lieutenant-general killed.

31
Lands in Africa, and carries on a ſucceſsful war in that country.

32
Returns to Spain, and defeats the Romans there.

33
Erects Luſitania into a republic.

The fame of theſe victories brought to the camp of Sertorius ſuch a number of illuſtrious Roman citizens of the Marian faction, that he formed a deſign of erecting Luſitania into a republic in oppoſition to that of Rome. Sylla was continually ſending freſh ſupplies to Metellus; but Sertorius with a handful of men, accuſtomed to range about the mountains, to endure hunger and thirſt, and live expoſed to the inclemencies of the weather, ſo haraſſed the Roman army, that Metellus himſelf began to be quite diſcouraged. At laſt, Sertorius hearing that Metellus had ſpoken diſreſpectfully of his courage, challenged his antagoniſt to end the war by ſingle combat; but Metellus very prudently declined the combat, as being advanced in years; yet this refuſal brought upon him the contempt of the unthinking multitude, upon which Metellus reſolved to retrieve his reputation by ſome ſignal exploit; and therefore laid ſiege to Lacobriga, a conſiderable city in thoſe parts. This he hoped to reduce in two days, as there was but one well in the place; but Sertorius having previouſly removed all thoſe who could be of no ſervice during the ſiege, and conveyed 6000 ſkins full of water into the city, Metellus continued a long time before it without making any impreſſion. At laſt, his proviſions being almoſt ſpent, he ſent out Aquinas at the head of 6000 men to procure a new ſupply; but Sertorius falling unexpectedly upon them, cut in pieces or took the whole detachment; the commander himſelf being the only man who eſcaped to carry the news of the diſaſter: upon which Metellus was obliged to raiſe the ſiege with diſgrace.

34
Obliges Metellu
raiſe the
ſiege of
cobriga.

35
Civilize
the Luſi
tanians.

And now Sertorius, having gained ſome intervals of eaſe in conſequence of the many advantages he had obtained over the Romans, began to civilize his new ſubjects. Their ſavage and furious manner of fighting he changed for the regular order and diſcipline of a well-formed army; he beſtowed liberally upon them gold and ſilver to adorn their arms, and by converſing familiarly with them, prevailed with them to lay aſide their own dreſs for the Roman *toga*. He ſent for all the children of the principal people, and placed them in the great city of Oſca, now Hueſca, in the kingdom of Aragon, where he appointed them maſters to inſtruct them in the Roman and Greek learning, that they might, as he pretended, be capable of ſharing with him the government of the republic. Thus he made them really hoſtages for the good behaviour of their parents; however, the latter were greatly pleaſed with the care he took of their children, and all Luſitania were in the higheſt degree attached to their new ſovereign. This attachment he took care to heighten by the power of ſuperſtition; for having procured a young hind of a milk-white colour, he made it ſo tame that it followed him wherever he went; and Sertorius gave out to the ignorant multitude, that this hind was inſpired by Diana, and revealed to him the deſigns of his enemies, of which he always took care to be well informed by the great number of ſpies whom he employed.

36
Pompe
Great
againſt
him.

While Sertorius was thus employed in eſtabliſhing his authority, the republic of Rome, alarmed at his ſucceſs, reſolved to cruſh him at all events. Sylla was now dead, and all the eminent generals in Rome ſolicited this honourable though dangerous employment. After much debate a decree was paſſed in favour of Pompey the Great, but without recalling Metellus. In the mean time, the troops of one Perpenna, or Perperna, had, in ſpite of all that their general could do, abandoned him, and taken the oath of allegiance to Sertorius. This was a moſt ſignal advantage to Sertorius; for Perpenna commanded an army of 33,000 men, and had come into Spain with a deſign to ſettle there as Sertorius had done; but as he was deſcended from one of the firſt families of Rome, he thought it below his dignity to ſerve under any general, however eminent he might be. But the troops of Perperna were of a different opinion; and therefore declaring that they would ſerve none but a general who could defend himſelf, they to a man joined Sertorius; upon which Perperna himſelf finding he could do no better, conſented to ſerve alſo as a ſubaltern.

37
ertorius
eſieges
auron.

38
akes and
rns it in
e ſight of
mpey.

On the arrival of Pompey in Spain, ſeveral of the cities which had hitherto continued faithful to Sertorius began to waver: upon which the latter reſolved, by ſome ſignal exploit, to convince them that Pompey could no more ſcreen them from his reſentment than Metellus. With this view he laid ſiege to Lauron, now Lirias, a place of conſiderable ſtrength. Pompey, not doubting but he ſhould be able to raiſe the ſiege, marched quite up to the enemy's lines, and found means to inform the garriſon that thoſe who beſieged them were themſelves beſieged, and would ſoon be obliged to retire with loſs and diſgrace. On hearing this meſſage, “ I will teach Sylla's diſciple (ſaid Sertorius), that it is the duty of a general to look behind as well as before him.” Having thus ſpoken, he ſent orders to a detachment of 6000 men, who lay concealed among the mountains, to come down and fall upon his rear if he ſhould offer to force the lines. Pompey, ſurpriſed at their ſudden appearance, durſt not ſtir out of his camp; and in the mean time the beſieged, deſpairing of relief, ſurrendered at diſcretion; upon which Sertorius granted them their lives and liberty, but reduced their city to aſhes.

39
efeats
mpey on
e banks
the
cro.

While Sertorius was thus ſucceſsfully contending with Pompey, his queſtor Hirtuleius was entirely defeated by Metellus, with the loſs of 40,000 men; upon which Sertorius advanced with the utmoſt expedition to the banks of the Sucro in Tarraconian Spain, with a deſign to attack Pompey before he could be joined by Metellus. Pompey, on his part, did not decline the combat; but, fearing that Metellus might ſhare the glory of the victory, advanced with the greateſt expedition. Sertorius put off the battle till towards the evening; Pompey, though he knew that the night would prove diſadvantageous to him, whether vanquiſhed or victorious, becauſe his troops were unacquainted with the country, reſolved to venture an engagement, eſpecially as he feared that Metellus might arrive in the mean time, and rob him of part of the glory of conquering ſo great a commander. Pompey, who commanded his own right wing, ſoon obliged Perperna, who commanded Sertorius's left, to give way. Hereupon Sertorius himſelf, taking upon him the command of that wing, brought back the fugitives to the charge, and obliged Pompey to fly in his turn. In his flight he was overtaken by a gigantic African, who had already lifted up his hand to diſcharge a blow at him with his broad ſword; but Pompey prevented him by cutting off his right hand at one blow. As he ſtill continued his flight, he was wounded and thrown from his horſe; ſo that he would certainly have been taken priſoner, had not the Africans who purſued him quarrelled about the rich furniture of his horſe. This gave an opportunity to the general to make his eſcape; ſo that at length he reached his camp with much difficulty. But in the mean time Afranius, who commanded the left wing of the Roman army, had entirely defeated the wing which Sertorius had left, and even purſued them ſo cloſe that he entered the camp along with them. Sertorius, returning ſuddenly, found the Romans buſy in plundering the tents; when taking advantage of their ſituation, he drove them out with great ſlaughter, and retook the camp. Next day he offered battle a ſecond time to Pompey: but Metellus then coming up with all his forces, he thought proper to decline an engagement with both commanders. In a few days, however, Pompey and Metellus agreed to attack the camp of Sertorius. The event was ſimilar to that of the former battle; Metellus defeated Perperna, and Sertorius routed Pompey. Being then informed of Perperna's miſfortune, he haſtened to his relief; rallied the fugitives, and repulſed Metellus in his turn, wounded him with his lance, and would certainly have killed him, had not the Romans, aſhamed to leave their general in diſtreſs, haſtened to his aſſiſtance, and renewed the fight with great fury. At laſt Sertorius was obliged to quit the field, and retire to the mountains. Pompey and Metellus haſtened to beſiege him; but while they were forming their camp, Sertorius broke through their lines, and eſcaped into Luſitania. Here he ſoon raiſed ſuch a powerful army, that the Roman generals, with their united forces, did not think proper to venture an engagement with him. They could not, however, reſiſt the perpetual attacks of Sertorius, who now drove them from place to place, till he obliged them to ſeparate; the one went into Gaul, and the other to the foot of the Pyrenees.

40
Pompey
defeated a
ſecond
time.

41
Pompey and
Metellus
driven from
Spain by
Sertorius.

42
Sertorius
treacherouſly
murdered.

An. 73.
B. C.

Thus did this celebrated commander triumph over all the power of the Romans; and there is little doubt but he would have continued to make head againſt all the other generals whom the republic could have ſent, had he not been aſſaſſinated at an entertainment by the infamous treachery of Perperna, in 73 B. C. after he had made head againſt the Roman forces for almoſt 10 years. Pompey was no ſooner informed of his death, than, without waiting for any new ſuccours, he marched againſt the traitor, whom he eaſily defeated and took priſoner; and having cauſed him to be executed, thus put an end, with very little glory, to a moſt dangerous war.

Many of the Spaniſh nations, however, ſtill continued to bear the Roman yoke with great impatience; and as the civil wars which took place firſt between Julius Cæſar and Pompey, and afterwards between Octavianus and Antony, diverted the attention of the republic from Spain, by the time that Auguſtus had become ſole maſter of the Roman empire, they were again in a condition to aſſert their liberty. The CANTABRIANS and ASTURIANS were the moſt powerful and valiant nations at that time in Spain; but, after incredible efforts, they were obliged to lay down their arms, or rather were almoſt exterminated by Agrippa, as related under theſe articles.

43
Spain under
the Romans.

When the Romans firſt became maſters of the weſtern peninſula of Europe, to which, as we have ſaid, they gave the name of Hiſpania, it was divided into two provinces, called *Citerior* and *Ulterior*, which were governed, ſometimes by prætors, and ſometimes by proconſuls. In the diſtribution of the empire by Auguſtus, *Hiſpania Citerior* contained the modern provinces of Gallicia, the Aſturias, Biſcay, Navarre, Leon, the two Caſtiles, Aragon, Catalonia, Murcia, and Valencia; and was denominated *Provincia Tarraconenſis*, from the city of Tarragona in Catalonia, which was then the ſeat of government. *Hiſpania Ulterior* was ſubdivided into Bætica, including the provinces now called Granada and

and Andaluſia; and Luſitania, comprehending the greateſt part of Eſtremadura, and the modern kingdom of Portugal. The province called *Tarraconenſis* was then inhabited by the following tribes, viz. the *Auſetani*, occupying the ſea coaſt, at the north-eaſt, between the Ter and the Lobregat, and having for their capital Germa; the *Ceretani*, inhabiting the diſtrict of Cerdana, at the foot of the Pyrenees, whoſe capital was *Julia*, the modern Llivia; the *Valetani*, occupying the ſea coaſt between the rivers Ter and Lobregat, in the immediate neighbourhood of the *Auſetani*, and whoſe capital was Barcelona; the *Coſetani* to the left of the mouth of the Ebro, with Tarragona for their capital; the *Locetani*, on the left bank of the river *Sicoris*; the *Illergetes*, extending from that river to the ſmall ſtream Gallego, which joins the Ebro near Zaragoza, whoſe capital was Lerida; the *Jacetani* in the northern extremity of Aragon, having their ſeat of government at Jaca; the *Vaſcones* in Navarre, and the *Varduii* in the modern Guipuzcoa. Theſe nations occupied the ſouthern and eaſtern parts of the province. The northern was poſſeſſed by the *Cariſti*, the *Oſtregones*, both in Biſcay; the *Cantabri*, cantoned near the ſource of the Ebro, and along the bay of Biſcay; the *Aſtures* in Aſturias and part of Leon; the *Callæci* in Gallicia; the *Vacceni* along the Douro; the *Arebaci* in Old Caſtile; the *Celtiberi*, between the Ebro and the ſource of the Tagus, and many others of inferior note.

Luſitania was held by three principal tribes, the *Luſitani*, occupying the greater part of the province, and having for their capital the modern Liſbon; the *Vettones* and the *Celtici*.

Bætica was inhabited by the *Turdetani*, the *Turduli*, the *Baſtitani*, and the *Baſtuli*.

All theſe diſtricts, with their principal towns, are minutely treated of by Dr Playfair, in the firſt volume of his geography.

44
State of Roman Spain.

When incorporated with the Roman empire, Spain partook of its tranquillity, and received in exchange for her liberty, at leaſt wiſe laws and a mild government. If ſhe could not prevent herſelf from falling under the dominion of the maſters of the world, ſhe was at leaſt the moſt powerful, the richeſt, and the happieſt province of their empire. Columella has left us an intereſting account of her agriculture under the firſt emperors. The tradition of her ancient population is probably exaggerated, but the ruins of ſeveral towns prove it to have been conſiderable. It was increaſed by a great many Roman families after the conqueſt; ſeveral legions were eſtabliſhed in Spain; 25 colonies were diſtributed in the moſt fertile parts of the country, and intermarried with the inhabitants. After a while the Spaniards, ſeeing in their maſters only countrymen, were the firſt to ſolicit the rights of Roman citizens, by which they were completely conſolidated. Some municipal towns went ſo far as to deſire permiſſion to take the title of colonies, though in the change they loſt their independence, nearly in the ſame manner as certain proprietors of lands under the feudal ſyſtem converted their domains into fiefs, in order to enjoy the honours attached to them. The government was, in general, milder in Spain than in the other Roman provinces. The adminiſtration was carried on in the towns by magiſtrates named by themſelves, and the different provinces were under the ſuperintendance of prætors, proconſuls, and legates or deputies, according to the different eras of the Roman empire; thoſe in their reſpective departments took care of all the works of public utility, the aqueducts, baths, circuſes, and highways, whoſe magnificent ruins are ſtill exiſting; but they were principally employed in collecting the revenues of the ſtate, which were ſingularly analogous to thoſe of the preſent times. They principally aroſe from dues, fines, or alienations of property, and the produce of the mines. Spain at that time drew from her own mines the ſame riches ſhe now draws from the new world, and they were diſtributed in nearly the ſame manner. One part belonged to the ſtate, and the other to the inhabitants of the country, who paid a certain duty on the metals which they procured from the mines. Their returns went on increaſing, and depended entirely on the number of hands which could be devoted to work in the mines. An employment, ſo laborious, however, which required a numerous population, tended to diminiſh that population by the exceſſive fatigues which it occaſioned. Agriculture alſo ſuffered by the accumulation of eſtates in the hands of a few wealthy landholders. By the little attention paid to it by the proprietors, and by the defects inſeparable from the ſyſtem of cultivation by means of ſlaves, commerce and induſtry languiſhed; and Spain, after having ſhared in the ſplendour of the Roman empire, was beginning to participate in its decline, when a new calamity, by completing her ruin, prepared her regeneration.

This calamity was the irruption of the northern hordes, which ſoon involved Spain in the general attack. This province was invaded firſt by the Franks, who in the third century had entered Gaul with a formidable force.

45
Spain invaded by the Frank
A. D. 26

The Rhine, though dignified by the title of Safeguard of the Provinces, was an imperfect barrier againſt the daring ſpirit of enterpriſe with which the Franks were actuated. Their rapid devaſtations ſtretched from the river to the foot of the Pyrenees; nor were they ſtopped by thoſe mountains. Spain, which had never dreaded, was unable to reſiſt the inroads of the Germans. During 12 years, the greateſt part of the reign of Gallienus, that opulent country was the theatre of unequal and deſtructive hoſtilities. Tarragona, the flouriſhing capital of a peaceful province, was ſacked and almoſt deſtroyed; and ſo late as the days of Oroſius, who wrote in the 5th century, wretched cottages, ſcattered amidſt the ruins of magnificent cities, ſtill recorded the rage of the barbarians. When the exhauſted country no longer ſupplied a variety of plunder, the Franks ſeized on ſome veſſels, and retreated to Mauritania.

46
By the Suevi, Va dals, &c.
An. 409.

The ſituation of Spain, ſeparated, on all ſides, from the enemies of Rome, by the ſea, by the mountains, and by intermediate provinces, had ſecured the long tranquillity of that remote and ſequeſtered country; and we may obſerve, as a ſure ſymptom of domeſtic happineſs, that, in a period of 400 years, Spain furniſhed very few materials to the hiſtory of the Roman empire. The footſteps of the Barbarians, who, in the reign of Gallienus, had penetrated beyond the Pyrenees, were ſoon obliterated by the return of peace; and in the 4th century of the Chriſtian era, the cities of Emerita or Merida, of Corduba, Seville, Bracara, and Tarragona, were numbered with the moſt illuſtrious of the Roman world.

The various plenty of the animal, the vegetable, and the mineral kingdoms, was improved and manufactured by the ſkill of an induſtrious people; and the peculiar advantages of naval ſtores contributed to ſupport an extenſive and profitable trade. The arts and ſciences flouriſhed under the protection of the emperors; and if the character of the Spaniards was enfeebled by peace and ſervitude, the hoſtile approach of the Germans, who had ſpread terror and deſolation from the Rhine to the Pyrenees, ſeemed to rekindle ſome ſparks of military ardour. As long as the defence of the mountains was intruſted to the hardy and faithful militia of the country, they ſucceſsfully repelled the frequent attempts of the Barbarians. But no ſooner had the national troops been compelled to reſign their poſt to the Honorian bands, in the ſervice of Conſtantine, than the gates of Spain were treacherouſly betrayed to the public enemy, about ten months before the ſack of Rome by the Goths. The conſciouſneſs of guilt, and the thirſt of rapine, prompted the mercenary guards of the Pyrenees to deſert their ſtation; to invite the arms of the Suevi, the Vandals, and the Alani; and to ſwell the torrent which was poured with irreſiſtible violence from the frontiers of Gaul to the ſea of Africa. The misfortunes of Spain may be deſcribed in the language of its moſt eloquent hiſtorian, who has conciſely expreſſed the paſſionate, and perhaps exaggerated, declamations of contemporary writers. "The irruption of theſe nations was followed by the moſt dreadful calamities; as the Barbarians exerciſed their indiſcriminate cruelty on the fortunes of the Romans and the Spaniards; and ravaged with equal fury the cities and the open country. The progreſs of famine reduced the miſerable inhabitants to feed on the fleſh of their fellow creatures; and even the wild beaſts, who multiplied, without controul, in the deſert, were exaſperated, by the taſte of blood, and the impatience of hunger, boldly to attack and devour their human prey. Peſtilence ſoon appeared, the inſeparable companion of famine; a large proportion of the people was ſwept away; and the groans of the dying excited only the envy of their ſurviving friends. At length the Barbarians ſatiated with carnage and rapine, and afflicted by the contagious evil which they themſelves had introduced, fixed their permanent ſeats in the depopulated country. The ancient Gallicia, whoſe limits included the kingdom of Old Caſtile, was divided between the Suevi and the Vandals, the Alani were ſcattered over the provinces of Carthagena and Luſitania, and from the Mediterranean to the Atlantic ocean; and the fruitful territory of Bætica was allotted to the Silingi, another branch of the Vandalic nation. After regulating this partition, the conquerors contracted with their new ſubjects ſome reciprocal engagements of protection and obedience: the lands were again cultivated; and the towns and villages were again occupied by a captive people. The greateſt part of the Spaniards was even diſpoſed to prefer this new condition of poverty and barbariſm, to the ſevere oppreſſions of the Roman government; yet there were many who ſtill aſſerted their native freedom, and who refuſed, more eſpecially in the mountains of Gallicia, to ſubmit to the barbarian yoke *."

414. The important preſent of the heads of Jovinus and Sebaſtian, had approved the friendſhip of Adolphus, and reſtored Gaul to the obedience of his brother Honorius. Peace was incompatible with the ſituation and temper of the king of the Goths. He readily accepted the propoſal of turning his victorious arms againſt the barbarians of Spain; the troops of Conſtantius intercepted his communication with the ſea-ports of Gaul, and gently preſſed his march towards the Pyrenees. He paſſed the mountains, and ſurpriſed, in the name of the emperor, the city of Barcelona. The fondneſs of Adolphus for his Roman bride, Placidia, was not abated by time or poſſeſſion; and the birth of a ſon, ſurnamed, from his illuſtrious grandſire, Theodoſius, appeared to fix him for ever in the intereſt of the republic. The loſs of that infant, whoſe remains were depoſited in a ſilver coffin in one of the churches near Barcelona, afflicted his parents; but the grief of the Gothic king was ſuſpended by the labours of the field: and the courſe of his victories was ſoon interrupted by domeſtic treaſon. He had imprudently received into his ſervice one of the followers of Sarus; a barbarian of a daring ſpirit, but of a diminutive ſtature; whoſe ſecret deſire of revenging the death of his beloved patron, was continually irritated by the ſarcaſms of his inſolent maſter. Adolphus was aſſaſſinated in the palace of Barcelona; the laws of the ſucceſſion were violated by a tumultuous faction; and a ſtranger to the royal race, Singeric, the brother of Sarus himſelf, was ſeated on the Gothic throne. An. 415. The firſt act of his reign was the inhuman murder of the ſix children of Adolphus, the iſſue of a former marriage, whom he tore, without pity, from the feeble arms of a venerable biſhop. The unfortunate Placidia, inſtead of the reſpectful compaſſion, which ſhe might have excited in the moſt ſavage breaſts, was treated with cruel and wanton inſult. The daughter of the emperor Theodoſius, confounded among a crowd of vulgar captives, was compelled to march on foot above 12 miles, before the horſe of a barbarian, the aſſaſſin of a huſband whom Placidia loved and lamented.

47
Conquered by the Goths.
An. 415—418.

But Placidia ſoon obtained the pleaſure of revenge; and the view of her ignominious ſufferings might rouſe an indignant people againſt the tyrant, who was aſſaſſinated on the ſeventh day of his uſurpation. After the death of Singeric, the free choice of the nation beſtowed the Gothic ſceptre on Wallia, whoſe warlike and ambitious temper appeared, in the beginning of his reign, extremely hoſtile to the republic. He marched, in arms, from Barcelona to the ſhores of the Atlantic ocean, which the ancients revered and dreaded as the boundary of the world. But when he reached the ſouthern promontory of Spain, and, from the rock now covered by the fortreſs of Gibraltar, contemplated the neighbouring and fertile coaſt of Africa, Wallia reſumed the deſigns of conqueſt, which had been interrupted by the death of Alaric. The winds and waves diſappointed the enterpriſes of the Goths; and the minds of a ſuperſtitious people were deeply affected by the repeated diſaſters of ſtorms and ſhipwrecks. In this diſpoſition, the ſucceſſor of Adolphus no longer refuſed to liſten to a Roman ambaſſador, whoſe propoſals were enforced by the real, or ſuppoſed, approach of a numerous army, under the conduct of the brave Conſtantius. A ſolemn treaty was ſtipulated and obſerved: Placidia was honourably reſtored to her brother; 600,000 meaſures of wheat were delivered to the hungry Goths; and Wallia engaged to draw his ſword in the ſervice of the empire. A bloody war was inſtantly excited among the barbarians of Spain; and the contending princes are ſaid to

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* ariana d eb. Hiſ- lib. v.

have addreſſed their letters, their ambaſſadors, and their hoſtages, to the throne of the weſtern emperor, exhorting him to remain a tranquil ſpectator of their conteſt; the events of which muſt be favourable to the Romans, by the mutual ſlaughter of their common enemies. The Spaniſh war was obſtinately ſupported, during three campaigns, with deſperate valour, and various ſucceſs; and the martial achievements of Wallia diffuſed through the empire the ſuperior renown of the Gothic hero. He exterminated the Silingi, who had irretrievably ruined the elegant plenty of the province of Bætica. He ſlew in battle the king of the Alani; and the remains of thoſe Scythian wanderers, who eſcaped from the field, inſtead of chooſing a new leader, humbly ſought a refuge under the ſtandard of the Vandals, with whom they were ever afterwards confounded. The Vandals themſelves, and the Suevi, yielded to the efforts of the invincible Goths. The promiſcuous multitude of barbarians, whoſe retreat had been intercepted, were driven into the mountains of Gallicia, where they ſtill continued, in a narrow compaſs, and on a barren ſoil, to exerciſe their domeſtic and implacable hoſtilities. In the pride of victory, Wallia was faithful to his engagements; he reſtored his Spaniſh conqueſts to the obedience of Honorius; and the tyranny of the imperial officers ſoon reduced an oppreſſed people to regret the time of their barbarian ſervitude. While the event of the war was ſtill doubtful, the firſt advantages obtained by the arms of Wallia, had encouraged the court of Ravenna to decree the honours of a triumph to their feeble ſovereign. He entered Rome like the ancient conquerors of nations; and if the monuments of ſervile corruption had not long ſince met with the fate which they deſerved, we ſhould probably find that a crowd of poets, and orators, of magiſtrates and biſhops, applauded the fortune, the wiſdom, and the invincible courage, of the emperor Honorius.

An. 428. After the retreat of the Goths, the authority of Honorius had obtained a precarious eſtabliſhment in Spain; except only in the province of Gallicia, where the Suevi and the Vandals had fortified their camps, in mutual diſcord, and hoſtile independence. The Vandals prevailed; and their adverſaries were beſieged in the Nervaſean hills, between Leon and Oviedo, till the approach of Count Aſterius compelled, or rather provoked, the victorious barbarians to remove the ſcene of the war to the plains of Bætica. The rapid progreſs of the Vandals ſoon required a more effectual oppoſition; and the maſter-general Coſtinus marched againſt them with a numerous army of Romans and Goths. Vanquiſhed in battle by an inferior enemy, Coſtinus fled with diſhonour to Tarragona; and this memorable defeat, which has been repreſented as the puniſhment, was moſt probably the effect, of his raſh preſumption. Seville and Carthagena became the reward, or rather the prey, of the ferocious conquerors; and the veſſels which they found in the harbour of Carthagena, might eaſily tranſport them to the iſles of Majorca and Minorca, where the Spaniſh fugitives, as in a ſecure receſs, had vainly concealed their families and their fortunes. The experience of navigation, and perhaps the proſpect of Africa, encouraged the Vandals to accept the invitation which they received from Count Boniface; and the death of Gonderic ſerved only to forward and animate the bold enterpriſe. In the room of a prince, not conſpicuous for any ſuperior powers of the mind or body, they acquired his baſtard brother, the terrible Genſeric; a name which, in the deſtruction of the Roman empire, has deſerved an equal rank with the names of Alaric and Attila. Almoſt in the moment of his departure he was informed, that Hermanric, king of the Suevi, had preſumed to ravage the Spaniſh territories, which he was reſolved to abandon. Impatient of the inſult, Genſeric purſued the haſty retreat of the Suevi as far as Merida; precipitated the king and his army into the river Anas, and calmly returned to the ſea ſhore, to embark his victorious troops. The veſſels which tranſported the Vandals over the modern ſtraits of Gibraltar, a channel only twelve miles in breadth, were furniſhed by the Spaniards, who anxiouſly wiſhed their departure; and by the African general, who had implored their formidable aſſiſtance.

When Theodoric king of the Viſigoths encouraged Avitus to aſſume the purple, he offered his perſon and his forces, as a faithful ſoldier of the republic. An. 45 The exploits of Theodoric ſoon convinced the world, that he had not degenerated from the warlike virtues of his anceſtors. After the eſtabliſhment of the Goths in Aquitain, and the paſſage of the Vandals into Africa, the Suevi who had fixed their kingdom in Gallicia, aſpired to the conqueſt of Spain, and threatened to extinguiſh the feeble remains of the Roman dominion. The provincials of Carthagena and Tarragona, afflicted by an hoſtile invaſion, repreſented their injuries and their apprehenſions. Count Fronto was diſpatched, in the name of the emperor Avitus, with advantageous offers of peace and alliance; and Theodoric interpoſed his weighty mediation, to declare that, unleſs his brother-in-law, the king of the Suevi, immediately retired, he ſhould be obliged to arm in the cauſe of juſtice and of Rome. "Tell him," replied the haughty Rechiarius, "that I deſpiſe his friendſhip and his arms; but that I ſhall ſoon try, whether he will dare to expect my arrival under the walls of Thoulouſe." Such a challenge urged Theodoric to prevent the bold deſigns of his enemy; He paſſed the Pyrenees at the head of the Viſigoths; the Franks and Burgundians ſerved under his ſtandard; and though he profeſſed himſelf the dutiful ſervant of Avitus, he privately ſtipulated, for himſelf and his ſucceſſors, the abſolute poſſeſſion of his Spaniſh conqueſts. The two armies, or rather the two nations, encountered each other on the banks of the river Urbicus, about 12 miles from Aſtorga; and the deciſive victory of the Goths appeared for a while to have extirpated the name and kingdom of the Suevi. From the field of battle Theodoric advanced to Braga, their metropolis, which ſtill retained the ſplendid veſtiges of its ancient commerce and dignity. His entrance was not polluted with blood, and the Goths reſpected the chaſtity of their female captives, more eſpecially of the conſecrated virgins; but the greateſt part of the clergy and people were made ſlaves, and even the churches and altars were confounded in the univerſal pillage. The unfortunate king of the Suevi had eſcaped to one of the ports of the ocean; but the obſtinacy of the winds oppoſed his flight; he was delivered to his implacable rival; and Rechiarius, who neither deſired nor expected mercy, received, with manly conſtancy, the death which he would probably have inflicted. After this bloody ſacrifice to policy or reſentment, Theodoric carried his victorious

victorious arms as far as Merida, the principal town of Luſitania, without meeting any reſiſtance, except from the miraculous powers of St Eulalia; but he was ſtopped in the full career of ſucceſs, and recalled from Spain, before he could provide for the ſecurity of his conqueſts. In his retreat towards the Pyrenees, he revenged his diſappointment on the country through which he paſſed; and in the ſack of Pallentia and Aſtorga, he ſhewed himſelf a faithleſs ally, as well as a cruel enemy.

48 troduc-ion of riſtiani- n. 586— 89.

Recared was the firſt Catholic king of Spain. He had imbibed the faith of his unfortunate brother, and he ſupported it with more prudence and ſucceſs. Inſtead of revolting againſt his father, Recared patiently expected the hour of his death. Inſtead of condemning his memory, he piouſly ſuppoſed, that the dying monarch had abjured the errors of Arianiſm, and recommended to his ſon the converſion of the Gothic nation. To accompliſh that ſalutary end, Recared convened an aſſembly of the Arian clergy and nobles, declared himſelf a Catholic, and exhorted them to imitate the example of their prince. The laborious interpretation of doubtful texts, or the curious purſuit of metaphyſical arguments, would have excited endleſs controverſy; and the monarch diſcreetly propoſed to his illiterate audience, two ſubſtantial and viſible arguments, the teſtimony of Earth and of Heaven. The *Earth* had ſubmitted to the Nicene ſynod: the Romans, the Barbarians, and the inhabitants of Spain, unanimouſly profeſſed the ſame orthodox creed; and the Viſigoths reſiſted, almoſt alone, the conſent of the Chriſtian world. A ſuperſtitious age was prepared to reverence, as the teſtimony of *Heaven*, the preternatural cures which were performed by the ſkill or virtue of the Catholic clergy; the baptiſmal fonts of Oſſet in Bætica, which were ſpontaneouſly repleniſhed each year, on the vigil of Eaſter; and the miraculous ſhrine of St Martin of Tours, which had already converted the Suevic prince and people of Gallicia. The Catholic king encountered ſome difficulties on this important change of the national religion. A conſpiracy, ſecretly fomented by the queen-dowager, was formed againſt his life; and two counts excited a dangerous revolt in the Narbonneſe Gaul. But Recared diſarmed the conſpirators, defeated the rebels, and executed ſevere juſtice; which the Arians, in their turn, might brand with the reproach of perſecution. Eight biſhops, whoſe names betray their Barbaric origin, abjured their errors; and all the books of Arian theology were reduced to aſhes, with the houſe in which they had been purpoſely collected. The whole body of the Viſigoths and Suevi were allured or driven into the pale of the Catholic communion; the faith, at leaſt, of the riſing generation, was fervent and ſincere; and the devout liberality of the Barbarians enriched the churches and monaſteries of Spain. Seventy biſhops aſſembled in the council of Toledo, received the ſubmiſſion of their conquerors; and the zeal of the Spaniards improved the Nicene creed, by declaring the proceſſion of the Holy Ghoſt from the Son, as well as from the Father; a weighty point of doctrine, which produced, long afterwards, the ſchiſm of the Greek and Latin churches. The royal proſelyte immediately ſaluted and conſulted Pope Gregory, ſurnamed the Great, a learned and holy prelate, whoſe reign was diſtinguiſhed by the converſion of heretics and infidels. The ambaſſadors of Recared reſpectfully offered on the threſhold of the Vatican his rich preſent of gold and gems: they accepted, as a lucrative exchange, the hairs of St John the Baptiſt; a croſs, which incloſed a ſmall piece of the true wood; and a key, that contained ſome particles of iron which had been ſcraped from the chains of St Peter *.

49 Legiſlative aſſemblies of the Goths in Spain.

After their converſion from idolatry or hereſy, the Franks and the Viſigoths were diſpoſed to embrace, with equal ſubmiſſion, the inherent evils, and the accidental benefits of ſuperſtition. But the prelates of France, long before the extinction of the Merovingian race, had degenerated into fighting and hunting barbarians. They diſdained the uſe of ſynods, forgot the laws of temperance and chaſtity, and preferred the indulgence of private ambition and luxury, to the greateſt intereſt of the ſacerdotal profeſſion. The biſhops of Spain reſpected themſelves, and were reſpected by the public: their indiſſoluble union diſguiſed their vices, and confirmed their authority; and the regular diſcipline of the church introduced peace, order, and ſtability into the government of the ſtate. From the reign of Recared, the firſt Catholic king, to that of Witiza, the immediate predeceſſor of the unfortunate Roderic, ſixteen national councils were ſucceſſively convened. The ſix metropolitans, Toledo, Seville, Merida, Braga, Tarragona and Narbonne, preſided according to their reſpective ſeniority; the aſſembly was compoſed of their ſuffragan biſhops, who appeared in perſon, or by their proxies; and a place was aſſigned to the moſt holy, or opulent, of the Spaniſh abbots. During the firſt three days of the convocation, as long as they agitated the eccleſiaſtical queſtions of doctrine and diſcipline, the profane laity was excluded from their debates; which were conducted, however, with decent ſolemnity. But, on the morning of the fourth day, the doors were thrown open for the entrance of the great officers of the palace, the dukes and counts of the provinces, the judges of the cities, and the Gothic nobles; and the decrees of Heaven were ratified by the conſent of the people. The ſame rules were obſerved in the provincial aſſemblies, the annual ſynods, which were empowered to hear complaints, and to redreſs grievances; and a legal government was ſupported by the prevailing influence of the Spaniſh clergy. The biſhops who, in each revolution, were prepared to flatter the victorious, and to inſult the proſtrate, laboured, with diligence and ſucceſs, to kindle the flames of perſecution, and to exalt the mitre above the crown. Yet the national councils of Toledo, in which the free ſpirit of the Barbarians was tempered, and guided by epiſcopal policy, have eſtabliſhed ſome prudent laws for the benefit of the king and people. The vacancy of the throne was ſupplied by the choice of the biſhops and palatines; and after the failure of the line of Alaric, the regal dignity was ſtill limited to the pure and noble blood of the Goths. The clergy, who anointed their lawful prince, always recommended, and ſometimes practiſed, the duty of allegiance; and the ſpiritual cenſures were denounced on the heads of the impious ſubjects, who ſhould reſiſt his authority, conſpire againſt his life, or violate, by an indecent union, the chaſtity even of his widow. But the monarch himſelf, when he aſcended the throne, was bound by a reciprocal oath to God and his people, that he would faithfully execute his important truſt. The real or imaginary faults of his adminiſtration were ſubject to
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* *Gibbon's Rome*, 4to vol. iii. p. 549.

the controul of a powerful ariſtocracy; and the biſhops and palatines were guarded by a fundamental privilege that they ſhould not be degraded, impriſoned, tortured, nor puniſhed with death, exile, or confiſcation, unleſs by the free and public judgment of their peers.

50 Code of the Viſigoths.

One of theſe legiſlative councils of Toledo, examined and ratified the code of laws which had been compiled by a ſucceſſion of Gothic kings, from the fierce Eurice, to the devout Egica. As long as the Viſigoths themſelves were ſatiſfied with the rude cuſtoms of their anceſtors, they indulged their ſubjects of Aquitaine and Spain in the enjoyment of the Roman law. Their gradual improvement in arts, in policy, and at length in religion, encouraged them to imitate, and to ſuperſede, theſe foreign inſtitutions, and to compoſe a code of civil and criminal juriſprudence, for the uſe of a great and united people. The ſame obligations, and the ſame privileges, were communicated to the nations of the Spaniſh monarchy; and the conquerors, inſenſibly renouncing the Teutonic idiom, ſubmitted to the reſtraints of equity, and exalted the Romans to the participation of freedom. The merit of this impartial policy was enhanced by the ſituation of Spain, under the reign of the Viſigoths. The provincials were long ſeparated from their Arian maſters, by the irreconcileable difference of religion. After the converſion of Recared had removed the prejudices of the Catholics, the coaſts, both of the ocean and Mediterranean, were ſtill poſſeſſed by the Eaſtern emperors, who ſecretly excited a diſcontented people to reject the yoke of the barbarians, and to aſſert the name and dignity of Roman citizens. The allegiance of doubtful ſubjects is indeed moſt effectually ſecured by their own perſuaſion, that they hazard more in a revolt, than they can hope to obtain by a revolution; but it has appeared ſo natural to oppreſs thoſe whom we hate and fear, that the contrary ſyſtem well deſerves the praiſe of wiſdom and moderation.

51 The Gothic kingdom overthrown by the Saracens. An. 711.

The Gothic princes continued to reign over a conſiderable part of Spain till the beginning of the 8th century, when their empire was overthrown by the Saracens. During this period, they had entirely expelled the eaſtern emperors from what they poſſeſſed in Spain, and even made conſiderable conqueſts in Barbary; but towards the end of the 7th century the Saracens overran all that part of the world with a rapidity which nothing could reſiſt; and having ſoon poſſeſſed themſelves of the Gothic dominions in Barbary, they made a deſcent upon Spain about the year 711 or 712. The king of the Goths at that time was called *Roderic*, and by his bad conduct had occaſioned great diſaffection among his ſubjects. He therefore determined to put all to the iſſue of a battle, knowing that he could not depend upon the fidelity of his own people if he allowed the enemy time to tamper with them. The two armies met in a plain near Xeres in Andaluſia. The Goths began the attack with great fury; but though they fought like men in deſpair, they were at laſt defeated with exceſſive ſlaughter, and their king himſelf was ſuppoſed to have periſhed in the battle, being never more heard of.

By this battle the Moors in a ſhort time rendered themſelves maſters of almoſt all Spain. The poor remains of the Goths were obliged to retire into the mountainous parts of Aſturias, Burgos, and Biſcay: the inhabitants of Aragon, Catalonia, and Navarre, though they might have made a conſiderable ſtand againſt the enemy, choſe for the moſt part to retire into France.

52 The powe of the Goths re vives und Pelagio. An. 71

In 718, however, the power of the Goths began again to revive under Don Pelagio or Pelayo, a prince of the royal blood, who headed thoſe that had retired to the mountains after the fatal battle of Xeres. The place where he firſt laid the foundation of his government was in the Aſturias, in the province of Liebana, about nine leagues in length and four in breadth. This is the moſt inland part of the country, full of mountains enormouſly high, and ſo much fortified by nature, that its inhabitants are capable of reſiſting almoſt any number of invaders. Alakor the Saracen governor was no ſooner informed of this revival of the Gothic kingdom, than he ſent a powerful army, under the command of one Alchaman, to cruſh Don Pelagio before he had time to eſtabliſh his power.

53 He gives the Saracens a dreadful overthrow

The king, though his forces were ſufficiently numerous (every one of his ſubjects arrived at man's eſtate being a ſoldier), did not think proper to venture a general engagement in the open field; but taking poſt with part of them himſelf in a cavern in a very high mountain, he concealed the reſt among precipices, giving orders to them to fall upon the enemy as ſoon as they ſhould perceive him attacked by them. Theſe orders were punctually executed, though indeed Don Pelagio himſelf had repulſed his enemies, but not without a miracle, as the Spaniſh hiſtorians pretend. The ſlaughter was dreadful; for the troops who lay in ambuſcade joining the reſt, and rolling down huge ſtones from the mountains upon the Moors (the name by which the Saracens were known in Spain), no fewer than 124,000 of theſe unhappy people periſhed in one day. The remainder fled till they were ſtopped by a river, and beginning to coaſt it, part of a mountain ſuddenly fell down, ſtopped up the channel of the river, and either cruſhed or drowned, by the ſudden riſing of the water, almoſt every one of that vaſt army.

54 Another army cut pieces or taken.

The Moors were not ſo much diſheartened by this diſaſter, but that they made a ſecond attempt againſt Don Pelagio. Their ſucceſs was as bad as ever, the greateſt part of their army being cut in pieces or taken; in conſequence of which, they loſt all the Aſturias, and never dared to enter the liſts with Pelagio afterwards. Indeed, their bad ſucceſs had in a great meaſure taken from them the deſire of conquering a country where little or nothing was to be gained; and therefore they rather directed their force againſt France, where they hoped for more plunder. Into this country they poured in prodigious multitudes; but were utterly defeated, in 732, by Charles Martel, with the loſs of 300,000 men, as the hiſtorians of thoſe times pretend.

The ſubſequent hiſtory of Spain is rendered ſo confuſed by the numerous kingdoms that were eſtabliſhed either by the Chriſtians or the Moors, that ſome chronological guide is neceſſary to make it intelligible. Before purſuing the thread of the narration, we ſhall lay before our readers the following chronological table of the cotemporary monarchs from Pelagio to Ferdinand VII.

Chronological TABLE of the Kings of Spain.

Year.	*Aſturias and Leon.*	*Caſtile.*	*Aragon.*	*Navarre.*	*Saracens.*
718	Pelagius.				
737	Favila.				
739	Alphonſo I.				
755	- - -	- - -	- -	- - -	Abdoolrahman I.
758	Froila I.				
768	Aurelio.				
774	Silo.				
783	Mauregat.				
788	Bermudo I.	- - -	- - -	- - -	Hiſſem.
791	Alphonſo II.				
795	- - -	- - -	- - -	- - -	Hachem.
822	- - -	- - -	- - -	- - -	Abdoulrahman II.
845	Ramiro I.				
851	Ordogno I.	- - -	- - -	Garcias Ximenes.	
853	- - -	- - -	- - -	- - -	Mahomet.
862	Alphonſo III.				
880	- - -	- - -	- - -	Fortunio I.	
886	- - -	- - -	- - -	- - -	Almundar.
888	- - -	- - -	- - -	- - -	Abdallah.
905	- - -	- - -	- - -	Sancho I.	
910	Garcias.				
912	- - -	- - -	- - -	- - -	Abdoulrahman III.
913	Ordogno II.				
923	Froila II.				
924	Alphonſo IV.				
926	- - -	- -	- - -	Garcias II.	
927	Ramiro II.				
950	Ordogno III.				
956	Sancho.				
961	- - -	- - -	- - -	- - -	Alhacan.
967	Ramiro III.				
976	- - -	- - -	- - -	- - -	Hiſſem.
978	- - -	- - -	- - -	Sancho II.	
982	Bermudo II.				
994	- - -	- - -	- - -	Garcias III.	
999	Alphonſo V.				
1000	- - -	- - -	- - -	Sancho III.	
1014	- - -	- - -	- - -	- - -	Cordova overthrown
1027	Bermudo III.				
1035	- - -	- - -	Ramiro I.	Garcias IV.	
1037	Sancho I. Ferdinand I. of Caſtile.	Ferdinand I.			
1054	- - -	- - -	- - -	Sancho IV.	
1063	- - -	- - -	Sancho.		
1067	Sancho II.	Sancho I.			
1073	Alphonſo VI.	Alphonſo I.			
1076	- - -	- - -	- - -	Sancho V.	
1094	- - -	- - -	Pedro I.	Pedro I.	
1104	- - -	- - -	Alphonſo I.	Alphonſo I.	
1109	Urraca.	Alphonſo II.			
1112	Alphonſo VII.				

Year.	*Aſturias and Leon.*	*Caſtile.*	*Aragon.*	*Navarre.*	*Saracens.*
1126	Alphonſo VIII.	Alphonſo III.			
1134	- - -	- - -	Ramiro II.	Garcias V.	
1137	- - -	- - -	Petronilla.		
1150	- - -	- - -	- - -	Sancho VI.	
1157	Ferdinand II.	Sancho II.			
1158	- - -	Alphonſo IV.			
1162	- - -	- - -	Alphonſo II.		
1188	Alphonſo IX.				
1194	- - -	- - -	- - -	Sancho VII.	
1196	- - -	- - -	Pedro II.		
1213	- - -	- - -	James I.		
1214	- - -	Henry.			
1217	- - -	Berenger. Ferd. I.			
1234	- - -	- - -	- - -	Thibaut I.	
1236	- - -	- - -	- - -	- - -	Mahomet.
1252	- - -	Alphonſo V.			
1253	- - -	- - -		Thibaut II.	
1270	- - -	- - -	- - -	Henry.	
1273	- - -	- - -	- - -	- - -	Muley.
1274	- - -	- - -	- - -	Joanna.	
1276	- - -	- - -	Pedro III.		
1284	- - -	Sancho III.			
1285	- - -	- - -	Alphonſo III.		
1291	- - -	- - -	James II.		
1295	- - -	Ferdinand II.			
1302	- - -	- - -	- - -	- - -	Mahomet II.
1304	- - -	- - -	- - -	Lewis.	
1310	- - -	- - -	- - -	- - -	Nazer.
1312	- - -	Alphonſo VI.			
1315	- - -	- - -	- - -	- - -	Iſmael.
1316	- - -	- - -	- - -	Philip.	
1322	- - -	- - -	- - -	Charles.	
1326	- - -	- - -	- - -	- - -	Mahomet III.
1327	- - -	- - -	Alphonſo IV.		
1328	- - -	- - -	- - -	Joanna II.	
1333	- - -	- - -	- - -	- - -	Juzaf I.
1336	- - -	- - -	Pedro IV.		
1349	- - -	- - -	- - -	Charles II.	
1350	- - -	Pedro.			
1354	- - -	- - -	- - -	- - -	Lago I.
1369	- - -	Henry II.			
1374	- - -	- - -	- - -	- - -	Mahomet IV.
1379	- - -	John.	- - -	- - -	Mahomet V.
1387	- - -	- - -	- - -	Charles III.	- -
1390	- - -	Henry III.			
1392	- - -	- - -	- - -	- - -	Juzaf II.
1395	- - -	- - -	Martin.		
1396	- - -	- - -	- - -	- - -	Balba.
1404	- - -	John II.			
1408	- - -	- - -	- - -	- - -	Juzaf III.
1412	- - -	- - -	Ferdinand I.		
1416	- - -	- - -	Alphonſo V.	- - -	Elaziri.
1423	- - -	- - -	- - -		
1425	- - -	- - -	- - -	Blanche.	
1427	- - -	- - -	- - -	- - -	Zagair.
1432	- - -	- - -	- - -	- - -	Juzaf IV.
1441	- - -	- - -	- - -	John.	
1445	- - -	- - -	- - -	- - -	Ben Oſmin.

Year.	*Aſturias and Leon.*	*Caſtile.*	*Aragon.*	*Navarre.*	*Saracens.*
1450	- - -	Henry IV.			
1453	- - -	- - -	- - -	- - -	Iſmael.
1458	- - -	- - -	John II.		
1459	- - -	- - -	Ferdinand II.		
1474	- - -	Iſabella and Ferdinand V.			
1475	- - -	- - -	- - -	Eleonora.	Abilhuſſan.
1479	- - -	- - -	- - -	Francis.	
1483	- - -	- - -	- - -	Catherine.	
1485	- - -	- - -	- - -	John.	Abouabdalla.
1504	- - -	Joan.			
1506	- - -	Philip I.			
1516	- - -	Charles I.	- - -	Henry.	
1555	- - -	- - -	- - -	Joanna III.	
1556	- - -	Philip II.	- - -	Anthony.	
1572	- - -	- - -	- - -	Henry.	
1598	- - -	Philip III.			

Kings of Spain.

Years.	*Monarchs.*
	House of Austria.
1516	Charles I. (V.).
1556	Philip II.
1598	Philip III.
1621	Philip IV.
1665	Charles II.
	House of Bourbon.
1700	Philip V.
1723	Louis I.
1724	Philip V. again.
1746	Ferdinand VI.
1759	Charles III.
1788	Charles IV.
1808	Ferdinand VII.

737. Don Pelagio died in 737; and ſoon after his death ſuch inteſtine diviſions broke out among the Moors, as greatly favoured the increaſe of the Chriſtian power. In 745 Don Alonſo the Catholic, ſon in law to Pelagio, in conjunction with his brother Froila, paſſed the mountains, and fell upon the northern part of Gallicia; and meeting with little reſiſtance, he recovered almoſt the whole of that province in a ſingle campaign. Next year he invaded the plains of Leon and Caſtile; and before the Moors could aſſemble any force to oppoſe him, he reduced Aſtorgas, Leon, Saldagna, Montes de Oca, Amaya, Alava, and all the country at the foot of the mountains. The year following he puſhed his conqueſts as far as the borders of Portugal, and the next campaign ravaged the country as far as Caſtile. Being ſenſible, however, that he was yet unable to defend the flat country which he had conquered, he laid the whole of it waſte, obliged the Chriſtians to retire to the mountains, and carried off all the Moors for ſlaves. Thus ſecured by a deſert frontier, he met with no interruption for ſome years; during which time, as his kingdom advanced in ſtrength, he allowed his ſubjects gradually to occupy part of the flat country, and to rebuild Leon and Aſtorgas, which he had demoliſhed. He died in 758, and was ſucceeded by his ſon Don Froila. In his time Abdoulrahman, the khaliff's viceroy in Spain, threw off the yoke, and rendered himſelf independent, fixing the ſeat of his government at Cordova. Thus the inteſtine diviſions among the Moors were compoſed; yet their ſucceſs ſeems to have been little better than before; for, ſoon after, Froila encountered the Moors with ſuch ſucceſs, that 54,000 of them were killed on the ſpot, and their general taken priſoner. Soon after he built the city of Oviedo, which he made the

55
quests
he Chri-
s.
745.

56
The Saracens in Spain throw off the yoke of the khaliffs.
An. 758.

the capital of his dominions, in order to be in a better condition to defend the flat country, which he now determined to people.

57
Hiſtory of the kingdom of Navarre.
An. 850.

In the year 850, the power of the Saracens received another blow by the riſe of the kingdom of Navarre. This kingdom, we are told, took its origin from an accidental meeting of gentlemen, to the number of 600, at the tomb of an hermit named *John*, who had died among the Pyrenees. At this place, where they had met on account of the ſuppoſed ſanctity of the deceaſed, they took occaſion to converſe on the cruelty of the Moors, the miſeries to which the country was expoſed, and the glory that would reſult from throwing off their yoke; which, they ſuppoſed, might eaſily be done, by reaſon of the ſtrength of their country. On mature deliberation, the project was approved; one Don Garcias Ximenes was appointed king, as being of illuſtrious birth, and looked upon as a perſon of great abilities. He recovered Ainſa, one of the principal towns of the country, out of the hands of the infidels, and his ſucceſſor Don Garcias Inigas extended his territories as far as Biſcay; however, the Moors ſtill poſſeſſed Portugal, Murcia, Andaluſia, Valencia, Granada, Tortoſa, with the interior part of the country as far as the mountains of Caſtile and Zaragoza. Their internal diſſenſions, which revived after the death of Abdoulrahman, contributed greatly to reduce the power of the infidels in general. In 778, Charles the Great being invited by ſome diſcontented Mooriſh governors, entered Spain with two great armies; one paſſing through Catalonia, and the other through Navarre, where he puſhed his conqueſts as far as the Ebro. On his return he was attacked and defeated by the Moors; though this did not hinder him from keeping poſſeſſion of all thoſe places he had already reduced. At this time he ſeems to have been maſter of Navarre: however, in 831 Count Azner, revolting from Pepin ſon to the emperor Louis, aſſerted the independency of Navarre; but the ſovereigns did not aſſume the title of kings till the time of Don Garcias, who began to reign in 857.

58
Conqueſts of Charles the Great.

An. 921.

In the mean time, the kingdom founded by Don Pelagio, now called the kingdom of *Leon* and *Oviedo*, continued to increaſe rapidly in ſtrength, and many advantages were gained over the Moors, who having two enemies to contend with, loſt ground every day. In 921, however, they gained a great victory over the united forces of Navarre and Leon, by which the whole force of the Chriſtians in Spain muſt have been entirely broken, had not the victors conducted their affairs ſo wretchedly, that they ſuffered themſelves to be almoſt entirely cut in pieces by the remains of the Chriſtian army. In ſhort, the Chriſtians became at length ſo terrible to the Moors, that it is probable they could not long have kept their footing in Spain, had not a great general, named *Mohammed Ebn Amir Almanzor*, appeared, in 979, to ſupport their ſinking cauſe. This man was viſir to the king of Cordova, and being exceedingly provoked againſt the Chriſtians on account of what his countrymen had ſuffered from them, made war with the moſt implacable fury. He took the city of Leon, murdered the inhabitants, and reduced the houſes to aſhes. Barcelona ſhared the ſame fate; Caſtile was reduced to a deſert; Gallicia and Portugal ravaged; and he is ſaid to have overcome the Chriſtians in fifty different engagements. At laſt, having taken and demoliſhed the city of Compoſtella, and carried off in triumph the gates of the church of St James, a flux happened to break out among his troops, which the ſuperſtitious Chriſtians ſuppoſed to be a divine judgment on account of his ſacrilege. Taking it for granted, therefore, that the Moors were now entirely deſtitute of all heavenly aid, they fell upon them with ſuch fury in the next engagement, that all the valour and conduct of Almanzor could not prevent a defeat. Overcome with ſhame and deſpair at this miſfortune, he deſired his followers to ſhift for themſelves, while he himſelf retired to Medina Cœli, and put an end to his life by abſtinence in the year 998.

59
Exploits of Almanzor a Saracen general.
An. 979.

60
He is de-
feated,
ſtarves hi
ſelf to
death.
An. 9

61
Riſe of
kingdom
Caſtile.
An 10

During this period a new Chriſtian principality appeared in Spain, namely that of Caſtile, which is now divided into the Old and New Caſtile. The Old Caſtile was recovered long before that called the *New*. It was ſeparated from the kingdom of Leon on one ſide by ſome little rivers; on the other, it was bounded by the Aſturias, Biſcay, and the province of Rioja. On the ſouth it had the mountains of Segovia and Avila; thus lying in the middle between the Chriſtian kingdom of Leon and Oviedo, and the Mooriſh kingdom of Cordova. Hence this diſtrict ſoon became an object of contention between the kings of Leon and thoſe of Cordova; and as the former were generally victorious, ſome of the principal Caſtilian nobility retained their independence under the protection of the Chriſtian kings, even when the power of the Moors was at its greateſt height. In 884, we firſt hear of Don Rodriguez aſſuming the title of *count of Caſtile*, though it does not appear that either his territory or title were given him by the king of Leon. Nevertheleſs, this monarch having taken upon him to puniſh ſome of the Caſtilian lords as rebels, the inhabitants made a formal renunciation of their allegiance, and ſet up a new kind of government. The ſupreme power was now veſted in two perſons of quality ſtyled *judges;* however, this method did not long continue to give ſatisfaction, and the ſovereignty was once more veſted in a ſingle perſon. By degrees Caſtile fell entirely under the power of the kings of Leon and Oviedo; and, in 1037, Don Sancho beſtowed it on his eldeſt ſon Don Ferdinand, with the title of *king;* and thus the territories of Caſtile were firſt firmly united to thoſe of Leon and Oviedo, and the ſovereigns were thenceforth ſtyled *kings of Leon and Caſtile.*

62
Riſe of
Aragon.
An. 1

Beſides all theſe, another Chriſtian kingdom was ſet up in Spain about the beginning of the 11th century. This was the kingdom of Aragon. The inhabitants were very brave, and lovers of liberty, ſo that it is probable they had in ſome degree maintained their independence, even when the power of the Moors was greateſt. The hiſtory of Aragon, however, during its infancy, is much leſs known than that of any of the others hitherto mentioned. We are only aſſured, that about the year 1035, Don Sancho, ſurnamed the *Great*, king of Navarre, erected Aragon into a kingdom in favour of his ſon Don Ramiro, and afterwards it became very powerful. At this time, then, we may imagine the continent of Spain divided into two unequal parts by a ſtraight line drawn from eaſt to weſt, from the coaſts of Valencia to a little below the mouth of the Douro. The country north of this belonged to the Chriſtians, who, as yet, had the ſmalleſt and leaſt valuable

63
State of
Spain in
the begi
ning of t
11th cen
tury.

64
ledo and
adrid ta-
n by the
riſtians.
1080.

able ſhare, and all the reſt to the Moors. In point of wealth and real power, both by land and ſea, the Moors were much ſuperior; but their continual diſſenſions greatly weakened them, and every day facilitated the progreſs of the Chriſtians. Indeed, had either of the parties been united, the other muſt ſoon have yielded; for though the Chriſtians did not make war upon each other conſtantly as the Moors did, their mutual feuds were yet ſufficient to have ruined them, had their adverſaries made the proper uſe of the advantages thus afforded them. But among the Moors almoſt every city was a kingdom; and as theſe petty ſovereignties ſupported one another very indifferently, they fell a prey one after another to their enemies. In 1080, the king of Toledo was engaged in a war with the king of Seville, another Mooriſh potentate; which being obſerved by Alphonſo king of Caſtile, he alſo invaded his territories; and in four years made himſelf maſter of the city of Toledo, with all the places of importance in its neighbourhood; from thenceforth making Toledo the capital of his dominions. In a ſhort time the whole province of New Caſtile ſubmitted; and Madrid, the preſent capital of Spain, fell into the hands of the Chriſtians, being at that time but a ſmall place.

65
ſignal
tory
ned over
Moors.
1212.

1236.

The Moors were ſo much alarmed at theſe conqueſts, that they not only entered into a general confederacy againſt the Chriſtians, but invited to their aſſiſtance Mahomet Ben Joſeph the ſovereign of Barbary. He accordingly came, attended by an incredible multitude; but was utterly defeated by the Chriſtians in the defiles of the Black Mountain, or Sierra Morena, on the borders of Andaluſia. This victory happened on the 16th of July 1212, and the anniverſary is ſtill celebrated at Toledo. This victory was not improved; the Chriſtian army immediately diſperſed themſelves, while the Moors of Andaluſia were ſtrengthened by the remains of the African army; yet, inſtead of being taught, by their paſt misfortunes, to unite among themſelves, their diſſenſions became worſe than ever, and the conqueſts of the Chriſtians became daily more rapid. In 1236, Don Ferdinand of Caſtile and Leon took the celebrated city of Cordova, the reſidence of the firſt Mooriſh kings; at the ſame time that James I. of Aragon diſpoſſeſſed them of the iſland of Majorca, and drove them out of Valencia. Two years after, Ferdinand made himſelf maſter of Murcia, and took the city of Seville; and in 1303 Ferdinand IV. reduced Gibraltar.

66
gland in-
feres in
Spaniſh
irs.

In the time of Edward III. we find England, for the firſt time, interfering in the affairs of Spain, on the following occaſion. In the year 1284 the kingdom of Navarre had been united to that of France by the marriage of Donna Joanna queen of Navarre with Philip the Fair of France. In 1328, however, the kingdoms were again ſeparated, though the ſovereigns of Navarre were ſtill related to thoſe of France. In 1350, Charles, ſurnamed the *Wicked*, aſcended the throne of Navarre, and married the daughter of John king of France. Notwithſtanding this alliance, and that he himſelf was related to the royal family of France, he ſecretly entered into a negociation with England againſt the French monarch, and even drew into his ſchemes the dauphin Charles, afterwards ſurnamed *the Wiſe*. The young prince, however, was ſoon after made fully ſenſible of the danger and folly of the connections into which he had entered; and, by way of atonement, promiſed to ſacrifice his aſſociates. Accordingly he invited the king of Navarre, and ſome of the principal nobility of the ſame party, to a feaſt at Rouen, where he betrayed them to his father. The moſt obnoxious were executed, and the king of Navarre was thrown into priſon. In this extremity, the party of the king of Navarre had recourſe to England. The prince of Wales, ſurnamed *the Black Prince*, invaded France, defeated King John at Poictiers, and took him priſoner *; which unfortunate event produced the moſt violent diſturbances in that kingdom. The dauphin, now about 19 years of age, naturally aſſumed the royal power during his father's captivity: but poſſeſſed neither experience nor authority ſufficient to remedy the prevailing evils. In order to obtain ſupplies, he aſſembled the ſtates of the kingdom: but that aſſembly, inſtead of ſupporting his adminiſtration, laid hold of the preſent opportunity to demand limitations of the prince's power, the puniſhment of paſt malverſations, and the liberty of the king of Navarre. Marcel, provoſt of the merchants of Paris, and firſt magiſtrate of that city, put himſelf at the head of the unruly populace, and puſhed them to commit the moſt criminal outrages againſt the royal authority. They detained the dauphin in a kind of captivity, murdered in his preſence Robert de Clermont and John de Conflans, mareſchals of France; threatened all the other miniſters with the like fate; and when Charles, who had been obliged to temporize and diſſemble, made his eſcape from their hands, they levied war againſt him, and openly rebelled. The other cities of the kingdom, in imitation of the capital, ſhook off the dauphin's authority, took the government into their own hands, and ſpread the contagion into every province.

67
The king of
Navarre
impriſoned
by John
king of
France.

* See
France,
N° 44.

68
Eſcapes,
and heads
the French
malecon-
tents.

Amidſt theſe diſorders, the king of Navarre made his eſcape from priſon, and preſented a dangerous leader to the furious malecontents. He revived his pretenſions to the crown of France; but in all his operations he acted more like a leader of banditti than one who aſpired to be the head of a regular government, and who was engaged by his ſtation to endeavour the re-eſtabliſhment of order in the community. All the French, therefore, who wiſhed to reſtore peace to their country, turned their eyes towards the dauphin; who, though not remarkable for his military talents, daily gained by his prudence and vigilance the aſcendant over his enemies. Marcel, the ſeditious provoſt of Paris, was ſlain in attempting to deliver that city to the king of Navarre. The capital immediately returned to its duty: the moſt conſiderable bodies of the mutinous peaſants were diſperſed or put to the ſword; ſome bands of military robbers underwent the ſame fate; and France began once more to aſſume the appearance of civil government.

John was ſucceeded in the throne of France by his ſon Charles V. a prince educated in the ſchool of adverſity, and well qualified, by his prudence and experience, to repair the loſſes which the kingdom had ſuſtained from the errors of his predeceſſors. Contrary to the practice of all the great princes of thoſe times, who held nothing in eſtimation but military courage, he ſeems to have laid it down as a maxim, never to appear at the head of his armies; and he was the firſt European monarch that ſhowed the advantage of policy and foreſight over a raſh and precipitate valour.

Before Charles could think of counterbalancing ſo

69
Is defeated, and obliged to ſubmit to the terms preſcribed by Charles V. of France.

great a power as England, it was neceſſary for him to remedy the many diſorders to which his own kingdom was expoſed. He accordingly turned his arms againſt the king of Navarre, the great diſturber of France during that age; and he defeated that prince, and reduced him to terms, by the valour and conduct of Bertrand du Gueſclin, one of the moſt accompliſhed captains of thoſe times, whom Charles had the diſcernment to chooſe as the inſtrument of his victories. He alſo ſettled the affairs of Britanny, by acknowledging the title of Mountfort, and receiving homage for his dominions. But much was yet to be done. On the concluſion of the peace of Bretigni, the many military adventurers who had followed the fortunes of Edward, being diſperſed into the ſeveral provinces, and poſſeſſed of ſtrong holds, refuſed to lay down their arms, or relinquiſh a courſe of life to which they were now accuſtomed, and by which alone they could earn a ſubſiſtence.

70
Account of the banditti called *companies* or *companions.*

They aſſociated themſelves with the banditti, who were already inured to the habits of rapine and violence; and, under the name of *companies* and *companions*, became a terror to all the peaceable inhabitants. Some Engliſh and Gaſcon gentlemen of character were not aſhamed to take the command of theſe ruffians, whoſe number amounted to near 40,000, and who bore the appearance of regular armies rather than bands of robbers. As Charles was not able by power to redreſs ſo enormous a grievance, he was led by neceſſity, as well as by the turn of his character, to correct it by policy; to diſcover ſome method of diſcharging into foreign countries this dangerous and inteſtine evil; and an occaſion now offered.

71
Reign of Pedro the Cruel, king of Caſtile.

Alphonſo XI. king of Caſtile, who took the city of Algezira from the Moors, after a famous ſiege of two years, during which artillery are ſaid firſt to have been uſed by the beſieged, had been ſucceeded by his ſon Pedro I. ſurnamed *the Cruel;* a prince equally perfidious, debauched, and bloody. He began his reign with the murder of his father's miſtreſs, Leonora de Guſman: his nobles fell every day the victims of his ſeverity: he put to death his couſin and one of his natural brothers, from groundleſs jealouſy; and he cauſed his queen Blanche de Bourbon, of the blood of France, to be thrown into priſon, and afterwards poiſoned, that he might enjoy in quiet the embraces of Mary de Padella, with whom he was violently enamoured.

72
The Companies employed againſt him.

Henry count of Traſtamara, the king's natural brother, alarmed at the fate of his family, and dreading his own, took arms againſt the tyrant; but having failed in the attempt, he fled to France, where he found the minds of men much inflamed againſt Pedro, on account of the murder of the French princeſs. He aſked permiſſion of Charles to enliſt the *companies* in his ſervice, and to lead them into Caſtile againſt his brother. The French king, charmed with the project, employed du Gueſclin in negociating with the leaders of theſe banditti. The treaty was ſoon concluded; and du Gueſclin having completed his levies, led the army firſt to Avignon, where the pope then reſided, and demanded, ſword in hand, abſolution for his ruffian ſoldiers, who had been excommunicated, and the ſum of 200,000 livres for their ſubſiſtence. The firſt was readily promiſed him, but ſome difficulty being made with regard to the ſecond, du Gueſclin replied, "My fellows, I believe, may make a ſhift to do without your abſolution, but the money is abſolutely neceſſary." His holineſs then extorted from the inhabitants of the city and its neighbourhood the ſum of 100,000 livres, and offered it to du Gueſclin. "It is not my purpoſe (cried that generous warrior) to oppreſs the innocent people. The pope and his cardinals can ſpare me double the ſum from their own pockets. I therefore inſiſt, that this money be reſtored to the owners; and if I hear they are defrauded of it, I will myſelf return from the other ſide of the Pyrenees, and oblige you to make them reſtitution." The pope found the neceſſity of ſubmitting, and paid from his own treaſury the ſum demanded.

73
He is d out, bu ſiſted b the Bla Prince.

A body of experienced and hardy ſoldiers, conducted by ſo able a general, eaſily prevailed over the king of Caſtile, whoſe ſubjects were ready to join the enemy againſt their oppreſſor. Pedro fled from his dominions, took ſhelter in Guienne, and craved the protection of the prince of Wales, whom his father had inveſted with the ſovereignty of the ceded provinces, under the title of the *principality of Aquitaine.* The prince promiſed his aſſiſtance to the dethroned monarch; and having obtained his father's conſent, he levied an army, and ſet out on his enterpriſe.

74
The Spaniards de feated, a Peter reſtored.

The firſt loſs which Henry of Traſtamara ſuffered from the interpoſition of the prince of Wales, was the recalling of the companies from his ſervice; and ſo much reverence did they pay to the name of Edward, that great numbers of them immediately withdrew from Spain, and enliſted under his ſtandard. Henry, however, beloved by his new ſubjects, and ſupported by the king of Aragon, was able to meet the enemy with an army of 100,000 men, three times the number of thoſe commanded by the Black Prince: yet du Gueſclin, and all his experienced officers, adviſed him to delay a deciſive action; ſo high was their opinion of the valour and conduct of the Engliſh hero! But Henry, truſting to his numbers, ventured to give Edward battle on the banks of the Ebro, between Najara and Navarette; where the French and Spaniards were defeated, with the loſs of above 20,000 men, and du Gueſclin and other officers of diſtinction taken priſoners. All Caſtile ſubmitted to the victor; Pedro was reſtored to the throne, and Edward returned to Guienne with his uſual glory; having not only overcome the greateſt general of his age, but reſtrained the moſt blood-thirſty tyrant from executing vengeance on his priſoners.

75
Is again driven ou defeated, and put to death.

This gallant warrior had ſoon reaſon to repent of his connection with a man like Pedro, loſt to all ſenſe of virtue and honour. The ungrateful monſter refuſed the ſtipulated pay to the Engliſh forces. Edward abandoned him: he treated his ſubjects with the utmoſt barbarity; their animoſity was rouſed againſt him; and du Gueſclin having obtained his ranſom, returned to Caſtile with the count of Traſtamara, and ſome forces levied anew in France. They were joined by the Spaniſh malecontents; and having no longer the Black Prince to encounter, they gained a complete victory over Pedro in the neighbourhood of Toledo. The tyrant now took refuge in a caſtle, where he was ſoon after beſieged by the victors, and taken priſoner in endeavouring to make his eſcape. He was conducted to his brother Henry; againſt whom he is ſaid to have ruſhed in a tranſport of rage, diſarmed as he was. Henry ſlew him with his own

own hand, in reſentment of his cruelties; and, though a baſtard, was placed on the throne of Caſtile, which he tranſmitted to his poſterity.

There is little doubt that the character of Pedro has been greatly miſrepreſented, and that what is conſidered by moſt hiſtorians as tyranny and wanton cruelty, was only an inflexible regard to juſtice, neceſſary perhaps, in thoſe days of anarchy and rebellion. Perhaps that unfortunate monarch owes to the hatred of thoſe he meant to reduce to order, much of the obloquy which has been ſo plentifully beſtowed upon him by hiſtorians, who have painted him to us as a tyrant ſo bloody, ſo wicked, as almoſt to exceed the bounds of probability. In Andaluſia, where he fixed his reſidence and ſeemed moſt to delight, his memory is not held in the ſame abhorrence. The Sevillian writers ſpeak of him very differently; and inſtead of his uſual appellation of *Pedro el cruel*, diſtinguiſh him by that of *el juſticiero*. It is certain that his baſtard-brother and murderer, Henry of Traſtamara, was guilty of crimes fully as atrocious as any of thoſe imputed to Pon Pedro; but as he deſtroyed him, his family and adherents, the friends of the new ſpurious race of monarchs were left at full liberty to blacken the characters of the adverſe party, without the fear of being called to an account for calumny, or even contradicted. Truth is now out of our reach; and for want of proper proofs to the contrary, we muſt ſit down contented with what hiſtory has left us; and allow Don Pedro to have been one of the moſt inhuman butchers that ever diſgraced a throne.

After the death of Pedro the Cruel, nothing remarkable happened in Spain for almoſt a whole century; but the debaucheries of Henry IV. of Caſtile rouſed the reſentment of his nobles, and produced a moſt ſingular inſurrection, which led to the aggrandizement of the Spaniſh monarchy.

Re of He the Im ent. An 50.

This prince, ſurnamed the *Impotent*, though continually ſurrounded with women, began his unhappy reign in 1450. He was totally enervated by his pleaſures; and every thing in his court conſpired to ſet the Caſtilians an example of the moſt abject flattery and moſt abandoned licentiouſneſs. The queen, a daughter of Portugal, lived as openly with her paraſites and her gallants as the king did with his minions and his miſtreſſes. Pleaſure was the only object, and effeminacy the only recommendation to favour: the affairs of the ſtate went every day into diſorder; till the nobility, with the archbiſhop of Toledo at their head, combining againſt the weak and flagitious adminiſtration of Henry, arrogated to themſelves, as one of the privileges of their order, the right of trying and paſſing ſentence on their ſovereign, which they executed in a manner unprecedented in hiſtory.

He or- mall epo- ed.

All the malecontent nobility were ſummoned to meet at Avila: a ſpacious theatre was erected in a plain without the walls of the town: an image, repreſenting the king, was ſeated on a throne, clad in royal robes, with a crown on its head, a ſceptre in its hand, and the ſword of juſtice by its ſide. The accuſation againſt Henry was read, and the ſentence of depoſition pronounced, in preſence of a numerous aſſembly. At the cloſe of the firſt article of the charge, the archbiſhop of Toledo advanced, and tore the crown from the head of the image; at the cloſe of the ſecond, the Conde de Placentia ſnatched the ſword of juſtice from its ſide; at the cloſe of the third, the Conde de Benavente wreſted the ſceptre from his hand; and at the cloſe of the laſt, Don Diego Lopez de Stuniga tumbled it headlong from the throne. At the ſame inſtant, Don Alphonſo, Henry's brother, a boy of about twelve years of age, was proclaimed king of Caſtile and Leon in his ſtead.

This extraordinary proceeding was followed by a civil war, which did not ceaſe till ſome time after the death of the young prince, on whom the nobles had beſtowed the kingdom. The archbiſhop and his party then continued to carry on war in the name of Iſabella the king's ſiſter, to whom they gave the title of *Infanta;* and Henry could not extricate himſelf out of theſe troubles, nor remain quiet upon his throne till he had ſigned one of the moſt humiliating treaties ever extorted from a ſovereign; he acknowledged his ſiſter Iſabella the only lawful heireſs of his kingdom, in prejudice to the rights of his reputed daughter Joan, whom the malecontents affirmed to be the offspring of an adulterous commerce between the queen and Don la Cueva. The grand object of the malecontent party now was the marriage of the princeſs Iſabella, upon which, it was evident, the ſecurity of the crown and the happineſs of the people muſt in a great meaſure depend. The alliance was ſought by ſeveral princes: the king of Portugal offered her his hand; the king of France demanded her for his brother, and the king of Aragon for his ſon Ferdinand. The malecontents very wiſely preferred the Aragonian prince, and Iſabella prudently made the ſame choice: articles were drawn up; and they were privately married by the archbiſhop of Toledo.

78 Is obliged to acknowledge his ſiſter Iſabella to be heireſs to the kingdom.

79 She is married to Ferdinand of Aragon.

Henry was enraged at this alliance, which he foreſaw would utterly ruin his authority, by furniſhing his rebellious ſubjects with the ſupport of a powerful neighbouring prince. He diſinherited his ſiſter, and eſtabliſhed the rights of his daughter. A furious civil war deſolated the kingdom. The names of Joan and Iſabella reſounded from every quarter, and were everywhere the ſummons to arms. But peace was at length brought about. Henry was reconciled to his ſiſter and Ferdinand; though it does not appear that he ever renewed Iſabella's right to the ſucceſſion: for he affirmed in his laſt moments, that he believed Joan to be his own daughter. The queen ſwore to the ſame effect; and Henry left a teſtamentary deed, tranſmitting the crown to this princeſs, who was proclaimed queen of Caſtile at Placentia. But the ſuperior fortune and ſuperior arms of Ferdinand and Iſabella prevailed: the king of Portugal was obliged to abandon his niece and intended bride, after many ineffectual ſtruggles, and ſeveral years of war. Joan retired into a convent; and the death of Ferdinand's father, which happened about this time, added the kingdoms of Aragon and Sicily to thoſe of Leon and Caſtile.

80 Union of the kingdoms of Aragon and Sicily with Leon and Caſtile. An. 1474.

81 Adminiſtration of Ferdinand and Iſabella.

Ferdinand and Iſabella were perſons of great prudence, and, as ſovereigns, highly worthy of imitation: but they do not ſeem to have merited all the praiſes beſtowed upon them by the Spaniſh hiſtorians. They did not live like man and wife, having all things in common under the direction of the huſband; but like two princes in cloſe alliance; they neither loved nor hated each other; were ſeldom in company together; had each a ſeparate council; and were frequently jealous of one another in the adminiſtration. But they were inſeparably united in their common intereſts; always acting upon the ſame principles, and forwarding the ſame ends. Their firſt object was the regulation of their government, which the civil wars had thrown into the greateſt diſorder. Rapine, outrage, and murder, were become ſo common, as not only to interrupt commerce, but in a great meaſure to ſuſpend all intercourſe between one place and another. Theſe evils the joint ſovereigns ſuppreſſed by their wiſe policy, at the ſame time that they extended the royal prerogative.

82
Inſtitution of the Holy Brotherhood,

About the middle of the 13th century, the cities in the kingdom of Aragon, and after their example thoſe in Caſtile, had formed themſelves into an aſſociation, diſtinguiſhed by the name of the *Holy Brotherhood.* They exacted a certain contribution from each of the aſſociated towns; they levied a conſiderable body of troops, in order to protect travellers and purſue criminals; and they appointed judges, who opened courts in various parts of the kingdom. Whoever was guilty of murder, robbery, or any act that violated the public peace, and was ſeized by the troops of the Brotherhood, was carried before their judges; who, without paying any regard to the excluſive juriſdiction which the lord of the place might claim, who was generally the author or abettor of the injuſtice, tried, and condemned the criminals. The nobles often murmured againſt the ſalutary inſtitution; they complained of it as an encroachment on one of their moſt valuable privileges, and endeavoured to get it aboliſhed. But Ferdinand and Iſabella, ſenſible of the beneficial effects of the Brotherhood, not only in regard to the police of their kingdom, but in its tendency to abridge, and by degrees annihilate, the territorial juriſdiction of the nobility, countenanced the inſtitution upon every occaſion, and ſupported it with the whole force of royal authority; by which means the prompt and impartial adminiſtration of juſtice was reſtored, and with it tranquillity and order returned.

83
and of the Inquiſition.

But at the ſame time that their Catholic majeſties (for ſuch was the title they now bore) were giving vigour to their civil government, and ſecuring their ſubjects from violence and oppreſſion, an intemperate zeal led them to eſtabliſh an eccleſiaſtical tribunal, equally contrary to the natural rights of humanity and the mild ſpirit of the goſpel. This was the court of inquiſition; which decides upon the honour, fortune, and even the life, of the unhappy wretch who happens to fall under the ſuſpicion of hereſy, or a contempt of any thing preſcribed by the church, without his knowing, being confronted with his accuſers, or permitted either defence or appeal. Six thouſand perſons were burnt by order of this ſanguinary tribunal within four years after the appointment of Torquemada, the firſt inquiſitor-general; and upwards of 100,000 felt its fury. The ſame furious and blinded zeal which led to the depopulation of Spain, led alſo to its aggrandizement.

84
Conqueſt of Granada.
An. 1492.

The kingdom of Granada now alone remained of all the Mahometan poſſeſſions in Spain. Princes equally zealous and ambitious were naturally diſpoſed to turn their eyes to that fertile territory, and to think of increaſing their hereditary dominions, by expelling the enemies of Chriſtianity, and extending its doctrines. Every thing conſpired to favour their project: the Mooriſh kingdom was a prey to civil wars; when Ferdinand, having obtained the bull of Sixtus IV. authorizing a cruſade, put himſelf at the head of his troops, and entered Granada. He continued the war with rapid ſucceſs: Iſabella attended him in ſeveral expeditions; and they were both in great danger at the ſiege of Malaga; an important city, which was defended with great courage, and taken in 1487. Baza was reduced in 1489, after the loſs of 20,000 men. Gaudix and Almeria were delivered up to them by the Mooriſh king Alzagel, who had firſt dethroned his brother Alboacen, and afterwards been chaſed from his capital by his nephew Abdali. That prince engaged in the ſervice of Ferdinand and Iſabella; who, after reducing every other place of eminence, undertook the ſiege of Granada. Abdali made a gallant defence; but all communication with the country being cut off, and all hopes of relief at an end, he capitulated, after a ſiege of eight months, on condition that he ſhould enjoy the revenue of certain places in the fertile mountains of Alpuxarras; that the inhabitants ſhould retain the undiſturbed poſſeſſion of their houſes, goods, and inheritances; the uſe of their laws, and the free exerciſe of their religion (B). Thus ended the empire of the Arabs in Spain, after it had continued about 800 years. They introduced the arts and ſciences into Europe at a time when it was loſt in darkneſs; they poſſeſſed many of the luxuries of life, when they were not even known among the neighbouring nations; and they ſeem to have given birth to that romantic gallantry which ſo eminently prevailed in the ages of chivalry, and which, blending itſelf with the veneration of the northern nations for the ſofter ſex, ſtill particularly diſtinguiſhes ancient from modern manners. But the Moors, notwithſtanding theſe advantages, and the eulogies beſtowed upon them by ſome writers, appear always to have been deſtitute of the eſſential qualities of a poliſhed people, humanity, generoſity, and mutual ſympathy.

The overthrow of the laſt Mooriſh kingdom was ſoon followed by the expulſion of the Saracens from Spain. This expulſion did not entirely take place till the 17th century. Vaſt numbers of the Moors, indeed, oppreſſed by their conquerors, abandoned a country where they could not reſide with comfort and with freedom. From the reign of Ferdinand of Caſtile, to that of Philip III. of Spain, more than 3,000,000 of thoſe people quitted Spain, and carried with them, not only a great part of their acquired wealth, but that induſtry and love of labour which are the foundation of national proſperity.

85
Proſpero ſtate of Spain under the Mooriſh minion.

The ſtate of Spain has never been ſo flouriſhing at any period of its civilization, as during the period when it was chiefly poſſeſſed by the Moors. The firſt Saracen invaders, and the twenty ſucceſſive lieutenants of the caliphs of Damaſcus, were attended by a numerous train of civil and military followers, who preferred a diſtant

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(B) The particulars of the conqueſt of Granada are involved in much obſcurity. If we were to credit the narrative of Giles Perez, as related by Mr Swinburne, the circumſtances which led to that conqueſt were of a moſt romantic nature. See Swinburne's Travels, Letter xxi.

diſtant fortune to narrow circumſtances at home; the private and public intereſt was promoted by the eſtabliſhment of faithful colonies, and the cities of Spain were proud to commemorate the tribe or the country of their eaſtern progenitors. Ten years after the conqueſt, a map of the province was preſented to the caliph, ſhewing the ſeas, the rivers, and the harbours, the inhabitants and cities, the climate, the ſoil, and the mineral productions of the earth. In the ſpace of two centuries the gifts of nature were improved by agriculture, the manufactures, and the commerce of an induſtrious people; though the effects of their diligence have been magnified by the idleneſs of their fancy. The firſt of the Ommiades who reigned in Spain ſolicited the ſupport of the Chriſtians; and in his edict of peace and protection, he contents himſelf with a modeſt impoſition of 10,000 ounces of gold, 10,000 pounds of ſilver, 10,000 horſes, as many mules, 1000 cuiraſſes, with an equal number of helmets and lances. The moſt powerful of his ſucceſſors derived from the ſame kingdom the annual tribute of 12,045,000 dinars or pieces of gold, about 6,000,000l. of ſterling money; a ſum which, in the 10th century, moſt probably ſurpaſſed the united revenues of the Chriſtian monarchs. His royal ſeat of Cordova contained 600 moſques, 900 baths, and 200,000 houſes; he gave laws to 80 cities of the firſt, to 300 of the ſecond and third order; and the fertile banks of the Guadalquiver were adorned with 12,000 villages and hamlets. The Arabs might exaggerate the truth; but they created and they deſcribe the moſt proſperous era of the riches, the cultivation, and the populouſneſs of Spain (c).

86
J..s expel-
le. from
S..n.

The conqueſt of Granada was followed by the expulſion, or rather the pillage and baniſhment, of the Jews, who had engroſſed all the wealth and commerce of Spain. The inquiſition exhauſted its rage againſt theſe unhappy people, many of whom pretended to embrace Chriſtianity, in order to preſerve their property. About the ſame time their Catholic majeſties concluded an alliance with the emperor Maximilian, and a treaty of marriage for their daughter Joan with his ſon Philip, archduke of Auſtria and ſovereign of the Netherlands. About this time alſo the contract was concluded with Chriſtopher Columbus for the diſcovery of new countries; and the counties of Rouſſillon and Cerdagne were agreed to be reſtored by Charles VIII. of France, before his expedition into Italy. The diſcovery of America was ſoon followed by extenſive conqueſts in that quarter, as is related under the articles MEXICO, PERU, CHILI, &c. which tended to raiſe the Spaniſh monarchy above any other in Europe.

87
Diſcovery
of America,
&c.

88
Acceſſion of
Charles V.
An. 1516.

On the death of Iſabella, which happened in 1506, Philip archduke of Auſtria came to Caſtile in order to take poſſeſſion of that kingdom as heir to his mother-in-law; but he dying in a ſhort time after, his ſon Charles V. afterwards emperor of Germany, became heir to the crown of Spain. His father at his death left the king of France governor to the young prince, and Ferdinand at his death left Cardinal Ximenes ſole regent of Caſtile, till the arrival of his grandſon. This man, whoſe character is no leſs ſingular than illuſtrious, who united the abilities of a great ſtateſman with the abject devotion of a ſuperſtitious monk, and the magnificence of a prime miniſter with the ſeverity of a mendicant, maintained order and tranquillity in Spain, notwithſtanding the diſcontents of a turbulent and high-ſpirited nobility. When they diſputed his right to the regency, he coolly ſhewed them the teſtament of Ferdinand, and the ratification of that deed by Charles; but theſe not ſatisfying them, and argument proving ineffectual, he led them inſenſibly towards a balcony, whence they had a view of a large body of troops under arms, and

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(c) Abdoulrahman III. monarch of Cordova, ſurpaſſed all his predeceſſors in ſplendour, riches, and expence; and his ſubjects vied with each other in profuſion and magnificence. Some idea may be entertained of the opulence and grandeur of the Moors of Cordova in the 10th century, by peruſing the following enumeration of the preſents made to Abdoulrahman by Abumelik his grand vizier, on his appointment to that office. We are told that the miniſter cauſed to be brought before the throne, and laid at the feet of his maſter,

400 lbs. of virgin gold.
Ingots of ſilver to the value of 420,000 ſequins.
400 lbs. of lignum aloes, one piece weighing 140 lbs.
500 oz. of ambergris.
300 oz. of camphor.
30 pieces of gold tiſſue, ſo rich that none but the caliph could wear it.
10 ſuits of Khoraſſan ſables.
100 ſuits of fur of a leſs valuable ſort.
48 ſets of gold and ſilk long trappings for horſes.
4000 lbs. of ſilk.
30 Perſian carpets.
800 iron coats-of-mail for war horſes.
1000 ſhields.
100,000 arrows.
15 led horſes of Arabia, as richly capariſoned as thoſe on which the caliph was wont to ride.
100 horſes of an inferior price.
20 mules with all their accoutrements.
40 young men, and 20 girls of exquiſite beauty, and moſt ſumptuouſly apparelled. This diſplay of riches was accompanied with a moſt flattering poem, compoſed by the miniſter in praiſe of his ſovereign, who in return for his homage, aſſigned him a penſion of 100,000 pieces of gold, about 50,000l. ſterling.

and a formidable train of artillery. “ Behold (ſaid the cardinal) the powers which I have received from his Catholic majeſty: by theſe I govern Caſtile; and will govern it, till the king, your maſter and mine, ſhall come to take poſſeſſion of his kingdom.” A declaration ſo bold and determined ſilenced all oppoſition; and Ximenes maintained his authority till the arrival of Charles in 1517.

89
Diſgrace and death of Cardinal Ximenes.

The young king was received with univerſal acclamations of joy; but Ximenes found little cauſe to rejoice. He was ſeized with a violent diſorder, ſuppoſed to be the effect of poiſon; and when he recovered, Charles, prejudiced againſt him by the Spaniſh grandees and his Flemiſh courtiers, ſlighted his advice, and allowed him every day to ſink into neglect. The cardinal did not bear this treatment with his uſual fortitude of ſpirit. He expected a more grateful return from a prince to whom he delivered a kingdom more flouriſhing than it had been in any former age, and authority more extenſive and better eſtabliſhed than the moſt illuſtrious of his anceſtors had ever poſſeſſed. Conſcious of his own integrity and merit, he could not therefore refrain from giving vent, at times, to indignation and complaint. He lamented the fate of his country, and foretold the calamities to which it would be expoſed from the inſolence, the rapaciouſneſs, and the ignorance of ſtrangers. But in the mean time he received a letter from the king, diſmiſſing him from his councils, under pretence of eaſing his age of that burden which he had ſo long and ſo ably ſuſtained. This letter proved fatal to the miniſter; for he expired in a few hours after reading it.

90
Maximilian attempts to get Charles elected emperor.

While Charles was taking poſſeſſion of the throne of Spain, in conſequence of the death of one grandfather, another was endeavouring to obtain for him the imperial crown. With this view Maximilian aſſembled a diet at Augſburg, where he cultivated the favour of the electors by many acts of beneficence, in order to engage them to chooſe that young prince as his ſucceſſor. But Maximilian himſelf never having been crowned by the pope, a ceremony deemed eſſential in that age, as well as in the preceding, he was conſidered only as king of the Romans, or emperor elect; and no example occurring in hiſtory of any perſon being choſen ſucceſſor to a king of the Romans, the Germans, always tenacious of their forms, obſtinately refuſed to confer upon Charles a dignity for which their conſtitution knew no name.

But though Maximilian could not prevail upon the German electors to chooſe his grandſon of Spain king of the Romans, he had diſpoſed their minds in favour of that prince; and other circumſtances, on the death of the emperor, conſpired to the exaltation of Charles. The imperial crown had ſo long continued in the Auſtrian line, that it began to be conſidered as hereditary in that family; and Germany, torn by religious diſputes, ſtood in need of a powerful emperor, not only to preſerve its own internal tranquillity, but alſo to protect it againſt the victorious arms of the Turks, who under Selim I. threatened the liberties of Europe. This fierce and rapid conqueror had already ſubdued the Mamelukes, and made himſelf maſter of Egypt and Syria. The power of Charles appeared neceſſary to oppoſe that of Selim. The extenſive dominions of the houſe of Auſtria, which gave him an intereſt in the preſervation of Germany; the rich ſovereignty of the Netherlands and Franche Compté; the entire poſſeſſion of the great and warlike kingdom of Spain, together with that of Naples and Sicily, all united to hold him up to the firſt dignity among Chriſtian princes; and the new world ſeemed only to be called into exiſtence that its treaſures might enable him to defend Chriſtendom againſt the infidels. Such was the language of his partiſans.

91
Francis I. aſpires to the ſame dignity.

Francis I. however, no ſooner received intelligence of the death of Maximilian, than he declared himſelf a candidate for the empire; and with no leſs confidence of ſucceſs than Charles. He truſted to his ſuperior years and experience; his great reputation in arms; and it was farther urged in his favour, that the impetuoſity of the French cavalry, added to the firmneſs of the German infantry, would prove irreſiſtible, and not only be ſufficient, under a warlike emperor, to ſet limits to the ambition of Selim, but to break entirely the Ottoman power, and prevent it from ever becoming dangerous again to Germany.

Both claims were plauſible. The dominions of Francis were leſs extenſive, but more united than thoſe of Charles. His ſubjects were numerous, active, brave, lovers of glory, and lovers of their king. Theſe were ſtrong arguments in favour of his power, ſo neceſſary at this juncture: but he had no natural intereſt in the Germanic body; and the electors, hearing ſo much of military force on each ſide, became more alarmed for their own privileges than the common ſafety. They determined to reject both candidates, and offered the imperial crown to Frederic, ſurnamed the *Wiſe*, duke of Saxony. But he, undazzled by the ſplendour of an object courted with ſo much eagerneſs, by two mighty monarchs, rejected it with a magnanimity no leſs ſingular than great.

92
Speech of Frederic duke of Saxony in favour of Charles.

“ In times of tranquillity (ſaid Frederic), we wiſh for an emperor who has no power to invade our liberties; times of danger demand one who is able to ſecure our ſafety. The Turkiſh armies, led by a warlike and victorious monarch, are now aſſembling: they are ready to pour in upon Germany with a violence unknown in former ages. New conjunctures call for new expedients. The imperial ſceptre muſt be committed to ſome hand more powerful than mine or that of any other German prince. We poſſeſs neither dominions, nor revenues, nor authority, which enable us to encounter ſuch a formidable enemy. Recourſe muſt be had, in this exigency, to one of the rival monarchs. Each of them can bring into the field forces ſufficient for our defence. But as the king of Spain is of German extraction, as he is a member and prince of the empire by the territories which deſcend to him from his grandfather, and as his dominions ſtretch along that frontier which lies moſt expoſed to the enemy, his claim, in my opinion, is preferable to that of a ſtranger to our language, to our blood, and to our country.” Charles was elected in conſequence of this ſpeech in the year 1520.

93
He is elected in conſequence of this ſpeech. An. 1520.

The two candidates had hitherto conducted their rivalſhip with emulation, but without enmity. They had even mingled in their competition many expreſſions of friendſhip and regard. Francis in particular declared with his uſual vivacity, that his brother Charles and he were fairly and openly ſuitors to the ſame miſtreſs: “ The moſt aſſiduous and fortunate (added he) will win her; and the other muſt reſt contented.” But the preference was no ſooner given to his rival, than Francis

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diſcovered all the paſſions natural to diſappointed ambition. He could not ſuppreſs his chagrin and indignation at being baulked in his favourite purſuit, and rejected, in the face of all Europe, for a youth yet unknown to fame. The ſpirit of Charles reſented ſuch contempt; and from this jealouſy, as much as from oppoſition of intereſts, aroſe that emulation between thoſe two great monarchs which involved them in almoſt perpetual hoſtilities, and kept their whole age in conſtant agitation.

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Charles and Francis had many interfering claims in Italy; and the latter thought himſelf bound in honour to reſtore the king of Navarre to his dominions, unjuſtly ſeized by the crown of Spain. They immediately began to negociate; and as Henry VIII. of England was the third prince of the age in power and in dignity, his friendſhip was eagerly courted by each of the rivals. He was the natural guardian of the liberties of Europe. Senſible of the conſequence which his ſituation gave him, and proud of his pre-eminence, Henry knew it to be his intereſt to keep the balance even between the contending powers, and to reſtrain both, by not joining entirely with either; but he was ſeldom able to reduce his ideas to practice. Vanity and reſentment were the great ſprings of all his undertakings; and his neighbours by touching theſe, found an eaſy way to draw him into their meaſures, and force him upon many raſh and inconſiderate enterpriſes.

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All the impolitic ſteps in Henry's government muſt not, however, be imputed to himſelf; many of them were occaſioned by the ambition and avarice of his prime miniſter and favourite Cardinal Wolſey. This man, who, by his talents and accompliſhments, had riſen from one of the loweſt conditions in life to the higheſt employments both in church and ſtate, enjoyed a greater degree of power and dignity than any Engliſh ſubject ever poſſeſſed, and governed the haughty, preſumptuous, and untractable ſpirit of Henry, with abſolute authority. Francis was equally well acquainted with the character of Henry and of his miniſter. He had ſucceſsfully flattered Wolſey's pride, by honouring him with particular marks of his confidence, and beſtowing upon him the appellations of *Father*, *Tutor*, and *Governor;* and he had obtained the reſtitution of Tournay, by adding a penſion to thoſe reſpectful titles. He now ſolicited an interview with the king of England near Calais; in hopes of being able, by familiar converſation, to attach him to his friendſhip and intereſt. while he gratified the cardinal's vanity, by affording him an opportunity of diſplaying his magnificence in the preſence of two courts, and of diſcovering to the two nations his influence over their monarchs. Charles dreaded the effects of this projected interview between two gallant princes, whoſe hearts were no leſs ſuſceptible of friendſhip than their manners were of inſpiring it. Finding it impoſſible, however, to prevent a viſit, in which the vanity of all parties was ſo much concerned, he endeavoured to defeat its purpoſe, and to pre-occupy the favour of the Engliſh monarch, and of his miniſter, by an act of complaiſance ſtill more flattering and more uncommon. Relying wholly upon Henry's generoſity for his ſafety, he landed at Dover, in his way from Spain to the Low Countries. The king of England, who was on his way to France, charmed with ſuch an inſtance of confidence, haſtened to receive his royal gueſt; and Charles, during his ſhort ſtay, had the addreſs not only to give Henry favourable impreſſions of his character and intentions, but to detach Wolſey entirely from the intereſt of Francis. The tiara had attracted the eye of that ambitious prelate; and as the emperor knew that the papacy was the ſole point of elevation, beyond his preſent greatneſs, at which he could aſpire, he made him an offer of his intereſt on the firſt vacancy.

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Henry viſits
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The day of Charles's departure, Henry went over to Calais with his whole court, in order to meet Francis. Their interview was in an open plain between Guiſnes and Ardres; where the two kings and their attendants diſplayed their magnificence with ſuch emulation and profuſe expence, as procured it the name of the *Field of the Cloth of Gold*. Here Henry erected a ſpacious houſe of wood and canvas, framed in London, on which, under the figure of an Engliſh archer, was the following motto, "He prevails whom I favour;" alluding to his own political ſituation, as holding in his hands the balance of power among the potentates of Europe. Feats of chivalry, however, parties of gallantry, and ſuch exerciſes as were in that age reckoned manly or elegant, rather than ſerious buſineſs, occupied the two courts during the time that they continued together, which was 18 days.

After taking leave of this ſcene of diſſipation, the king of England paid a viſit to the emperor and Margaret of Savoy at Gravelines, and engaged them to go along with him to Calais; where the artful and politic Charles completed the impreſſion which he had begun to make on Henry and his favourite, and effaced all the friendſhip to which the frank and generous nature of Francis had given birth. He renewed his aſſurances of aſſiſting Wolſey in obtaining the papacy; and he put him in preſent poſſeſſion of the revenues belonging to the ſees of Badajoz and Palencia in Spain. He flattered Henry's pride, by convincing him of his own importance, and of the juſtneſs of the motto which he had choſen; offering to ſubmit to his ſole arbitration any difference that might ariſe between him and Francis.

99
Charles inveſted with
the imperial crown
at Aix-la-Chapelle.

This important point being ſecured, Charles repaired to Aix-la-Chapelle, where he was ſolemnly inveſted with the crown and ſceptre of Charlemagne, in preſence of a more ſplendid and numerous aſſembly than had appeared on any former inauguration. About the ſame time Solyman the Magnificent, one of the moſt accompliſhed, enterpriſing, and victorious of the Turkiſh princes, and a conſtant and formidable rival to the emperor, aſcended the Ottoman throne.

The firſt act of Charles's adminiſtration was to appoint a diet of the empire, to be held at Worms, in order to concert with the princes proper meaſures for checking the progreſs of "thoſe new and dangerous opinions which threatened to diſturb the peace of Germany, and to overturn the religion of their anceſtors." The opinions propagated by Luther and his followers were here meant. But all his efforts for that purpoſe were inſufficient, as is related under the articles LUTHER and REFORMATION.

100
War between
Francis and
Charles.
An. 1521.

In 1521, the Spaniards, diſſatisfied with the departure of their ſovereign, whoſe election to the empire they foreſaw would interfere with the adminiſtration of his own kingdom, and incenſed at the avarice of the Flemings, to whom the direction of public affairs had been committed ſince the death of Cardinal Ximenes, ſeveral grandees, in order to ſhake off this oppreſſion, entered into an aſſociation, to which they gave the name of the *Sancta Juncta;* and the ſword was appealed to as the means of redreſs. This ſeemed to Francis a favourable juncture for reinſtating the family of John d'Albert in the kingdom of Navarre. Charles was at a diſtance from that part of his dominions, and the troops uſually ſtationed there had been called away to quell the commotions in Spain. A French army, under Andrew de Foix, ſpeedily conquered Navarre; but that young and inexperienced nobleman, puſhed on by military ardour, ventured to enter Caſtile. The Spaniards, though divided among themſelves, united againſt a foreign enemy, routed his forces, took him priſoner, and recovered Navarre in a ſhorter time than he had ſpent in ſubduing it.

Hoſtilities thus begun in one quarter, between the rival monarchs, ſoon ſpread to another. The king of France encouraged the duke of Bouillon to make war againſt the emperor, and to invade Luxembourg. Charles, after humbling the duke, attempted to enter France; but was repelled and worſted before Mezieres by the famous Chevalier Bayard, diſtinguiſhed among his cotemporaries by the appellation of *The Knight without fear and without reproach;* and who united the talents of a great general to the punctilious honour and romantic gallantry of the heroes of chivalry. Francis broke into the Low Countries, where, by an exceſs of caution, an error not natural to him, he loſt an opportunity of cutting off the whole imperial army; and, what was of ſtill more conſequence, he diſguſted the conſtable Bourbon, by giving the command of the van to the duke of Alençon.

During theſe operations in the field, an unſucceſsful congreſs was held at Calais, under the mediation of Henry VIII. It ſerved only to exaſperate the parties which it was intended to reconcile. A league was ſoon after concluded, by the intrigues of Wolſey, between the pope, Henry, and Charles, againſt France. Leo had already entered into a ſeparate league with the emperor, and the French were faſt loſing ground in Italy.

101 Rapid conqueſts of Charles.

The inſolence and exactions of Mareſhal de Lautrec, governor of Milan, had totally alienated the affections of the Milaneſe from France. They reſolved to expel the troops of that nation, and put themſelves under the government of Francis Sforza, brother to Maximilian their late duke. In this reſolution, they were encouraged by the pope, who excommunicated Lautrec, and took into his pay a conſiderable body of Swiſs. The papal army, commanded by Proſper Colonna, an experienced general, was joined by ſupplies from Germany and Naples; while Lautrec, neglected by his court, and deſerted by the Swiſs in its pay, was unable to make head againſt the enemy. The city of Milan was betrayed by the inhabitants to the confederates; Parma and Placentia were united to the eccleſiaſtical ſtate; and of their conqueſts in Lombardy, only the town of Cremona, the caſtle of Milan, and a few inconſiderable forts, remained in the hands of the French.

Leo X. received the accounts of this rapid ſucceſs with ſuch tranſports of joy, as are ſaid to have brought on a fever, which occaſioned his death. The ſpirit of the confederacy was broken, and its operations ſuſpended by this accident. The Swiſs were recalled; ſome other mercenaries diſbanded for want of pay; and only the Spaniards, and a few Germans in the emperor's ſervice, remained to defend the duchy of Milan. But Lautrec, who with the remnant of his army had taken ſhelter in the Venetian territories, deſtitute both of men and money, was unable to improve this favourable opportunity as he wiſhed. All his efforts were rendered ineffectual by the vigilance and ability of Colonna and his aſſociates.

Meantime much diſcord prevailed in the conclave. Wolſey's name, notwithſtanding all the emperor's magnificent promiſes, was ſcarcely mentioned there. Julio de Medici, Leo's nephew, thought himſelf ſure of the election; when, by an unexpected turn of fortune, Cardinal Adrian of Utrecht, Charles's preceptor, who at that time governed Spain in the emperor's name, was unanimouſly raiſed to the papacy, to the aſtoniſhment of all Europe and the great diſguſt of the Italians.

102 Francis invades Italy.

Francis, rouſed by the riſing conſequence of his rival, reſolved to exert himſelf with freſh vigour, in order to wreſt from him his late conqueſts in Lombardy. Lautrec received a ſupply of money, and a reinforcement of 10,000 Swiſs. With this reinforcement he was enabled once more to act offenſively, and even to advance within a few miles of the city of Milan; when money again failing him, and the Swiſs growing mutinous, he was obliged to attack the imperialiſts in their camp at Bicocca, where he was repulſed with great ſlaughter, having loſt his braveſt officers and beſt troops. Such of the Swiſs as ſurvived ſet out immediately for their own country; and Lautrec, deſpairing of being able to keep the field, retired into France. Genoa, which ſtill remained ſubject to Francis, and made it eaſy to execute any ſcheme for the recovery of Milan, was ſoon after taken by Colonna: the authority of the emperor and his faction was everywhere eſtabliſhed in Italy. The citadel of Cremona was the ſole fortreſs which remained in the hands of the French.

The affliction of Francis for ſuch a ſucceſſion of miſfortunes was augmented by the unexpected arrival of an Engliſh herald, who in the name of his ſovereign declared war againſt France. The courage of this excellent prince, however, did not forſake him; though his treaſury was exhauſted by expenſive pleaſures, no leſs than by hoſtile enterpriſes, he aſſembled a conſiderable army, and put his kingdom in a poſture of defence for reſiſting this new enemy, without abandoning any of the ſchemes which he was forming againſt the emperor. He was ſurpriſed, but not alarmed, at ſuch a denunciation.

103 Charles viſits England a ſecond time.

Meanwhile Charles, willing to draw as much advantage as poſſible from ſo powerful an ally, paid a ſecond viſit to the court of England in his way to Spain, where his preſence was become neceſſary. His ſucceſs exceeded his moſt ſanguine expectations. He not only gained the entire friendſhip of Henry, who publicly ratified the treaty of Bruges; but diſarmed the reſentment of Wolſey, by aſſuring him of the papacy on Adrian's death; an event ſeemingly not diſtant, by reaſon of his age and infirmities. In conſequence of theſe negociations an Engliſh army invaded France, under the command of the earl of Surrey; who, at the end of the campaign, was obliged to retire, with his forces greatly reduced,

reduced, without being able to make himſelf maſter of one place within the French frontier. Charles was more fortunate in Spain: he ſoon quelled the tumults which had there ariſen in his abſence.

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While the Chriſtian princes were thus waſting each other's ſtrength, Solyman the Magnificent entered Hungary, and made himſelf maſter of Belgrade, reckoned the chief barrier of that kingdom againſt the Turkiſh power. Encouraged by this ſucceſs, he turned his victorious arms againſt the iſland of Rhodes, at that time the ſeat of the knights of St John of Jeruſalem; and though every prince in that age acknowledged Rhodes to be the great bulwark of Chriſtendom in the eaſt, ſo violent was their animoſity againſt each other, that they ſuffered Solyman without diſturbance to carry on his operations againſt that city and iſland. Liſle Adam, the grandmaſter, made a gallant defence; but, after incredible efforts of courage, patience, and military conduct, during a ſiege of ſix months, he was obliged to ſurrender the place, having obtained an honourable capitulation from the ſultan, who admired and reſpected his heroic qualities (ſee RHODES and MALTA). Charles and Francis were equally aſhamed of having occaſioned ſuch a loſs to Chriſtendom by their conteſts; and the emperor, by way of reparation, granted to the knights of St John the ſmall iſland of Malta, where they fixed their reſidence, and continued long to retain their ancient ſpirit, though much diminiſhed in power and ſplendour.

Adrian VI. though the creature of the emperor, and devoted to his intereſt, endeavoured to aſſume the impartiality which became the common father of Chriſtendom, and laboured to reconcile the contending princes, that they might unite in a league againſt Solyman, whoſe conqueſt of Rhodes rendered him more formidable than ever to Europe. The Italian ſtates were no leſs deſirous of peace than the pope: and ſo much regard was paid by the hoſtile powers to the exhortations of his holineſs, and to a bull which he iſſued, requiring all Chriſtian princes to conſent to a truce for three years, that the imperial, the French, and the Engliſh ambaſſadors at Rome, were empowered to treat of that matter; but while they waſted their time in fruitleſs negociations, their maſters were continuing their preparations for war; and other negociations ſoon took place. The confederacy againſt France became more formidable than ever.

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The Venetians, who had hitherto adhered to the French intereſt, formed engagements with the emperor for ſecuring Francis Sforza in the poſſeſſion of the duchy of Milan; and the pope, from a perſuaſion that the ambition of the French monarch was the only obſtacle to peace, acceded to the ſame alliance. The Florentines, the dukes of Ferrara and Mantua, and all the Italian powers, followed this example. Francis was left without a ſingle ally, to reſiſt the efforts of a multitude of enemies, whoſe armies every where threatened, and whoſe territories encompaſſed his dominions. The emperor in perſon menaced France with an invaſion on the ſide of Guienne; the forces of England and the Netherlands hovered over Picardy, and a numerous body of Germans was preparing to ravage Burgundy.

The dread of ſo many and ſuch powerful adverſaries, it was thought, would have obliged Francis to keep wholly on the defenſive, or at leaſt have prevented him from entertaining any thoughts of marching into Italy. But before his enemies were able to ſtrike a blow, Francis had aſſembled a great army, with which he hoped to diſconcert all the emperor's ſchemes, by marching it in perſon into Italy: and this bold meaſure, the more formidable becauſe unexpected, could ſcarcely have failed of the deſired effect, had it been immediately carried into execution. But the diſcovery of a domeſtic conſpiracy, which threatened the deſtruction of his kingdom, obliged Francis to ſtop ſhort at Lyons.

106
Francis marches towards Italy, but is obliged to return by a domeſtic conſpiracy.

Charles duke of Bourbon, lord high conſtable of France, was a prince of the moſt ſhining merit: his great talents equally fitted him for the council or the field, while his eminent ſervices to the crown entitled him to its firſt favour. But unhappily Louiſa ducheſs of Angouleme, the king's mother, had contracted a violent averſion againſt the houſe of Bourbon, and had taught her ſon, over whom ſhe had acquired an abſolute aſcendant, to view all the conſtable's actions with a jealous eye. After repeated affronts he retired from court, and began to liſten to the advances of the emperor's miniſters. Meantime the ducheſs of Bourbon died; and as the conſtable was no leſs amiable than accompliſhed, the ducheſs of Angouleme, ſtill ſuſceptible of the tender paſſions, formed the ſcheme of marrying him. But Bourbon, who might have expected every thing to which an ambitious mind can aſpire, from the doating fondneſs of a woman who governed her ſon and the kingdom, incapable of imitating Louiſa in her ſudden tranſition from hate to love, or of meanly counterfeiting a paſſion for one who had ſo long purſued him with unprovoked malice, rejected the match with diſdain, and turned the propoſal into ridicule. At once deſpiſed and inſulted by the man whom love only could have made her ceaſe to perſecute, Louiſa was filled with all the rage of diſappointed woman; ſhe reſolved to ruin, ſince ſhe could not marry Bourbon. For this purpoſe ſhe commenced an iniquitous ſuit againſt him; and by the chicanery of Chancellor du Prat, the conſtable was ſtripped of his whole family-eſtate. Driven to deſpair by ſo many injuries, he entered into a ſecret correſpondence with the emperor and the king of England; and he propoſed, as ſoon as Francis ſhould have croſſed the Alps, to raiſe an inſurrection among his numerous vaſſals, and introduce foreign enemies into the heart of France.

Happily Francis got intimation of this conſpiracy before he left the kingdom; but not being ſufficiently convinced of the conſtable's guilt, he ſuffered ſo dangerous a foe to eſcape; and Bourbon entering into the emperor's ſervice, employed all the force of his enterpriſing genius, and his great talents for war, to the prejudice of his prince and his native country.

107
A French army enters Italy.

In conſequence of the diſcovery of this plot, and the eſcape of the powerful conſpirator, Francis relinquiſhed his intention of leading his army in perſon into Italy. He was ignorant how far the infection had ſpread among his ſubjects, and afraid that his abſence might encourage them to make ſome deſperate attempt in favour of a man ſo much beloved. He did not, however, abandon his deſign on the Milaneſe, but ſent forward an army of 30,000 men, under the command of Admiral Bonnivet. Colonna, who was entruſted with the defence of that duchy, was in no condition to reſiſt ſuch a force; and the city of Milan, on which the whole territory depends,

pends, muſt have fallen into the hands of the French, had not Bonnivet, who poſſeſſed none of the talents of a general, waſted his time in frivolous enterpriſes, till the inhabitants recovered from their conſternation. The imperial army was reinforced. Colonna died; and Lannoy, viceroy of Naples, ſucceeded him in the command: but the chief direction of military operations was committed to Bourbon and the marquis de Peſcara, the greateſt generals of their age. Bonnivet, deſtitute of troops to oppoſe this new army, and ſtill more of the talents which could render him a match for its leaders, after various movements and encounters, was reduced to the neceſſity of attempting a retreat into France. He was followed by the imperial generals, and routed at Biagraſſa, where the famous Chevalier Bayard was killed.

108
Defeated at Biagraſſa.

The emperor and his allies were leſs ſucceſsful in their attempts upon France. They were baffled in every quarter: and Francis, though ſtripped of his Italian dominions, might ſtill have enjoyed in ſafety the glory of having defended his native kingdom againſt one half of Europe, and have bid defiance to all his enemies; but underſtanding that the king of England, diſcouraged by his former fruitleſs enterpriſes, and diſguſted with the emperor, was making no preparations for any attempt on Picardy, his ancient ardour ſeized him for the conqueſt of Milan, and he determined, notwithſtanding the advanced ſeaſon, to march into Italy.

109
Francis determines to enter Italy in perſon.

The French army no ſooner appeared in Piedmont, than the whole Milaneſe was thrown into conſternation. The capital opened its gates. The forces of the emperor and Sforza retired to Lodi: and had Francis been ſo fortunate as to purſue them, they muſt have abandoned that poſt, and been totally diſperſed; but his evil genius led him to beſiege Pavia, a town of conſiderable ſtrength, well garriſoned, and defended by Antonio de Leyva, one of the braveſt officers in the Spaniſh ſervice; before which place he was defeated and taken priſoner on the twenty-fourth day of February 1524.

110
Is defeated and taken priſoner at Pavia.
An. 1524.

The captivity of Francis filled all Europe with alarm. Almoſt the whole French army was cut off; Milan was immediately abandoned; and in a few weeks not a Frenchman was left in Italy. The power of the emperor, and ſtill more his ambition, became an object of univerſal terror; and reſolutions were everywhere taken to ſet bounds to it. Meanwhile Francis, deeply impreſſed with a ſenſe of his misfortune, wrote to his mother Louiſa, whom he had left regent of the kingdom, the following ſhort but expreſſive letter: "All, Madam, is loſt but honour." The ſame courier that carried this letter, carried alſo diſpatches to Charles; who received the news of the ſignal and unexpected ſucceſs which had crowned his arms with the moſt hypocritical moderation. He would not ſuffer any public rejoicings to be made on account of it; and ſaid, he only valued it, as it would prove the occaſion of reſtoring peace to Chriſtendom. Louiſa, however, did not truſt to thoſe appearances; if ſhe could not preſerve what was yet left, ſhe determined at leaſt that nothing ſhould be loſt through her negligence or weakneſs. Inſtead of giving herſelf up to ſuch lamentations as were natural to a woman ſo remarkable for maternal tenderneſs, ſhe diſcovered all the foreſight, and exerted all the activity, of a conſummate politician. She took every poſſible meaſure for putting the kingdom in a poſture of defence, while ſhe employed all her addreſs to appeaſe the reſentment and to gain the friendſhip of England; and a ray of comfort from that quarter ſoon broke in upon the French affairs.

111
Hypocritical conduct of Charles.

Though Henry VIII. had not entered into the war againſt France from any concerted political views, he had always retained ſome imperfect idea of that balance of power which it was neceſſary to maintain between Charles and Francis; and the preſervation of which he boaſted to be his peculiar office. By his alliance with the emperor, he hoped to recover ſome part of thoſe territories on the continent which had belonged to his anceſtors; and therefore willingly contributed to give him the aſcendency above his rival; but having never dreamt of any event ſo deciſive and fatal as the victory at Pavia, which ſeemed not only to have broken, but to have annihilated the power of Francis, he now became ſenſible of his own danger, as well as that of all Europe, from the loſs of a proper counterpoiſe to the power of Charles. Inſtead of taking advantage of the diſtreſſed condition of France, Henry therefore determined to aſſiſt her in her preſent calamities. Some diſguſts alſo had taken place between him and Charles, and ſtill more between Charles and Wolſey. The elevation of the cardinal of Medici to St Peter's chair, on the death of Adrian, under the name of Clement VII. had made the Engliſh miniſter ſenſible of the inſincerity of the emperor's promiſes, while it extinguiſhed all his hopes of the papacy; and he reſolved on revenge. Charles, too, had ſo ill ſupported the appearance of moderation which he aſſumed, when firſt informed of his good fortune, that he had already changed his uſual ſtyle to Henry; and inſtead of writing to him with his own hand, and ſubſcribing himſelf "your affectionate ſon and couſin," he dictated his letters to a ſecretary, and ſimply ſubſcribed himſelf "Charles." Influenced by all theſe motives, together with the glory of raiſing a fallen enemy, Henry liſtened to the flattering ſubmiſſions of Louiſa; entered into a defenſive alliance with her as regent of France, and engaged to uſe his beſt offices in order to procure the deliverance of her ſon from a ſtate of captivity.

112
France
ſiſted by
Henry V

Meanwhile Francis was rigorouſly confined; and ſevere conditions being propoſed to him as the price of his liberty, he drew his dagger, and, pointing it at his breaſt, cried, "'Twere better that a king ſhould die thus!" His hand was withheld: and flattering himſelf, when he grew cool, that ſuch propoſitions could not come directly from Charles, he deſired that he might be removed to Spain, where the emperor then reſided. His requeſt was complied with; but he languiſhed long before he obtained a ſight of his conqueror. At laſt he was favoured with a viſit; and the emperor dreading a general combination againſt him, or that Francis, as he threatened, might, in the obſtinacy of his heart, reſign his crown to the dauphin, agreed to abate ſomewhat of his former demands. A treaty was accordingly concluded at Madrid; in conſequence of which Francis obtained his liberty. The chief article in this treaty was, that Burgundy ſhould be reſtored to Charles as the rightful inheritance of his anceſtors, and that Francis's two eldeſt ſons ſhould be immediately delivered up as hoſtages for the performance of the conditions ſtipulated. The exchange of the captive monarch

113
Francis
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by his
queror.

114
Is at laſ
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narch for his children was made on the borders between France and Spain. The moment that Francis entered his own dominions, he mounted a Turkiſh horſe, and putting it to its ſpeed, waved his hand, and cried aloud ſeveral times, "I am yet a king! I am yet a king!"

115
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Francis never meant to execute the treaty of Madrid: he had even left a proteſt in the hands of notaries before he ſigned it, that his conſent ſhould be conſidered as an involuntary deed, and be deemed null and void. Accordingly, as ſoon as he arrived in France, he aſſembled the ſtates of Burgundy, who proteſted againſt the article relative to their province; and Francis coldly replied to the imperial ambaſſadors, who urged the immediate execution of the treaty, that he would religiouſly perform the articles relative to himſelf, but in thoſe affecting the French monarchy, he muſt be directed by the ſenſe of the nation. He made the higheſt acknowledgments to the king of England for his friendly interpoſition, and offered to be entirely guided by his counſels. Charles and his miniſters ſaw that they were over-reached in thoſe very arts of negociation in which they ſo much excelled, while the Italian ſtates obſerved with pleaſure, that Francis was reſolved not to execute a treaty which they conſidered as dangerous to the liberties of Europe. Clement abſolved him from the oath which he had taken at Madrid; and the kings of France and England, the pope, the Swiſs, the Venetians, the Florentines, and the duke of Milan, entered into an alliance, to which they gave the name of the *Holy League*, becauſe his Holineſs was at the head of it, in order to oblige the emperor to deliver up Francis's two ſons on the payment of a reaſonable ranſom, and to re-eſtabliſh Sforza in the quiet poſſeſſion of the Milaneſe.

In conſequence of this league, the confederate army took the field, and Italy once more became the ſcene of war. But Francis, who it was thought would have infuſed ſpirit and vigour into the whole body, had gone through ſuch a ſcene of diſtreſs, that he was become diffident of himſelf, diſtruſtful of his fortune, and deſirous of tranquillity. He flattered himſelf, that the dread alone of ſuch a confederacy would induce Charles to liſten to what was equitable, and therefore neglected to ſend due reinforcements to his allies in Italy. Meantime the duke of Bourbon, who commanded the Imperialiſts, had made himſelf maſter of the whole Milaneſe, of which the emperor had promiſed him the inveſtiture;

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and his troops beginning to mutiny for want of pay, he led them to Rome, and promiſed to enrich them with the ſpoils of that city. He was as good as his word; for though he himſelf was ſlain in planting a ſcaling ladder againſt the walls, his ſoldiers, rather enraged than diſcouraged by his death, mounted to the aſſault with the utmoſt ardour, animated by the greatneſs of the prize, and, entering the city ſword in hand, plundered it for ſeveral days.

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ered.

Never did Rome in any age ſuffer ſo many calamities, not even from the Barbarians, by whom ſhe was often ſubdued, the Huns, Vandals, or Goths, as now from the ſubjects of a Chriſtian and Catholic monarch. Whatever was reſpectable in modeſty, or ſacred in religion, ſeemed only the more to provoke the rage of the ſoldiery. Virgins ſuffered violation in the arms of their parents, and upon thoſe altars to which they had fled for ſafety. Venerable prelates, after enduring every indignity and every torture, were thrown into dungeons, and menaced with the moſt cruel death, in order to make them reveal their ſecret treaſures. Clement himſelf, who had neglected to make his eſcape in time, was taken priſoner, and found that the ſacredneſs of his character could neither procure him liberty nor reſpect.

118
The pope confined.

He was confined till he ſhould pay an enormous ranſom impoſed by the victorious army, and ſurrender to the emperor all the places of ſtrength belonging to the church.

119
Shameful hypocriſy of Charles.

Charles received the news of this extraordinary event with equal ſurpriſe and pleaſure; but in order to conceal his joy from his Spaniſh ſubjects, who were filled with horror at the inſult offered to the ſovereign pontiff, and to leſſen the indignation of the reſt of Europe, he expreſſed the moſt profound ſorrow for the ſucceſs of his arms. He put himſelf and his court into mourning; ſtopped the rejoicings for the birth of his ſon Philip, and ordered prayers to be put up in all the churches of Spain for the recovery of the pope's liberty, which he could immediately have procured by a letter to his generals.

The concern expreſſed by Henry and Francis for the calamity of their ally was more ſincere. Alarmed at the progreſs of the imperial arms, they had, even before the taking of Rome, entered into a cloſer alliance, and agreed to invade the Low Countries with a powerful army; but no ſooner did they hear of the pope's captivity, than they changed, by a new treaty, the ſcene of the projected war from the Netherlands to Italy, and reſolved to take the moſt vigorous meaſures for reſtoring him to liberty. Henry, however, contributed only money.

120
A French army enters Italy, but is utterly ruined.

A French army entered Italy, under the command of Marſhal Lautrec; Clement obtained his freedom; and war was for a time carried on by the confederates with ſucceſs; but the death of Lautrec, and the revolt of Andrew Doria, a Genoeſe admiral in the ſervice of France, entirely changed the face of affairs. The French army was utterly ruined; and Francis, diſcouraged and almoſt exhauſted by ſo many unſucceſsful enterpriſes, began to think of peace, and of obtaining the releaſe of his ſons by conceſſions, not by the terror of his arms.

At the ſame time Charles, notwithſtanding the advantages he had gained, had many reaſons to wiſh for an accommodation. Sultan Solyman having overrun Hungary, was ready to break in upon the Auſtrian territories with the whole force of the Eaſt; and the progreſs of the Reformation in Germany threatened the tranquillity of the empire. In conſequence of this ſituation of affairs, though pride made both parties conceal or diſſemble their real ſentiments, two ladies were permitted to reſtore peace to Europe.

121
Peace concluded at Cambray.

Margaret of Auſtria, Charles's aunt, and Louiſa, Francis's mother, met in 1529 at Cambray, and ſettled the terms of accommodation between the French king and the emperor. Francis agreed to pay two millions of crowns as the ranſom of his two ſons, to reſign the ſovereignty of Flanders and Artois, and to forego all his Italian claims; and Charles ceaſed to demand the reſtitution of Burgundy.

All the ſteps of this negociation had been communicated to the king of England; and Henry was, on that occaſion, ſo generous to his friend and ally Francis, that he ſent him an acquittal of near ſix hundred thouſand crowns, in order to enable him to fulfil his agreement

with

with Charles. But Francis's Italian confederates were leſs ſatisfied with the treaty of Cambray. They were almoſt wholly abandoned to the will of the emperor; and ſeemed to have no other means of ſecurity left but his equity and moderation. Of theſe, from his paſt conduct, they had not formed the moſt advantageous idea. But Charles's preſent circumſtances, more eſpecially in regard to the Turks, obliged him to behave with a generoſity inconſiſtent with his character. The Florentines alone, whom he reduced under the dominion of the family of Medici, had reaſon to complain of his ſeverity. Sforza obtained the inveſtiture of Milan and his pardon: and every other power experienced the lenity of the conqueror.

122
Charles goes into Germany.

After having received the imperial crown from the hands of the pope at Bologna, Charles proceeded on his journey to Germany, where his preſence was become highly neceſſary; for although the conduct and valour of his brother Ferdinand, on whom he had conferred the hereditary dominions of the houſe of Auſtria, and who had been elected king of Hungary, had obliged Solyman to retire with infamy and loſs, his return was to be feared, and the diſorders of religion were daily increaſing; an account of which, and of the emperor's tranſactions with the Proteſtants, is given under the article REFORMATION.

123
He undertakes an expedition againſt the ſtate of Barbary.
An. 1541.

Charles having exerted himſelf as much as he could againſt the reformers, undertook his firſt expedition againſt the piratical ſtates of Africa. Barbary, or that part of the African continent lying along the coaſt of the Mediterranean ſea, was then nearly in the ſame condition which it is at preſent. Morocco, Algiers, and Tunis, were its principal ſtates; and the two laſt were neſts of pirates. Barbaroſſa, a famous corſair, had ſucceeded his brother in the kingdom of Algiers, which he had formerly aſſiſted him to uſurp. He regulated with much prudence the interior police of his kingdom, carried on his piracies with great vigour, and extended his conqueſts on the continent of Africa; but perceiving that the natives ſubmitted to his government with impatience, and fearing that his continual depredations would one day draw upon him a general combination of the Chriſtian powers, he put his dominions under the protection of the grand ſeignior. Solyman, flattered by ſuch an act of ſubmiſſion, and charmed with the boldneſs of the man, offered him the command of the Turkiſh fleet. Proud of this diſtinction, Barbaroſſa repaired to Conſtantinople, and made uſe of his influence with the ſultan to extend his own dominion. Partly by force, partly by treachery, he uſurped the kingdom of Tunis; and being now poſſeſſed of greater power, he carried on his depredations againſt the Chriſtian ſtates with more deſtructive violence than ever.

Daily complaints of the piracies and ravages committed by the galleys of Barbaroſſa were brought to the emperor by his ſubjects, both in Spain and Italy; and all Chriſtendom ſeemed to look up to him, as its greateſt and moſt fortunate prince, for relief from this new and odious ſpecies of oppreſſion. At the ſame time Muley Haſcen, the exiled king of Tunis, finding none of the African princes able or willing to ſupport him in recovering his throne, applied to Charles for aſſiſtance againſt the uſurper. Equally deſirous of delivering his dominions from the dangerous neighbourhood of Barbaroſſa, of appearing as the protector of an unfortunate prince, and of acquiring the glory annexed in that age to every expedition againſt the Mahometans, the emperor readily concluded a treaty with Muley Haſcen, and ſet ſail for Tunis with a formidable armament. The Goletta, a ſea-port town, fortified with 300 pieces of cannon, was taken, together with all Barbaroſſa's fleet: he was defeated in a pitched battle, and 10,000 Chriſtian ſlaves, having knocked off their fetters, and made themſelves maſters of the citadel, Tunis was preparing to ſurrender. But while Charles was deliberating on the conditions, his troops fearing that they would be deprived of the booty which they had expected, broke ſuddenly into the town, and pillaged and maſſacred without diſtinction. Thirty thouſand perſons periſhed by the ſword, and 10,000 were made priſoners. The ſceptre was reſtored to Muley Haſcen, on condition that he ſhould acknowledge himſelf a vaſſal of the crown of Spain, put into the emperor's hands all the fortified ſea-ports in the kingdom of Tunis, and pay annually 12,000 crowns for the ſubſiſtence of the Spaniſh garriſon in the Goletta. Theſe points being ſettled, and 20,000 Chriſtian ſlaves freed from bondage either by arms or by treaty, Charles returned to Europe, where his preſence was become neceſſary; while Barbaroſſa, who had retired to Bona, recovered new ſtrength, and again became the tyrant of the ocean.

124
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125
Francis a
tempts in
vain to re
vive his
pretenſion
to Italy.

The king of France took advantage of the emperor's abſence to revive his pretenſions in Italy. The treaty of Cambray had repreſſed but not extinguiſhed the flames of diſcord. Francis in particular, who waited only for a favourable opportunity of recovering the territories and reputation which he had loſt, continued to negociate againſt his rival with different courts. But all his negociations were diſconcerted by unforeſeen accidents. The death of Clement VII. (whom he had gained by marrying his ſon the duke of Orleans, afterwards Henry II. to Catharine of Medici, the niece of that pontiff), deprived him of all the ſupport which he hoped to receive from the court of Rome. The king of England, occupied with domeſtic cares and projects, declined engaging in the affairs of the continent; and the Proteſtant princes, aſſociated by the league of Smalkalde, to whom Francis had alſo applied, and who ſeemed diſpoſed at firſt to liſten to him, filled with indignation and reſentment at the cruelty with which ſome of their reformed brethren had been treated in France, refuſed to have any connection with the enemy of their religion.

Francis was neither cruel nor bigotted: he was too indolent to concern himſelf about religious diſputes; but his principles becoming ſuſpected, at a time when the emperor was gaining immortal glory by his expedition againſt the infidels, he found it neceſſary to vindicate himſelf by ſome extraordinary demonſtration of reverence for the eſtabliſhed faith. The indiſcreet zeal of ſome Proteſtant converts furniſhed him with the occaſion. They had affixed to the gates of the Louvre and other public places papers containing indecent reflections on the rites of the Romiſh church. Six of the perſons concerned in this raſh action were ſeized; and the king, pretending to be ſtruck with horror at their blaſphemies, appointed a ſolemn proceſſion, in order to avert the wrath of heaven. The holy ſacrament was carried through the city of Paris in great pomp: Francis walked uncovered before it, bearing a torch in his hand;

126
His barbarity to the Proteſtants.

hand; the princes of the blood ſupported the canopy over it; the nobles walked behind. In preſence of this numerous aſſembly, the king declared, that if one of his hands were infected with hereſy, he would cut it off with the other; "and I would ſacrifice (added he) even my own children, if found guilty of that crime." As an awful proof of his ſincerity, the ſix unhappy perſons who had been ſeized were publicly burnt, before the proceſſion was finiſhed, and in the moſt cruel manner. They were fixed upon a machine which deſcended into the flames, and retired alternately, until they expired.—No wonder that the Proteſtant princes were incenſed at ſuch barbarity!

127 ...ſes an ...y ...ch to-...ds Italy.

Francis, though unſupported by any ally, commanded his army to advance towards the frontiers of Italy, under pretence of chaſtiſing the duke of Milan for a breach of the law of nations, in putting to death his ambaſſador. The operations of war, however, ſoon took a new direction. Inſtead of marching directly to the Milaneſe, Francis commenced hoſtilities againſt the duke of Savoy, with whom he had cauſe to be diſſatiſfied, and on whom he had ſome claims; and before the end of the campaign, this feeble prince ſaw himſelf ſtripped of all his dominions, except the province of Piedmont. To complete his misfortunes, the city of Geneva, the ſovereignty of which he claimed, and where the reformed opinions had already got footing, threw off his yoke; and its revolt drew along with it the loſs of the adjacent territory. Geneva was then an imperial city, and till lately remained entirely free *.

128 Geneva th...ws off ...yoke of ...duke of S...y.

In this extremity the duke of Savoy ſaw no reſource but in the emperor's protection; and as his misfortunes were chiefly occaſioned by his attachment to the imperial intereſt, he had a title to immediate aſſiſtance. But Charles, who was juſt returned from his African expedition, was not able to lend him the neceſſary ſupport. His treaſury was entirely drained, and he was obliged to diſband his army till he could raiſe new ſupplies. Mean time the death of Sforza duke of Milan entirely changed the nature of the war, and afforded the emperor full leiſure to prepare for action. The French monarch's pretext for taking up arms was at once cut off; but as the duke died without iſſue, all Francis's rights to the duchy of Milan, which he had yielded only to Sforza and his deſcendants, returned to him in full force. He inſtantly renewed his claim to it; and if he had ordered his army immediately to advance, he might have made himſelf maſter of it. But he unfortunately waſted his time in fruitleſs negociations, while his more politic rival took poſſeſſion of the duchy as a vacant fief of the empire; and though Charles ſeemed ſtill to admit the equity of Francis's claim, he delayed granting the inveſtiture under various pretences, and as ſecretly taking every poſſible meaſure to prevent him from regaining footing in Italy.

...9 Ch...es tak... poſ-ſeſſ... of Mi...

During the time gained in this manner, Charles had recruited his finances, and of courſe his armies; and finding himſelf in a condition for war, he at laſt threw off the maſk under which he had ſo long concealed his deſigns from the court of France. Entering Rome with great pomp, he pronounced before the pope and cardinals, aſſembled in full conſiſtory, a violent invective againſt Francis, by way of reply to his propoſitions concerning the inveſtiture of Milan. Yet Francis, by an unaccountable fatality, continued to negotiate, as if it had been ſtill poſſible to terminate their differences in an amicable manner; and Charles, finding him ſo eager to run into the ſnare, favoured the deception, and, by ſeeming to liſten to his propoſals, gained yet more time for the execution of his ambitious projects.

We...ſs of F...cis

131 Charles attempts to ſubvert the French monarchy,

If misfortunes had rendered Francis too diffident, ſucceſs had made Charles too ſanguine. He preſumed on nothing leſs than the ſubverſion of the French monarchy; nay, he conſidered it as a certain event. Having chaſed the forces of his rival out of Piedmont and Savoy, he puſhed forward at the head of 50,000 men, contrary to the advice of his moſt experienced miniſters and generals, to invade the ſouthern provinces of France; while two other armies were ordered to enter it, the one on the ſide of Picardy, the other on the ſide of Champagne. He thought it impoſſible that Francis could reſiſt ſo many unexpected attacks on ſuch different quarters; but he found himſelf miſtaken.

132 but is diſappointed in his deſigns.

The French monarch fixed on the moſt effectual plan for defeating the invaſion of a powerful enemy; and he prudently perſevered in following it, though contrary to his own natural temper and to the genius of his people. He determined to remain altogether upon the defenſive, and to deprive the enemy of ſubſiſtence by laying waſte the country before them. The execution of this plan was committed to the mareſchal Montmorency its author, a man happily fitted for ſuch a truſt by the inflexible ſeverity of his diſpoſition. He made choice of a ſtrong camp, under the walls of Avignon, at the confluence of the Rhone and Durance, where he aſſembled a conſiderable army; while the king, with another body of troops, encamped at Valence, higher up the Rhone. Marſeilles and Arles were the only towns he thought it neceſſary to defend; and each of theſe he furniſhed with a numerous garriſon of his beſt troops. The inhabitants of the other towns were compelled to abandon their habitations: the fortifications of ſuch places as might have afforded ſhelter to the enemy were thrown down; corn, forage, and proviſions of every kind, were carried off or deſtroyed; the mills and ovens were ruined, and the wells filled up or rendered uſeleſs.

This devaſtation extended from the Alps to Marſeilles, and from the ſea to the confines of Dauphiny; ſo that the emperor, when he arrived with the van of his army on the confines of Provence, inſtead of that rich and populous country which he expected to enter, beheld nothing but one vaſt and deſert ſolitude. He did not, however, deſpair of ſucceſs, though he ſaw that he would have many difficulties to encounter; and as an encouragement to his officers, he made them liberal promiſes of lands and honours in France. But all the land which any of them obtained was a grave, and their maſter loſt much honour by this raſh and preſumptuous enterpriſe. After unſucceſsfully inveſting Marſeilles and Arles, after attempting in vain to draw Montmorency from his camp at Avignon, and not daring to attack it, Charles having ſpent two inglorious months in Provence, and loſt one half of his troops by diſeaſe or by famine, was under the neceſſity of ordering a retreat; and though he was ſome time in motion before the enemy ſuſpected his intention, it was conducted with ſo much precipitation and diſorder, as to deſerve the name of a flight, ſince the light troops of France turned it into a perfect rout. The invaſion of

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* ...e Ge-...

Picardy was not more ſucceſsful: the imperial forces were obliged to retire without effecting any conqueſt of importance.

Charles had no ſooner conducted the ſhattered remains of his army to the frontiers of Milan, than he ſet out for Genoa; and unwilling to expoſe himſelf to the ſcorn of the Italians after ſuch a reverſe of fortune, he embarked directly for Spain.

133
Violent animoſity between him and Francis.

Meanwhile Francis gave himſelf up to that vain reſentment which had formerly diſgraced the proſperity of his rival. They had frequently, in the courſe of their quarrels, given each other the lie, and mutual challenges had been ſent; which, though productive of no ſerious conſequences between the parties, had a powerful tendency to encourage the pernicious practice of duelling. Charles, in his invective pronounced at Rome, had publicly accuſed Francis of perfidy and breach of faith; Francis now exceeded Charles in the indecency of his accuſations. The dauphin dying ſuddenly, his death was imputed to poiſon: Montecuculi his cupbearer was put to the rack; and that unhappy nobleman, in the agonies of torture, accuſed the emperor's generals Gonzaga and de Leyva, of inſtigating him to the deteſtable act. The emperor himſelf was ſuſpected; nay, this extorted confeſſion, and ſome obſcure hints, were conſidered as inconteſtable proofs of his guilt; though it was evident to all mankind, that neither Charles nor his generals could have any inducement to perpetrate ſuch a crime, as Francis was ſtill in the vigour of life himſelf, and had two ſons beſides the dauphin, grown up to a good age.

134
Charles ſummoned to appear at Paris.

But the incenſed monarch's reſentment did not ſtop here. Francis was not ſatisfied with endeavouring to blacken the character of his rival by an ambiguous teſtimony which led to the moſt injurious ſuſpicions, and upon which the moſt cruel conſtructions had been put; he was willing to add rebellion to murder. For this purpoſe he went to the parliament of Paris; where being ſeated with the uſual ſolemnities, the advocate-general appeared, and accuſed Charles of Auſtria (ſo he affected to call the emperor) of having violated the treaty of Cambray, by which he was freed from the homage due to the crown of France for the counties of Artois and Flanders; adding, that this treaty being now void, he was ſtill to be conſidered as a vaſſal of France, and conſequently had been guilty of rebellion in taking arms againſt his ſovereign. The charge was ſuſtained, and Charles was ſummoned to appear before the parliament of Paris at a day fixed. The term expired; and no perſon appearing in the emperor's name, the parliament gave judgment, that Charles of Auſtria had forfeited, by rebellion and contumacy, the counties of Flanders and Artois, and declared theſe fiefs reunited to the crown of France.

Francis, ſoon after this vain diſplay of his animoſity, marched into the Low Countries, as if he had intended to execute the ſentence pronounced by his parliament; but a ſuſpenſion of arms took place, through the interpoſition of the queens of France and Hungary, before any thing of conſequence was effected: and this ceſſation of hoſtilities was followed by a truce concluded at Nice, through the mediation of the reigning pontiff Paul III. of the family of Farneſe, a man of a venerable character and pacific diſpoſition.

135
Francis leagues with the Turks.

136
A truce conclude

Each of theſe rival princes had ſtrong reaſons to incline them to peace. The finances of both were exhauſted; and the emperor, the more powerful of the two, was deeply impreſſed with the dread of the Turkiſh arms, which Francis had drawn upon him by a league with Solyman. In conſequence of this league, Barbaroſſa with a great fleet appeared on the coaſt of Naples; filled that kingdom with conſternation; landed without reſiſtance near Taranto; obliged Caſtro, a place of ſome ſtrength, to ſurrender; plundered the adjacent country; and was taking meaſures for ſecuring and extending his conqueſts, when the unexpected arrival of Doria, the famous Genoeſe admiral, together with the pope's galleys and a ſquadron of the Venetian fleet, made it prudent for him to retire. The ſultan's forces alſo invaded Hungary, where Mahmet the Turkiſh general, after gaining ſeveral inferior advantages, defeated the Germans in a great battle at Eſſek on the Drave. Happily for Charles and Europe it was not in Francis's power at this juncture either to join the Turks or aſſemble an army ſtrong enough to penetrate into the Milaneſe. The emperor, however, was ſenſible that he could not long reſiſt the efforts of two ſuch powerful confederates, nor expect that the ſame fortunate circumſtances would concur a ſecond time in his favour; he therefore thought it neceſſary, both for his ſafety and reputation, to give his conſent to a truce: and Francis choſe rather to run the riſk of diſobliging his new ally the ſultan, than to draw on his head the indignation, and perhaps the arms of all Chriſtendom, by obſtinately obſtructing the re-eſtabliſhment of tranquillity, and contributing to the aggrandizement of the Infidels.

137
Intervie between Francis a Charles.

Theſe conſiderations inclined the contending monarchs to liſten to the arguments of the holy father; but he found it impoſſible to bring about a final accommodation between them, each inflexibly perſiſted in aſſerting his own claims. Nor could he prevail on them to ſee one another, though both came to the place of rendezvous: ſo great was the remains of diſtruſt and rancour, or ſuch the difficulty of adjuſting the ceremonial! Yet, improbable as it may ſeem, a few days after ſigning the truce, the emperor, in his paſſage to Barcelona, being driven on the coaſt of Provence, Francis invited him to come aſhore; frankly viſited him on board his galley, and was received and entertained with the warmeſt demonſtrations of eſteem and affection. Charles, with an equal degree of confidence, paid the king next day a viſit at Aigues-mortes; where theſe two hoſtile rivals and vindictive enemies, who had accuſed each other of every kind of baſeneſs, converſing together with all the cordiality of brothers, ſeemed to vie with each other in expreſſions of reſpect and friendſhip.

138
Advantag gained by the pope from this pacification.

Beſides the glory of having reſtored tranquillity to Europe, the pope gained a point of much conſequence to his family. He obtained for his grandſon, Margaret of Auſtria, the emperor's natural daughter, formerly wife of Alexander de Medici, whom Charles had raiſed to the ſupreme power in Florence. Laurenein de Medici, the kinſman and intimate companion of Alexander, had aſſaſſinated him by one of the blackeſt treaſons recorded in hiſtory. Under pretence of having ſecured him an aſſignation with a lady of the higheſt rank and great beauty, he drew him into a ſecret apartment of his houſe, and there ſtabbed him as he lay careleſsly on a couch, expecting the embrace of the lovely fair, whom he had often

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often ſolicited in vain. Laurenein, however, did not reap the fruits of his crime; for though ſome of his countrymen extolled him as a third Brutus, and endeavoured to ſeize this occaſion for recovering their liberties, the government of Florence paſſed into the hands of Coſmo II. another kinſman of Alexander. Coſmo was deſirous of marrying the widow of his predeceſſor; but the emperor choſe rather to oblige the pope, by beſtowing his daughter upon Octavio Farneſe, ſon of the duke of Parma.

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Charles had ſoon farther cauſe to be ſenſible of his obligations to the holy father for bringing about the treaty of Nice. His troops everywhere mutinied for want of pay, and the ability of his generals only could have prevented a total revolt. He had depended, as his chief reſource for diſcharging the arrears due to his ſoldiers, upon the ſubſidies which he expected from his Caſtilian ſubjects. For this purpoſe he aſſembled the Cortes of Caſtile at Toledo; and having repreſented to them the great expence of his military operations, he propoſed to levy ſuch ſupplies as the preſent exigency of affairs demanded, by a general exciſe on commodities; but the Spaniards, who already felt themſelves oppreſſed by a load of taxes unknown to their anceſtors, and who had often complained that their country was drained of its wealth and inhabitants, in order to proſecute quarrels in which they had no intereſt, determined not to add voluntarily to their own burdens. The nobles, in particular, inveighed with great vehemence againſt the impoſition propoſed, as an encroachment on the valuable and diſtinguiſhing privilege of their order, that of being exempted from the payment of any tax. After employing arguments and promiſes in vain, Charles diſmiſſed the aſſembly with indignation; and from that period neither the nobles nor the prelates have been called to the Cortes, on pretence that ſuch as pay no part of the public taxes ſhould not claim a vote in laying them on. Theſe aſſemblies have ſince conſiſted merely of the procurators or repreſentatives of 18 cities, two from each; in all 36 members, who are abſolutely at the devotion of the crown.

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The citizens of Ghent, ſtill more bold, broke out not long after into open rebellion againſt the emperor's government, on account of a tax which they judged contrary to their ancient privileges, and a deciſion of the council of Mechlin in favour of the imperial authority. Enraged at an unjuſt impoſition, and rendered deſperate on ſeeing their rights betrayed by that very court which was bound to protect them, they flew to arms, ſeized ſeveral of the emperor's officers, and drove ſuch of the nobility as reſided among them out of the city. Senſible, however, of their inability to ſupport what their zeal had prompted them to undertake, and deſirous of ſecuring a protector againſt the formidable forces with which they might expect ſoon to be attacked, they offered to acknowledge the king of France as their ſovereign, to put him into immediate poſſeſſion of their city, and to aſſiſt him in recovering thoſe provinces in the Netherlands which had anciently belonged to his crown. True policy directed Francis to comply with this propoſal. The counties of Flanders and Artois were more valuable than the duchy of Milan, for which he had ſo long contended; and their ſituation in regard to France made it more eaſy to conquer or to defend them. But Francis over-rated the Milaneſe. He had lived in friendſhip with the emperor ever ſince their interview at Aigues-mortes, and Charles had promiſed him the inveſtiture of that duchy. Forgetting, therefore, all his paſt injuries, and the deceitful promiſes by which he had been ſo often duped, the credulous, generous Francis, not only rejected the propoſitions of the citizens of Ghent, but communicated to the emperor his whole negociation with the malecontents.

142
Extreme credulity of Francis.

Judging of Charles's heart by his own, Francis hoped by this ſeemingly diſintereſted proceeding to obtain at once the inveſtiture of Milan; and the emperor, well acquainted with the weakneſs of his rival, flattered him in this apprehenſion, for his own ſelfiſh purpoſes. His preſence being neceſſary in the Netherlands, he demanded a paſſage through France. It was immediately granted him; and Charles, to whom every moment was precious, ſet out, notwithſtanding the remonſtrances of his council and the fears of his Spaniſh ſubjects, with a ſmall but ſplendid train of 100 perſons. He was met on the frontiers of France by the dauphin and the duke of Orleans, who offered to go into Spain, and remain there as hoſtages, till he ſhould reach his own dominions; but Charles replied, that the king's honour was ſufficient for his ſafety, and proſecuted his journey without any other ſecurity. The king entertained him with the utmoſt magnificence at Paris, and the two young princes did not take leave of him till he entered the Low Countries; yet he ſtill found means to evade his promiſe, and Francis continued to believe him ſincere.

143
He allows Charles to paſs through his dominions.

144
Severity of Charles to the city of Ghent.

The citizens of Ghent, alarmed at the approach of the emperor, who was joined by three armies, ſent ambaſſadors to implore his mercy, and offered to throw open their gates. Charles only condeſcended to reply, "That he would appear among them as a ſovereign and a judge, with the ſceptre and the ſword." He accordingly entered the place of his nativity on the anniverſary of his birth; and inſtead of that lenity which might have been expected, exhibited an awful example of his ſeverity. Twenty-ſix of the principal citizens were put to death: a greater number was baniſhed: the city was declared to have forfeited its privileges; a new ſyſtem of laws and political adminiſtration was preſcribed; and a large fine was impoſed on the inhabitants, in order to defray the expence of erecting a citadel, together with an annual tax for the ſupport of a garriſon. They were not only deſpoiled of their ancient immunities, but made to pay, like conquered people, for the means of perpetuating their own ſlavery.

145
His baſe treatment of Francis.

Having thus re-eſtabliſhed his authority in the Low Countries, and being now under no neceſſity of continuing that ſcene of falſehood and diſſimulation with which he had amuſed the French monarch, Charles began gradually to throw aſide the veil under which he had concealed his intentions with reſpect to the Milaneſe, and at laſt peremptorily refuſed to give up a territory of ſuch value, or voluntarily to make ſuch a liberal addition to the ſtrength of an enemy by diminiſhing his own power. He even denied that he had ever made any promiſe which could bind him to an action ſo fooliſh, and ſo contrary to his own intereſt.

This tranſaction expoſed the king of France to as much ſcorn as it did the emperor to cenſure. The credulous ſimplicity of Francis ſeemed to merit no other return, after experiencing ſo often the duplicity and artifices of his rival. He remonſtrated, however, and exclaimed

claimed as if this had been the firſt circumſtance in which the emperor had deceived him. The inſult offered to his underſtanding affected him even more ſenſibly than the injury done to his intereſt; and he diſcovered ſuch reſentment as made it obvious that he would ſeize on the firſt opportunity of revenge, and that a new war would ſoon deſolate the European continent.

146 He is obliged to make conceſſions to the Proteſtants.

Meanwhile Charles was obliged to turn his attention towards the affairs of Germany. The Proteſtants having in vain demanded a general council, preſſed him earneſtly to appoint a conference between a ſelect number of divines of each party, in order to examine the points in diſpute. For this purpoſe a diet was aſſembled at Ratiſbon: and ſuch a conference, notwithſtanding the oppoſition of the pope, was held with great ſolemnity in the preſence of the emperor. But the divines choſen to manage the controverſy, though men of learning and moderation, were only able to ſettle a few ſpeculative opinions, all points relative to worſhip and juriſdiction ſerving to inflame the minds of the diſputants. Charles, therefore, finding his endeavours to bring about an accommodation ineffectual, and being impatient to cloſe the diet, prevailed on a majority of the members to approve of the following edict of receſs; viz. that the articles concerning which the divines had agreed, ſhould be held as points decided; that thoſe about which they had differed, ſhould be referred to the determination of a general council, or if that could not be obtained, to a national ſynod: and ſhould it prove impracticable alſo to aſſemble a ſynod of Germany, that a general diet of the empire ſhould be called within 18 months, in order to give final judgment on the whole controverſy; that, in the mean time, no innovations ſhould be attempted, nor any endeavours employed to gain proſelytes.

This diet gave great offence to the pope. The bare mention of allowing a diet, compoſed chiefly of laymen, to paſs judgment in regard to articles of faith, appeared to him no leſs criminal and profane than the worſt of thoſe hereſies which the emperor ſeemed ſo zealous to ſuppreſs. The Proteſtants alſo were diſſatisfied with it, as it conſiderably abridged the liberty which they at that time enjoyed. They murmured loudly againſt it; and Charles, unwilling to leave any ſeeds of diſcontent in the empire, granted them a private declaration, exempting them from whatever they thought injurious or oppreſſive in the receſs, and aſcertaining to them the full poſſeſſion of all their former privileges.

The ſituation of the emperor's affairs at this juncture made theſe extraordinary conceſſions neceſſary. He foreſaw a rupture with France to be unavoidable, and he was alarmed at the rapid progreſs of the Turks in Hungary. A great revolution had happened in that kingdom. John Zapol Scæpus, by the aſſiſtance of Solyman, had wreſted from the king of the Romans a conſiderable part of the country. John died, and left an infant ſon. Ferdinand attempted to take advantage of the minority, in order to repoſſeſs himſelf of the whole kingdom; but his ambition was diſappointed by the activity and addreſs of George Martinuzzi, biſhop of Waradin, who ſhared the regency with the queen. Senſible that he was unable to oppoſe the king of the Romans in the field, Martinuzzi ſatisfied himſelf with holding out the fortified towns, all of which he provided with every thing neceſſary for defence; and at the ſame time he ſent ambaſſadors to Solyman, beſeeching him to extend towards the ſon that imperial protection which had ſo generouſly maintained the father on his throne. Ferdinand uſed his utmoſt endeavours to thwart this negociation, and even meanly offered to hold the Hungarian crown on the ſame ignominious condition by which John had held it, that of paying tribute to the Porte. But the ſultan ſaw ſuch advantages from eſpouſing the intereſt of the young king, that he inſtantly marched into Hungary; and the Germans, having formed the ſiege of Buda, were defeated with great ſlaughter before that city. Solyman, however, inſtead of becoming the protector of the infant ſovereign whom he had relieved, made uſe of this ſucceſs to extend his own dominions: he ſent the queen and her ſon into Tranſilvania, which province he allotted them, and added Hungary to the Ottoman empire.

147 Undertak an unſucceſsful ex pedition againſt A giers.

Happily for the Proteſtants, Charles received intelligence of this revolution ſoon after the diet at Ratiſbon; and by the conceſſions which he made them, he obtained ſuch liberal ſupplies, both of men and money, as left him under little anxiety about the ſecurity of Germany. He therefore haſtened to join his fleet and army in Italy, in order to carry into execution a great and favourite enterpriſe which he had concerted againſt Algiers: though it would certainly have been more conſiſtent with his dignity to have conducted the whole force of the empire againſt Solyman, the common enemy of Chriſtendom, who was ready to enter his Auſtrian dominions. But many reaſons induced Charles to prefer the African expedition: he wanted ſtrength, or at leaſt money, to combat the Turks in ſo diſtant a country as Hungary; and the glory which he had formerly acquired in Barbary led him to hope for the like ſucceſs, while the cries of his Spaniſh ſubjects rouſed him to take vengeance on their ravagers. But the unfortunate event of this expedition has already been related under the article ALGIERS, N° 14—20.

148 War between Francis ar Charles.

The loſs which the emperor ſuffered in this calamitous expedition encouraged the king of France to begin hoſtilities, on which he had been for ſome time reſolved; and an action diſhonourable to civil ſociety furniſhed him with too good a pretext for taking arms. The marquis del Guaſto, governor of the Milaneſe, having got intelligence of the motions and deſtination of two ambaſſadors, Rincon and Fergoſo, whom Francis had diſpatched, the one to the Ottoman Porte, the other to the republic of Venice; knowing how much his maſter wiſhed to diſcover the intentions of the French monarch, and of what conſequence it was to retard the execution of his meaſures, he employed ſome ſoldiers belonging to the garriſon of Pavia to lie in wait for theſe ambaſſadors as they ſailed down the Po, who murdered them and moſt of their attendants, and ſeized their papers. Francis immediately demanded reparation for this barbarous outrage; and as Charles endeavoured to put him off with an evaſive anſwer, he appealed to all the courts of Europe, ſetting forth the heinouſneſs of the injury, the iniquity of the emperor in diſregarding his juſt requeſt, and the neceſſity of vengeance. But Charles, who was a more profound negociator, defeated in a great meaſure the effects of theſe repreſentations: he ſecured the fidelity of the Proteſtant princes in Germany, by granting them new conceſſions; and he engaged the king of England to eſpouſe his cauſe, under pretence of defending Europe againſt the Infidels; while Francis was only able to form an alliance with the kings of Denmark and Sweden (who for the firſt time intereſted themſelves in the quarrels of the more potent monarchs of the ſouth), and to renew his treaty with Solyman, which drew on him the indignation of Chriſtendom.

But the activity of Francis ſupplied all the defects of his negociation. Five armies were ſoon ready to take the field, under different generals, and with different deſtinations. Nor was Charles wanting in his preparations. He and Henry a ſecond time made an ideal diviſion of the kingdom of France. But as the hoſtilities which followed terminated in nothing deciſive, and were diſtinguiſhed by no remarkable event, except the battle of Ceriſoles (gained by Count d'Enguien over the imperialiſts, and in which 10,000 of the emperor's beſt troops fell) at laſt Francis and Charles, mutually tired of haraſſing each other, concluded at Creſpy a treaty of peace, in which the king of England was not mentioned; and from being implacable enemies, became once more, to appearance, cordial friends, and even allies by the ties of blood.

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The chief articles of this treaty were, that all the conqueſts which either party had made ſince the truce of Nice ſhould be reſtored; that the emperor ſhould give in marriage to the duke of Orleans, either his own eldeſt daughter, with the Low Countries, or the ſecond daughter of his brother Ferdinand, with the inveſtiture of the Milaneſe; that Francis ſhould renounce all pretenſions to the kingdom of Naples, as well as to the ſovereignty of Flanders and Artois, and Charles give up his claim to the duchy of Burgundy; and that both ſhould unite in making war againſt the Turks.

The emperor was chiefly induced to grant conditions ſo advantageous to France, by a deſire of humbling the Proteſtant princes in Germany. With the papal juriſdicton, he foreſaw they would endeavour to throw off the imperial authority; and he determined to make his zeal for the former a pretence for enforcing and extending the latter. However, the death of the duke of Orleans before the conſummation of his marriage, diſentangled the emperor from the moſt troubleſome ſtipulation in the treaty of Creſpy; and the French monarch, being ſtill engaged in hoſtilities with England, was unable to obtain any reparation for the loſs which he ſuffered by this unforeſeen event. Theſe hoſtilities, like thoſe between Charles and Francis, terminated in nothing deciſive. Equally tired of a ſtruggle attended with no glory or advantage to either, the contending princes concluded, at Campe, near Ardies, a treaty of peace; in which it was ſtipulated, that France ſhould pay the arrears due by former treaties to England. But theſe arrears did not exceed one-third of the ſums expended by Henry on his military operations; and Francis being in no condition to diſcharge them, Boulogne (a chargeable pledge) was left in the hands of the Engliſh as a ſecurity for the debt.

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In conſequence of the emperor's reſolution to humble the Proteſtant princes, he concluded a diſhonourable peace with the Porte, ſtipulating that his brother Ferdinand ſhould pay tribute for that part of Hungary which he ſtill poſſeſſed; while the ſultan enjoyed the imperial and undiſturbed poſſeſſion of all the reſt. At the ſame time he entered into a league with Pope Paul III. for the extirpation of hereſy; but in reality with a view to oppreſs the liberties of Germany. Here, however, his ambition met with a ſevere check; for though he was ſucceſsful at firſt, he was obliged in 1552 to conclude a peace with the Proteſtants on their own terms; as has been related under the article REFORMATION, N° 26—32.

151
Attempts
to recover
ſome of his
provinces.

By the peace concluded on this occaſion the emperor loſt Metz, Toul, and Verdun, which had formed the barrier of the empire on that quarter; and therefore ſoon after put himſelf at the head of an army, in order to recover theſe three biſhoprics. In order to conceal the deſtination of his army, he gave out, that he intended to lead it into Hungary, to ſecond Maurice in his operations againſt the Infidels; and as that pretext failed him, when he began to advance towards the Rhine, he propagated a report that he was marching firſt to chaſtiſe Albert of Brandenburg, who had refuſed to be included in the treaty of Paſſau, and whoſe cruel exactions in that part of Germany called loudly for redreſs.

152
Is obliged
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The French, however, were not deceived by theſe arts. Henry immediately gueſſed the true object of Charles's armament, and reſolved to defend his conqueſt with vigour. The defence of Metz, againſt which it was foreſeen the whole weight of the war would be turned, was committed to Francis of Lorraine, duke of Guiſe, who poſſeſſed in an eminent degree all the qualities that render men great in military command. He repaired with joy to the dangerous ſtation; and many of the French nobility, and even princes of the blood, eager to diſtinguiſh themſelves under ſuch a leader, entered Metz as volunteers. The city was of great extent, ill fortified, and the ſuburbs large. For all theſe defects the duke endeavoured to provide a remedy. He repaired the old fortifications with all poſſible expedition, labouring with his own hands; the officers imitated his example; and the ſoldiers, thus encouraged, cheerfully ſubmitted to the moſt ſevere toils; he erected new works, and he levelled the ſuburbs with the ground. At the ſame time he filled the magazines with proviſions and military ſtores, compelled all uſeleſs perſons to leave the place, and laid waſte the neighbouring country; yet ſuch were his popular talents, as well as his arts of acquiring an aſcendant over the minds of men, that the citizens not only refrained from murmuring, but ſeconded him with no leſs ardour than the ſoldiers in all his operations—in the ruin of their eſtates, and in the havoc of their public and private buildings.

Meanwhile the emperor continued his march towards Lorraine, at the head of 60,000 men. On his approach, Albert of Brandenburg, whoſe army did not exceed 20,000, withdrew into that principality as if he intended to join the French king; and Charles, notwithſtanding the advanced ſeaſon, it being towards to the end of October, laid ſiege to Metz, contrary to the advice of his moſt experienced officers.

The attention of both the beſiegers and the beſieged was turned for ſome time towards the motions of Albert, who ſtill hovered in the neighbourhood, undetermined which ſide to take, though reſolved to ſell his ſervice. Charles at laſt came up to his price, and he joined the imperial army. The emperor now flattered himſelf that nothing could reſiſt his force; but he found himſelf deceived. After a ſiege of almoſt 60 days, du-

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ring which he had attempted all that was thought poſſible for art or valour to effect, and had loſt upwards of 30,000 men by the inclemency of the weather, diſeaſes, or the ſword of the enemy, he was obliged to abandon the enterpriſe.

153
Miſerable condition of his army.

When the French ſallied out to attack the enemy's rear, the imperial camp was filled with the ſick and wounded, with the dead and the dying. All the roads by which the army retired were ſtrewed with the ſame miſerable objects; who, having made an effort beyond their ſtrength to eſcape, and not being able to proceed, were left to periſh without aſſiſtance. Happily that, and all the kind offices which their friends had not the power to perform, they received from their enemies. The duke of Guiſe ordered them all to be taken care of, and ſupplied with every neceſſary; he appointed phyſicians to attend, and direct what treatment was proper for the ſick and wounded, and what refreſhments for the feeble; and ſuch as recovered he ſent home, under an eſcort of ſoldiers, and with money to bear their charges. By theſe acts of humanity, leſs common in that age, the duke of Guiſe completed that heroic character which he had juſtly acquired by his brave and ſucceſsful defence of Metz.

154
His further misfortunes.

The emperor's misfortunes were not confined to Germany. During his reſidence at Villach, he had been obliged to borrow 200,000 crowns of Coſmo de Medici; and ſo low was his credit, that he was obliged to put Coſmo in poſſeſſion of the principality of Piombino as a ſecurity for that inconſiderable ſum; by which means he loſt the footing he had hitherto maintained in Tuſcany. Much about the ſame time he loſt Sienna. The citizens, who had long enjoyed a republican government, roſe againſt the Spaniſh garriſon, which they had admitted as a check upon the tyranny of the nobility, but which they found was meant to enſlave them; forgetting their domeſtic animoſities, they recalled the exiled nobles; they demoliſhed the citadel, and put themſelves under the protection of France.

To theſe unfortunate events one ſtill more fatal had almoſt ſucceeded. The ſevere adminiſtration of the viceroy of Naples had filled that kingdom with murmuring and diſſatisfaction. The prince of Salerno, the head of the malecontents, fled to the court of France. The French monarch, after the example of his father, applied to the grand ſignior; and Solyman, at that time highly incenſed againſt the houſe of Auſtria on account of the proceedings in Hungary, ſent a powerful fleet into the Mediterranean, under the command of the corſair Dragut, an officer trained up under Barbaroſſa, and ſcarcely inferior to his maſter in courage, talents, or in good fortune. Dragut appeared on the coaſt of Calabria at the time appointed; but not being joined by the French fleet according to concert, he returned to Conſtantinople, after plundering and burning ſeveral places, and filling Naples with conſternation.

155
Is ſucceſsful in the Low Countries.

Highly mortified by ſo many diſaſters, Charles retired into the Low Countries, breathing vengeance againſt France: and here the war was carried on with conſiderable vigour. Impatient to efface the ſtain which his military reputation had received before Metz, Charles laid ſiege to Terouane; and the fortifications being in diſrepair, that important place was carried by aſſault. Heſdin alſo was inveſted, and carried in the ſame manner. The king of France was too late in aſſembling his forces to afford relief to either of theſe places; and the emperor afterwards cautiouſly avoided an engagement.

156
But not in other places.

The imperial arms were leſs ſucceſsful in Italy. The viceroy of Naples failed in an attempt to recover Sienna; and the French not only eſtabliſhed themſelves more firmly in Tuſcany, but conquered part of the iſland of Corſica. Nor did the affairs of the houſe of Auſtria go on better in Hungary during the courſe of this year. Iſabella and her ſon appeared once more in Tranſylvania, at a time when the people were ready for revolt, in order to revenge the death of Martinuzzi, whoſe loſs they had ſeverely felt. Some noblemen of eminence declared in favour of the young king; and the baſhaw of Belgrade, by Solyman's order, eſpouſing his cauſe, in oppoſition to Ferdinand, Caſtaldo, the Auſtrian general, was obliged to abandon Tranſylvania to Iſabella and the Turks.

157
Marriage between Philip of Spain and Mary of England.
An. 1554.

In order to counterbalance thoſe and other loſſes, the emperor, in 1554, concerted a marriage between his ſon Philip and Mary of England, in hopes of adding that kingdom to his other dominions. Meanwhile the war between Henry and Charles was carried on with various ſucceſs in the Low Countries, and in Italy much to the diſadvantage of France. The French, under the command of Strozzi, were defeated in the battle of Merciano; Sienna was reduced by Medicino, the Florentine general, after a ſiege of ten months; and the gallant Sienneſe were ſubjected to the Spaniſh yoke. Much about the ſame time a plot was formed by the Franciſcans, but happily diſcovered before it could be carried into execution, to betray Metz to the Imperialiſts. The father guardian, and twenty other monks, received ſentence of death on account of this conſpiracy; but the guardian, before the time appointed for his execution, was murdered by his incenſed accomplices, whom he had ſeduced; and ſix of the youngeſt were pardoned.

158
Charles reſigns his dominions to his ſon Philip.
An. 1556.

While war thus raged in Italy and the Low Countries, Germany enjoyed ſuch profound tranquillity, as afforded the diet full leiſure to confirm and perfect the plan of religious pacification agreed upon at Paſſau, and referred to the conſideration of the next meeting of the Germanic body. During the negociation of this treaty, an event happened which aſtoniſhed all Europe, and confounded the reaſonings of the wiſeſt politicians. The emperor Charles V. though no more than 56, an age when objects of ambition operate with full force on the mind, and are generally purſued with the greateſt ardour, had for ſome time formed the reſolution of reſigning his hereditary dominions to his ſon Philip. He now determined to put it in execution. Various have been the opinions of hiſtorians concerning a reſolution ſo ſingular and unexpected; but the moſt probable ſeem to be, the diſappointments which Charles had met with in his ambitious hopes, and the daily decline of his health. He had early in life been attacked with the gout; and the fits were now become ſo frequent and ſevere, that not only the vigour of his conſtitution was broken, but the faculties of his mind were ſenſibly impaired. He therefore judged it more decent to conceal his infirmities in ſome ſolitude, than to expoſe them any longer to the public eye; and as he was unwilling to to forfeit the ſame, or loſe the acquiſitions of his better years, by attempting to guide the reins of government when he was no longer able to hold them with ſteadineſs, he determined to ſeek in the tranquillity of retirement, that happineſs which he had in vain purſued amidſt the tumults of war and the intrigues of ſtate.

In conſequence of this reſolution, Charles, who had already ceded to his ſon Philip the kingdom of Naples and the duchy of Milan, aſſembled the ſtates of the Low Countries at Bruſſels; and ſeating himſelf for the laſt time in the chair of ſtate, he explained to his ſubjects the reaſons of his reſignation, and ſolemnly devolved his authority upon Philip. He recounted with dignity, but without oſtentation, all the great things which he had undertaken and performed ſince the commencement of his adminiſtration. "I have dedicated (obſerved he) from the 17th year of my age, all my thoughts and attention to public objects, reſerving no portion of my time for the indulgence of eaſe, and very little for the enjoyment of private pleaſure. Either in a pacific or hoſtile manner, I have viſited Germany nine times, Spain ſix times, France four times, Italy ſeven times, the Low Countries ten times, England twice, Africa as often; and while my health permitted me to diſcharge the duty of a ſovereign, and the vigour of my conſtitution was equal in any degree to the arduous office of governing ſuch extenſive dominions, I never ſhunned labour, nor repined under fatigue; but now, when my health is broken, and my vigour exhauſted by the rage of an incurable diſtemper, my growing infirmities admoniſh me to retire; nor am I ſo fond of reigning, as to retain the ſceptre in an impotent hand, which is no longer able to protect my ſubjects. Inſtead of a ſovereign worn out with diſeaſes (continued he), and ſcarce half alive, I give you one in the prime of life, already accuſtomed to govern, and who adds to the vigour of youth all the attention and ſagacity of maturer years." Then turning towards Philip, who fell on his knees, and kiſſed his father's hand, "It is in your power (ſaid Charles), by a wiſe and virtuous adminiſtration, to juſtify the extraordinary proof which I give this day of my paternal affection, and to demonſtrate that you are worthy of the extraordinary confidence which I repoſe in you. Preſerve (added he) an inviolable regard for religion; maintain the Catholic faith in its purity; let the laws of your country be ſacred in your eyes; encroach not on the rights of your people; and if the time ſhould ever come when you ſhall wiſh to enjoy the tranquillity of private life, may you have a ſon to whom you can reſign your ſceptre with as much ſatisfaction as I give up mine to you." A few weeks after, he reſigned to Philip the ſovereignty of Spain and America; reſerving nothing to himſelf out of all theſe vaſt poſſeſſions but an annual penſion of 100,000 crowns.

Charles was now impatient to embark for Spain, where he had fixed on a place of retreat; but by the advice of his phyſicians, he put off his voyage for ſome months, on account of the ſeverity of the ſeaſon; and, by yielding to their judgment, he had the ſatisfaction before he left the Low Countries of taking a conſiderable ſtep towards a peace with France. This he ardently longed for; not only on his ſon's account, whoſe adminiſtration he wiſhed to commence in quietneſs, but that he might have the glory, when quitting the world, of reſtoring to Europe that tranquillity which his ambition had baniſhed out of it almoſt from the time that he aſſumed the reins of government.

The great bar to ſuch a pacification, on the part of France, was the treaty which Henry had concluded with the Pope; and the emperor's claims were too numerous to hope for adjuſting them ſuddenly. A truce of five years was therefore propoſed by Charles; during which term, without diſcuſſing their reſpective pretenſions, each ſhould retain what was in his poſſeſſion; and Henry, through the perſuaſion of the conſtable Montmorency, who repreſented the imprudence of ſacrificing the true intereſts of his kingdom to the raſh engagements that he had come under with Paul, authoriſed his ambaſſadors to ſign at Vaucelles a treaty, which would inſure to him for ſo conſiderable a period the important conqueſt which he had made on the German frontier, together with the greater part of the duke of Savoy's dominions.

159
A truce of five years concluded with France.

The Pope, when informed of this tranſaction, was no leſs filled with terror and aſtoniſhment than rage and indignation. But he took equal care to conceal his fear and his anger. He affected to approve highly of the truce; and he offered his mediation, as the common father of Chriſtendom, in order to bring about a definitive peace. Under this pretext, he appointed Cardinal Rebibo his nuncio to the court of Bruſſels, and his nephew Cardinal Caraffa to that of Paris. The public inſtructions of both were the ſame; but Caraffa, beſides theſe, received a private commiſſion, to ſpare neither intreaties, promiſes, nor bribes, in order to induce the French monarch to renounce the truce and renew his engagements with the holy ſee. He flattered Henry with the conqueſt of Naples; he gained by his addreſs the Guiſes, the queen, and even the famous Diana of Poictiers, ducheſs of Valentinois, the king's miſtreſs; and they eaſily ſwayed the king himſelf, who already leaned to that ſide towards which they wiſhed to incline him. All Montmorency's prudent remonſtrances were diſregarded; the nuncio (by powers from Rome) abſolved Henry from his oath of truce; and that weak prince ſigned a new treaty with the Pope; which rekindled with freſh violence the flames of war, both in Italy and the Low Countries.

160
Quarrel betwixt the pope and King Philip.

No ſooner was Paul made acquainted with the ſucceſs of this negociation than he proceeded to the moſt indecent extremities againſt Philip. He ordered the Spaniſh ambaſſador to be impriſoned; he excommunicated the Colonnas, becauſe of their attachment to the imperial houſe; and he conſidered Philip as guilty of high treaſon, and to have forfeited his right to the kingdom of Naples, which he was ſuppoſed to hold of the holy ſee, for afterward affording them a retreat in his dominions.

Alarmed at a quarrel with the Pope, whom he had been taught to regard with the moſt ſuperſtitious veneration, as the vicegerent of Chriſt and the common father of Chriſtendom, Philip tried every gentle method before he made uſe of force. He even conſulted ſome Spaniſh divines on the lawfulneſs of taking arms againſt a perſon ſo ſacred. They decided in his favour; and Paul continuing inexorable, the duke of Alva, to whom the

the negociations as well as the war had been committed, entered the eccleſiaſtical ſtate at the head of 10,000 veterans, and carried terror to the gates of Rome.

The haughty pontiff, though ſtill inflexible and undaunted himſelf, was forced to give way to the fears of the cardinals, and a truce was concluded for 40 days. Mean time the duke of Guiſe arriving with a ſupply of 20,000 French troops, Paul became more arrogant than ever, and baniſhed all thoughts from his mind but thoſe of war and revenge. The duke of Guiſe, however, who had precipitated his country into this war, chiefly from a deſire of gaining a field where he might diſplay his own talents, was able to perform nothing in Italy worthy of his former fame. He was obliged to abandon the ſiege of Civetella; he could not bring the duke of Alva to a general engagement; his army periſhed by diſeaſes; and the Pope neglected to furniſh the neceſſary reinforcements. He begged to be recalled; and France ſtood in need of his abilities.

Philip, though willing to have avoided a rupture, was no ſooner informed that Henry had violated the truce of Vaucelles, than he determined to act with ſuch vigour, as ſhould convince Europe that his father had not erred in reſigning to him the reins of government. He immediately aſſembled in the Low Countries a body of 50,000 men, and obtained a ſupply of 10,000 from England, which he had engaged in his quarrel; and as he was not ambitious of military fame, he gave the command of his army to Emanuel Philibert duke of Savoy, one of the greateſt generals of that warlike age.

161
The French entirely defeated at St Quintin.
An. 1557.

The duke of Savoy kept the enemy for ſome time in ſuſpenſe with regard to his deſtination; at laſt he ſeemed to threaten Champagne; towards which the French drew all their troops; then turning ſuddenly to the right, he advanced by rapid marches into Picardy, and laid ſiege to St Quintin. It was deemed in thoſe times a town of conſiderable ſtrength; but the fortifications had been much neglected, and the garriſon did not amount to a fifth part of the number requiſite for its defence: it muſt therefore have ſurrendered in a few days, if the admiral de Coligny had not taken the gallant reſolution of throwing himſelf into it with ſuch a body of men as could be collected on a ſudden. This he effected in ſpite of the enemy, breaking through their main body. The place, however, was cloſely inveſted; and the conſtable Montmorency, anxious to extricate his nephew out of that perilous ſituation, in which his zeal for the public had engaged him, as well as to ſave a town of ſuch importance, raſhly advanced to its relief with forces one half inferior to thoſe of the enemy. His army was cut in pieces, and he himſelf made priſoner.

The cautious temper of Philip on this occaſion ſaved France from devaſtation, if not ruin. The duke of Savoy propoſed to overlook all inferior objects, and march ſpeedily to Paris, which, in its preſent conſternation, he could not have failed to make himſelf maſter of; but Philip, afraid of the conſequences of ſuch a bold enterpriſe, deſired him to continue the ſiege of St Quintin, in order to ſecure a ſafe retreat in caſe of any diſaſtrous event. The town, long and gallantly defended by Coligny, was at laſt taken by ſtorm; but not till France was in a ſtate of defence.

Philip was now ſenſible that he had loſt an opportunity which could never be recalled, of diſtreſſing his enemy, and contented himſelf with reducing Horn and Catelet; which petty towns, together with St Quintin, were the ſole fruits of one of the moſt deciſive victories gained in the 16th century. The Catholic king, however, continued in high exultation on account of his ſucceſs; and as all his paſſions were tinged with ſuperſtition, he vowed to build a church, a monaſtery, and a palace, in honour of St Lawrence, on the day ſacred to whoſe memory the battle of St Quintin had been fought. He accordingly laid the foundation of an edifice, in which all theſe were included, and which he continued to forward at a vaſt expence, for 22 years. The ſame principle which dictated the vow directed the building. It was ſo formed as to reſemble a gridiron—on which culinary inſtrument, according to the legendary tale, St Lawrence had ſuffered martyrdom. Such is the origin of the famous Eſcurial near Madrid, the royal reſidence of the kings of Spain.

162
Peace co cluded.

The firſt account of that fatal blow which France had received at St Quintin, was carried to Rome by the courier whom Henry had ſent to recal the duke of Guiſe. Paul remonſtrated warmly againſt the departure of the French army; but Guiſe's orders were peremptory. The arrogant pontiff therefore found it neceſſary to accommodate his conduct to the exigency of his affairs, and to employ the mediation of the Venetians, and of Coſmo de Medici, in order to obtain peace. The firſt overtures of this nature were eagerly liſtened to by the Catholic king, who ſtill doubted the juſtice of his cauſe, and conſidered it as his greateſt misfortune to be obliged to contend with the Pope. Paul agreed to renounce his league with France; and Philip ſtipulated on his part, that the duke of Alva ſhould repair in perſon to Rome, and after aſking pardon of the holy father in his own name and in that of his maſter, for having invaded the patrimony of the church, ſhould receive abſolution from that crime. Thus Paul, through the ſuperſtitious timidity of Philip, finiſhed an unpropitious war not only without any detriment to the apoſtolic ſee, but ſaw his conqueror humbled at his feet: and ſo exceſſive was the veneration of the Spaniards in that age for the papal character, that the duke of Alva, the proudeſt man perhaps of his time, and accuſtomed from his infancy to converſe with princes, acknowledged, that when he approached Paul, he was ſo much overawed, that his voice failed, and his preſence of mind forſook him.

163
Conseque ces of the war in It ly.

But though this war, which at its commencement threatened mighty revolutions, was terminated without occaſioning any alteration in thoſe ſtates which were its immediate object, it produced effects of conſiderable conſequence in other parts of Italy. In order to detach Octavio Farneſe, duke of Parma from the French intereſt, Philip reſtored to him the city of Placentia and its territory, which had been ſeized by Charles V. and he granted to Coſmo de Medici the inveſtiture of Sienna, as an equivalent for the ſums due to him. By theſe treaties, the balance of power among the Italian ſtates was poiſed with more equality, and rendered leſs variable than it had been ſince it received the firſt violent ſhock from the invaſion of Charles VIII. and Italy henceforth ceaſed to be the theatre on which the monarchs of Spain, France, and Germany, contended for fame and dominion. Their hoſtilities, excited by new objects, ſtained other regions of Europe with blood, and made other ſtates feel, in their turn, the miſeries of war.

164
e French
ſucceſsful
the Low
untries.

The duke of Guiſe, who left Rome the ſame day that his adverſary the duke of Alva made his humiliating ſubmiſſion to the Pope, was received in France as the guardian angel of the kingdom. He was appointed lieutenant-general in chief, with a juriſdiction almoſt unlimited; and, eager to juſtify the extraordinary confidence which the king had repoſed in him, as well as to perform ſomething ſuitable to the high expectations of his countrymen, he undertook in winter the ſiege of Calais. Having taken that place, he next inveſted Thionville in the duchy of Luxembourg, one of the ſtrongeſt towns on the frontiers of the Netherlands; and forced it to capitulate after a ſiege of three weeks. But the advantages on this quarter were more than balanced by an event which happened in another part of the Low Countries. The mareſchal de Termes governor of Calais, who had penetrated into Flanders and taken Dunkirk, was totally routed near Gravelines, and taken priſoner by Count Egmont. This diſaſter obliged the duke of Guiſe to relinquiſh all his other ſchemes, and haſten towards the frontiers of Picardy, that he might there oppoſe the progreſs of the enemy.

The eyes of all France were now turned towards the duke of Guiſe, as the only general on whoſe arms victory always attended, and in whoſe conduct as well as good fortune they could confide in every danger. His ſtrength was nearly equal to the duke of Savoy's, each commanding about 40,000 men. They encamped at the diſtance of a few leagues from one another; and the French and Spaniſh monarchs having joined their reſpective armies, it was expected that, after the viciſſitudes of war, a deciſive battle would at laſt determine which of the rivals ſhould take the aſcendency for the future in the affairs of Europe. But both monarchs, as if by agreement, ſtood on the defenſive; neither of them diſcovering any inclination, though each had it in his power, to reſt the deciſion of a point of ſuch importance on the iſſue of a ſingle battle.

165
ce con-
ded be-
en Hen-
nd Phi-

During this ſtate of inaction, peace began to be mentioned in each camp, and both Henry and Philip diſcovered an equal diſpoſition to liſten to any overture that tended to re-eſtabliſh it. The private inclinations of both kings concurred with their political intereſts and the wiſhes of their people. Philip languiſhed to return to Spain, the place of his nativity, and peace only could enable him, either with decency or ſafety, to quit the Low Countries. Henry was now deſirous of being freed from the avocations of war, that he might have leiſure to turn the whole force of his government towards ſuppreſſing the opinions of the reformers, which were ſpreading with ſuch rapidity in Paris and the other great towns, that they began to grow formidable to the eſtabliſhed church. Court intrigues conſpired with theſe public and avowed motives to haſten the negociation, and the abbey of Cercamp was fixed on as the place of congreſs.

166
th of
rles V.

While Philip and Henry were making theſe advances towards a treaty which reſtored tranquillity to Europe, Charles V. whoſe ambition had ſo long diſturbed it, but who had been for ſome time dead to the world, ended his days in the monaſtery of St Juſtus in Eſtremadura, which he had choſen as the place of his retreat, as is particularly related under the article CHARLES V.

After the death of Charles, the kingdom of Spain ſoon loſt great part of its conſequence. Though Charles had uſed all his intereſt to get his ſon Philip elected emperor of Germany, he had been totally diſappointed; and thus the grandeur of Philip II. never equalled that of his father. His dominions were alſo conſiderably abridged by his tyrannical behaviour in the Netherlands. In conſequence of this, the United Provinces revolted; and after a long and bloody war obtained their liberty *. In this quarrel Elizabeth of England took part againſt Philip, which brought on a war with Spain. The great loſſes he ſuſtained in theſe wars exhauſted the kingdom both of men and money, notwithſtanding the great ſums imported from America. Indeed the diſcovery of that country has much impoveriſhed, inſtead of enriching Spain; for thus the inhabitants have been rendered lazy and averſe to every kind of manufacture or traffic, which only can be a durable ſource of riches and ſtrength to any nation. The ruin of the kingdom in this reſpect, however, was completed by Philip III. who, at the inſtigation of the inquiſition, and by the advice of his prime miniſter the duke of Lerma, expelled from the kingdom all the Moreſcoes or Moors, deſcendants of the ancient conquerors of Spain. Thirty days only were allowed them to prepare for their departure, and it was death to remain beyond that time. The reaſon for this barbarous decree was, that theſe people were ſtill Mahometans in their hearts, though they conformed externally to the rite of Chriſtianity, and thus might corrupt the true faith. The Moreſcoes, however, choſe themſelves a king, and attempted to oppoſe the royal mandate; but, being almoſt entirely unprovided with arms, they were ſoon obliged to ſubmit, and were all baniſhed the kingdom. By this violent and impolitic meaſure, Spain loſt almoſt a million of induſtrious inhabitants; and as the kingdom was already depopulated by bloody wars, by repeated emigrations to America, and enervated by luxury, it now ſank into a ſtate of languor from which it has never recovered.

167
Revolt of
the United
Provinces.

168
Expulſion
of the
Moors, and
its bad con-
ſequences
to Spain.

169
Philip IV.
An. 1621.

The reign of Philip IV. the ſucceſſor of Philip III. commenced in 1621. He had not been long ſeated on the throne before the expiration of the 12 years truce which Philip III. had concluded with the United Provinces, again involved Spain in the calamities of war. The renewed conteſt was carried on with vigour by both the contending powers, till in the year 1648 the Spaniſh monarch was compelled to ſign the treaty of Munſter, by which the United Provinces were declared free and independent. From this period the power of the Spaniſh monarchy began to decline, as it had already been ſeverely ſhaken by the loſs of Portugal.

170
Final loſs
of the
United
Provinces.

171
Revolt of
Portugal.
An. 1640.

This event took place in 1640, when the Portugueſe finally threw off the Spaniſh yoke, and that country remained an independent kingdom, till the power of Bonaparte compelled its lawful monarch to abandon his European territories. Philip IV. alſo proſecuted an unſucceſsful war with France. This war was terminated in 1659, and Philip died about ſix years after.

172
Charles II.
An. 1665.

The new monarch, Charles II. was only four years old when he ſucceeded to the throne. He was of a feeble conſtitution, and a weak capacity. The war which had been occaſioned by the revolt of Portugal, continued till the year 1668, when a peace was concluded, and the independence of that kingdom was acknowledged. Hoſtilities had been renewed with France, but

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* See *United Provinces.*

but greatly to the diſadvantage of the Spaniards, who loſt ſome of the richeſt and beſt fortified towns which they ſtill poſſeſſed in Flanders. The peace of Nimeguen between France and Spain was ſigned in the year 1678. Charles II. died in 1700, and with him ended the male line of the houſe of Auſtria; a dynaſty to which Spain owes leſs than to any other race of its monarchs.

Hiſtorians have been fond of repreſenting the dominion of the Auſtrian princes in Spain as productive of the greateſt glory and advantage to that kingdom. The reign of Charles V. may indeed be ſaid to have been a glorious reign; but little of its glory belonged to Spain, and the emperor certainly neglected her intereſts in advancing thoſe of his more favoured territories. The picture given by the Spaniſh hiſtorians of the ſtate of Spain at the acceſſion and during the reign of Philip II. fully evinces how little that kingdom had profited by the change in the line of its ſucceſſion. Agriculture was neglected; commerce was fettered by enormous duties, and the people were held in the chains of ignorance and ſuperſtition.

173 Acceſſion of the Houſe of Bourbon. An. 1700.

Charles II. was ſucceeded by Philip V. duke of Anjou, and grandſon to Louis XIV. of France, who had been nominated heir to the Spaniſh throne by the late monarch. The tranſactions of the war which was ſoon declared againſt France and Spain, by England, Holland, and the empire, aſſiſted by Savoy, Portugal, and Pruſſia, have been already related under the article BRITAIN, from N° 345 to N° 371. The treaty of Utrecht, which terminated the differences between the principal contending powers, was ſigned in 1713, and in 1715 a permanent peace was concluded between Spain and Portugal. Hoſtilities, however, ſtill continued with Savoy and Sardinia, and in 1715 the iſland of Sardinia was taken by a Spaniſh fleet, and the year following another fleet belonging to the ſame nation invaded Sicily, but was defeated by the Britiſh admiral Byng. By a new treaty in 1720, Sardinia was given to the duke of Savoy, and Sicily to the emperor; and by the treaty of Seville, concluded in 1729, the duchies of Tuſcany, Parma, and Placentia, were ceded to Spain. In 1731, the Spaniſh king invaded Naples, took poſſeſſion of that kingdom, and conferred it on his ſon Don Carlos, in conſequence of which war was declared between Spain and the empire in 1733. At the end of that year the palace of Madrid was conſumed by fire, and all the archives relating to the Indies periſhed in the flames.

In 1739, hoſtilities were renewed between Spain and Britain, (ſee BRITAIN, N° 403); but the only ſucceſſes acquired by the latter power were the capture of Porto Bello by Admiral Vernon, and that of the Manilla galeon by Commodore Anſon. After a long and turbulent reign, Philip V. died in 1746.

174 Ferdinand VI. An. 1746.

Ferdinand VI. a mild, prudent, and beneficent prince, reformed abuſes in the adminiſtration of juſtice, and management of the finances. He revived commerce, eſtabliſhed manufactures, and promoted the proſperity of his kingdom. In April A. D. 1755, Quito in South America was deſtroyed by an earthquake.

175 Charles III. An. 1759.

Charles III. ſucceeded Ferdinand in 1759. The famous family compact was concluded at Verſailles, A. D. 1761, among the four kings of the houſe of Bourbon. The Engliſh, alarmed by the naval preparations of Spain, declared war in 1762 (ſee BRITAIN, N° 450), and took Havannah in the iſland of Cuba, and Manilla in the Eaſt Indies. Notwithſtanding this ſucceſs, peace was haſtily concluded at Fountainbleau, in November, by which the Havannah was reſtored. In 1767 the Jeſuits were expelled from Spain. An unſucceſsful expedition was concerted againſt Algiers, A. D. 1775, the particulars of which are related in M. Swinburne's Travels, letter v. In the war between Great Britain and her American colonies, Spain, by the intrigues of the French court, was prevailed on to take up arms in ſupport of the latter. At the concluſion of that calamitous war, Great Britain, in a treaty with Spain, ceded to this power, Eaſt and Weſt Florida, and the iſland of Minorca. Charles died in 1788, and was ſucceeded by his ſecond ſon Charles Anthony prince of Aſturias, the eldeſt having been declared incapable of inheriting the crown.

176 Charles An. 17

Charles IV. had not been long ſeated on the throne before the portentous revolution in France involved Europe in a general ſcene of political and military conteſt. The king of Spain joined the general confederacy againſt the new republic, and in conſequence was numbered among the objects of its reſentment, by a declaration of war in 1793. The military operations of Spain, however, were extremely languid; and after two campaigns, in which ſhe might be ſaid to carry on rather a defenſive than offenſive war, againſt the republican armies (ſee FRANCE, N° 411), ſhe was compelled to conclude a treaty of peace, which was ſigned at Baſil on the 22d July 1795. By this treaty the French republic reſtored to the king of Spain all the conqueſts which ſhe had made from him ſince the commencement of hoſtilities, and received in exchange all right and property in the Spaniſh part of St Domingo.

177 Engages the confederation againſt France. An. 179

178 War between Spa and Brita An. 179

This treaty was ſoon followed by a rupture with Great Britain. On 5th October 1796, the court of Spain publiſhed a manifeſto againſt this country, to which the court of London made a ſpirited reply; and about the ſame time was publiſhed a treaty of offenſive and defenſive alliance, which had been concluded about two months before, between the king of Spain and the French republic. In the war which followed between Spain and Great Britain, his Catholic majeſty could boaſt of but little honour or ſucceſs; and the French republic gained little from its new ally, but the contributions of money, which ſhe from time to time compelled him to advance. On the 14th of February 1797, a Spaniſh fleet of 27 ſail of the line was defeated by Sir John Jervis off Cape St Vincent (ſee FRANCE, N° 482); and four of the Spaniſh line of battle ſhips were left in the hands of the victors. From this time till the temporary termination of hoſtilities by the peace of Amiens in 1802, there is nothing remarkable in the tranſactions of Spain. An. 179

On the renewal of the war in 1803, Spain was again compelled, by the overbearing power of France, to take an active part againſt Great Britain, and fitted out a formidable fleet, which was united to a conſiderable naval force of the new-made emperor of the French. The Spaniſh declaration of war againſt Britain is dated at Madrid on the 12th of December 1804; and on the 21ſt of October 1805, the combined fleets of France and Spain were nearly annihilated by Lord Nelſon's deciſive victory off Cape Trafalgar. An. 180 An. 180

After this terrible blow to the naval power of Spain, nothing

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nothing of importance took place till 1808, when the deſigns of Bonaparte againſt the independence of Spain, which had been long ſuſpected, were openly avowed, in conſequence of a domeſtic diſpute, probably fomented by the emiſſaries of France, which took place between Charles IV. and the prince of Aſturias. During the winter of 1807-8 the public mind in Spain had been greatly agitated. Some accuſed the prince of the Peace, Don Manuel Godoy, (who had long held the helm of ſtate, and was the richeſt and moſt powerful ſubject in the kingdom), of having concerted with the queen to deſtroy the prince of Aſturias. Others accuſed the prince of Aſturias of being at the head of a party to dethrone his father. Solemn councils and long proceedings, followed up by exiles and violent acts, far from calming opinions, ſerved to agitate them ſtill more.

In March 1808, ſeveral diſturbances happened at Aranjuez. Theſe diſturbances were excited by a report that the royal family were about to quit Spain and emigrate to America. In conſequence of this report, the populace of the neighbouring villages repaired in crowds to Aranjuez, where they found the attendants of the court packing up the baggage of the royal houſehold; and underſtood that relays of horſes were ſtationed on the road to Seville, and that every thing was prepared for the departure of the royal fugitives, who were to take ſhipping at that port. It was ſuſpected that Don Manuel Godoy, or, as he has commonly been called, the prince of the Peace, was the chief inſtigator of this unpopular meaſure; and the fury of the people was directed chiefly againſt that nobleman, whoſe palace they attacked on the 18th of March. He, however, found means to eſcape for the preſent, but was afterwards arreſted in a garret of his own houſe. In the mean time the king iſſued two decrees with a view to allay the popular ferment; but as this ſtill continued, he on the 19th took the extraordinary reſolution of abdicating the throne in favour of the prince of Aſturias. This reſolution was made known by a royal decree, in which Charles declared that, as his natural infirmities no longer permitted him to ſupport the weight of government, and the re-eſtabliſhment of his health required a change of climate, he had after the moſt mature deliberation reſolved to abdicate his crown in favour of his heir the prince of Aſturias; and this reſolution he declared to be the reſult of his own free will.

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The new ſovereign was accordingly proclaimed by the title of Ferdinand VII. and iſſued an edict confiſcating the effects of Don Manuel Godoy, and announcing the appointment of the duke of Infantado, a nobleman deſervedly popular for his talents and virtues, to the preſidency of Caſtile and the command of the royal guards.

Theſe diſturbances have commonly been attributed to the machinations of the French emperor, who had gained a complete aſcendency over the weak Charles; and had rendered the prince of the Peace entirely ſubſervient to the views which he had formed on the independence and the liberties of Spain. How far this ſuppoſition is correct, it is impoſſible for us at this time to determine; but it is rendered probable by the active meaſures taken about this time by Napoleon to awe by a French force the Spaniſh nation. Murat the grand duke of Berg was at this time on his march towards the capital with a body of French troops; and his march was haſtened by the information which he had received of the tumults at Aranjuez. This general cauſed it to be intimated to Ferdinand, that the emperor of the French was on his journey to Spain, and adviſed him to meet his maſter on the road. In the mean time he was tampering with the ſelf-depoſed monarch, whom he aſſured of the aſſiſtance of Bonaparte in reinſtating him on the throne. Charles accordingly addreſſed a letter to Bonaparte, in which he contradicts the aſſertion of his decree of the 19th; and declares that his abdication was a meaſure of compulſion; and throws himſelf on the protection of that great monarch, his friend and ally, from whom alone he and his ſubjects can hope to derive tranquillity and happineſs.

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Deſigns of Bonaparte on the independence of Spain.

It appears to have been the deſign of Murat to draw out of Spain the whole of the royal family, and in this deſign he completely ſucceeded. Ferdinand ſet out to meet Bonaparte, accompanied by the French general Savary, and had advanced as far as Vittoria, where he was left by Savary, and where he found himſelf ſurrounded by French troops. He was compelled to remain at Vittoria, until Savary, who had proceeded to Bayonne, where Bonaparte then was, ſhould return and intimate to him the pleaſure of his maſter. When the general returned, he brought with him a letter from Napoleon to Ferdinand. In this letter, which is addreſſed to Ferdinand as prince of Aſturias, and not as king of Spain, Bonaparte aſſured the prince, that the ſole object of his journey into Spain was to make ſuch reforms in that kingdom as would be agreeable to the public feelings. Without pretending to judge reſpecting the late revolution, he cautions Ferdinand againſt the danger to be apprehended from ſovereigns permitting their ſubjects to take juſtice into their own hands. After inſinuating his own power over the royal family of Spain, and adverting to the tumults that had taken place, in which ſome of his troops had fallen, he makes uſe of the following expreſſion, "a few of my ſoldiers may be murdered; but the ſubjugation of Spain ſhall be the conſequence of it."

Ferdinand confounded at the conduct of the French emperor, and alarmed for his own perſonal ſafety, was compelled to proceed on his journey. When he arrived at Bayonne he was received by the prince of Neufchatel and Duroc, and was conducted to a place by no means ſuited to his rank or his character as ally of Bonaparte. He however dined with the emperor; but after he had retired, General Savary brought a meſſage from his maſter, intimating his determination that the preſent royal family of Spain ſhould give up to him all right and title to the crown of that kingdom, and that they ſhould be ſucceeded by a branch of his own family. Aſtoniſhed at this intimation, Ferdinand ſent his prime miniſter Cevallos, to canvaſs the matter with M. Champagny, the confidential ſecretary of Napoleon. The conference was held in an apartment adjoining the cabinet of the emperor, and, as it appeared, within his hearing: for when Cevallos was arguing with great warmth and ſtrength of reaſoning on the injuſtice and even impolicy of the propoſed meaſures, both he and Champagny were ordered into the emperor's preſence; and the former was reviled in the groſſeſt terms, branded with the appellation of a traitor, accuſed of having maintained that the recognition of Bonaparte was not neceſſary to the validity of his maſter's title to the throne of Spain, and of having affirmed that if the French dared to attack the independence of the Spaniſh monarchy, three hundred thouſand men would riſe to defend it and repel the invaders. After Napoleon had thus indulged the violence of his temper, he entered in a harſh and arrogant ſtyle on a diſcuſſion of the points in diſpute between his ſecretary and Cevallos; and finding that he could neither convince nor ſilence the Spaniſh miniſter, he abruptly concluded with the following peremptory declaration: "I have a ſyſtem of policy of my own; you ought to adopt more liberal ideas, to be leſs ſuſceptible on the point of honour, and not ſacrifice the proſperity of Spain to the intereſt of the Houſe of Bourbon." From this time the deſtiny of the Spaniſh royal family was fixed. Ferdinand the monarch of the people's choice was already a captive, and not many days elapſed before the reſt of the royal family was in the ſame ſituation. On the firſt of May, Ferdinand had made a conditional renunciation of his crown in favour of his father, and on the fifth of the ſame month Bonaparte had a long converſation with Charles the Fourth and his queen. Ferdinand was called in by his father, to hear, in the preſence of him and the queen, the diſguſting and humiliating expreſſions which were uttered by the French emperor, expreſſions of ſuch a nature, that Cevallos ſays he dares not record them. All the parties were ſeated except Ferdinand; he was ordered by his father to make an abſolute renunciation of the crown, on pain of being treated as an uſurper and a conſpirator againſt the right of his parents. With this requiſition Ferdinand complied, and thus completed the abdication of his family; for it appeared that on the preceding day Charles had executed the deed of reſignation, which transferred to the emperor of the French his title to the crown of Spain, on conſideration of receiving during his life an annuity of eighty millions of reals, of a dowry to his queen of two millions of reals, and to the infantes of Spain the annual ſum of four hundred thouſand livres.

Thus had Bonaparte effected the transference of the Spaniſh nation from the Bourbon dynaſty to his own family, ſo far at leaſt as that transference could be effected by the formal renunciation in his favour of the royal family, and by a ſtrong but ſuſpicious recommendation from them to the Spaniſh nation to receive their new ſovereign, whoever he ſhould be, with ſubmiſſion and obedience. Filled as the annals of mankind are with examples of treachery, perfidy, and violence, it would be difficult to point out a deed which in every part of its performance, in its own nature, or in the character of the means by which it was effected, bears ſuch ſtrong marks of unjuſt and lawleſs tyranny.

It was ſoon underſtood that Napoleon deſigned the crown of Spain for his brother Joſeph, who had ſome time before been placed on the throne of Naples. In an addreſs to the Spaniſh nation, which Bonaparte publiſhed immediately after the abdication of Charles and Ferdinand, he informed them that he did not mean to reign over them in perſon, but that he would give them a ſovereign every way reſembling himſelf. In the beginning of June Joſeph Bonaparte arrived in the neighbourhood of Bayonne, where he was received by a deputation of the grandees of Spain and from the council of Caſtile, and preſented with a congratulatory addreſs, written in the moſt fulſome ſtyle of adulation, on his acceſſion to the Spaniſh throne.

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But though the nomination of Joſeph Bonaparte was eaſily effected, it was not ſo eaſy to place him on the throne in oppoſition to the almoſt unanimous will of the Spaniſh nation. Ferdinand the Seventh was the darling of the people; and his acceſſion to the crown had been hailed by them, both as placing them under the dominion of a beloved monarch, and as releaſing them from the tyranny of Godoy, who was an object of almoſt univerſal deteſtation. They had hitherto ſubmitted with patience to the influence and power of France, hopeleſs of reſcuing themſelves while Charles poſſeſſed the throne, and while the prince of the Peace directed his councils; but the acceſſion of Ferdinand, and the conſequent diſgrace of the favourite, had led them to hope that they ſhould now find a ſovereign willing to direct and aſſiſt their efforts to regain their independence. Under theſe expectations, a great part of the nation had come forward to offer their aſſiſtance in ſupporting the claims of the new monarch. The province of Catalonia, the moſt induſtrious and the moſt warlike of the Spaniſh nation, particularly diſtinguiſhed itſelf by the promptitude and extent of its offers. Soon after Ferdinand had aſcended the throne, the captain-general of Catalonia, relying on the well-known reſources and diſpoſitions of the inhabitants, had come forward with an offer of a military force of above a hundred thouſand men; and other provinces would have followed this example, but Ferdinand had diſcouraged theſe military preparations, and appeared willing to ſubmit quietly to French bondage.

The ſpirit which had animated the Spaniards thus boldly to ſupport their favourite ſovereign, was not of a nature to be chilled and repreſſed by his timidity or example. The hatred which they had conceived againſt the French daily found freſh ſources of nouriſhment. They ſaw Ferdinand, who had rejected their proffered ſervices leſt he ſhould expoſe himſelf to the ſuſpicion or diſpleaſure of Bonaparte, enticed by deceit, or compelled by violence, to relinquiſh his kingdom and commit himſelf to the power of his enemy. They anticipated the conſequences, and prepared to reſiſt them with vigour and unanimity. The renunciation of the royal family in favour of Bonaparte was no ſooner known in Spain, than the northern provinces burſt into open inſurrection. Aſturias and Gallicia ſet the glorious example; and it was ſoon followed by almoſt every part of Spain, not immediately occupied or overawed by the armies of France.

One of the firſt ſteps taken by the leaders of the inſurrection was, to aſſemble the juntas or general aſſemblies of the provinces. When theſe were organized, they iſſued proclamations, calling on the Spaniards to riſe in defence of their ſovereign, and in the aſſertion of their own independence. Beſides theſe proclamations from the provincial juntas, addreſſes were publiſhed in almoſt very province by the leaders of the popular cauſe; in particular, the province of Aragon was addreſſed by Palafox, a name celebrated in the annals of the Spaniſh revolution, in a bold and ſpirited manifeſto. The junta of Seville, which aſſembled on the 27th of May, formed itſelf into a ſupreme junta of government, cauſed Ferdinand to be proclaimed king of Spain, took poſſeſſion of the military ſtores, and iſſued an order for all males from 16 to 45, who had not children, to enroll themſelves in the national armies.

It was natural that, when entering on ſo determined

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an oppoſition to the meaſures of Bonaparte, the Spaniards ſhould turn their eyes towards that nation, by whom alone the ambitious views of that potentate had been ſucceſsfully combated. A peace and alliance with Britain was evidently not only a meaſure of policy, but would afford them the moſt effectual aſſiſtance in the formidable ſtruggle in which they were about to engage. Accordingly, deputies were diſpatched to Great Britain from ſeveral of the provinces, to ſolicit the aid and friendſhip of that country, and to concert meaſures with the Britiſh miniſtry for executing the plans which had been contrived for freeing the kingdom from the French yoke. The junta of Seville iſſued a declaration of war with France, and declared the Spaniſh nation on terms of peace and amity with Britain. The Spaniſh deputies were empowered to ſolicit ſupplies of arms, ammunition, clothing and money; but it was thought that a ſupply of Britiſh troops would be unneceſſary, the Spaniſh patriots conſidering themſelves as fully equal to the defence of their country. The cauſe of the Spaniſh patriots was eagerly embraced by the court of London, and by the Britiſh nation at large, and the moſt active meaſures were quickly taken to ſend them effectual aid.

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While theſe preparations were making on the part of the Spaniards, the French forces were collecting in great numbers, both on the frontiers, and in the neighbourhood of the capital. Above 25,000 men, under the command of Beſſieres and Laſſoles, threatened the provinces of Aſturias and Biſcay, or occupied the plains of Caſtile. Ten thouſand men were ſhut up in the citadel of Barcelona; and, to relieve them, a ſtrong body of French troops had marched from the frontiers, and laid ſiege to Zaragoza. A conſiderable body under General Moncey attacked the city of Valencia; while the grand duke of Berg, after having detached General Dupont at the head of 20,000 men, to quiet the inſurrection of the ſouthern provinces, held Madrid with about 15,000 troops. Junot, with about 25,000 men, had entered Portugal, and taken poſſeſſion of the capital. The whole French force at this time in Spain cannot be computed at leſs than 100,000 men. Theſe were oppoſed by a very numerous, but undiſciplined force, commanded by generals of acknowledged bravery, but differing widely from each other in experience and military prudence. General Palafox commanded in Aragon; General Caſtanos in the ſouthern provinces; and General Blake in the north.

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The firſt exertions of the Spaniſh patriots were eminently ſucceſsful, though they have been greatly exaggerated in the newſpapers publiſhed under authority of the juntas. The harbour of Cadiz, which contained a numerous and well-appointed fleet, was under the command of the marquis de Solano, a man notoriouſly attached to the French intereſt; and here lay a French fleet, conſiſting of five ſhips of the line and a frigate. One of the firſt efforts of the patriots was, to obtain poſſeſſion both of Cadiz and the French fleet, and in this they completely ſucceeded. Solano was arreſted and put to death, and Don Morla was appointed in his room. In the beginning of June the French fleet was ſummoned to ſurrender, and on the admiral's refuſal, was furiouſly attacked by the batteries on ſhore, and obliged to capitulate. The force detached by Murat, under Dupont, was attacked near Baylen on the 22d July by Major-general Reding, ſecond in command under Caſtanos, and after having been defeated, was compelled to ſurrender at diſcretion. The French force beſieging Zaragoza, was repeatedly attacked by General Palafox, and ſuffered conſiderable loſſes, while that city held out with the moſt heroic bravery. Perhaps there are few inſtances in the annals of modern warfare, in which ſuch perſevering and ſucceſsful courage has been diſplayed, as by the defenders of Zaragoza. All the means of attack which were in poſſeſſion of the French, directed by the ſkill with which their long experience and ſucceſs had ſupplied them, were made uſe of. The inhabitants were obliged continually to be upon their guard, and to be prepared to reſiſt the moſt unexpected and ſecret, as well as the moſt open and violent aſſaults. The city was frequently bombarded in the middle of the night, at the ſame time that the gates were attempted to be forced, under cover of the ſhells. More than once the French got into ſome parts of the town; but they were received with ſo much coolneſs and bravery, that they were never able to preſerve what they had with ſo much difficulty and loſs acquired. The women vied with their huſbands, ſons, and brothers, in the diſplay of patriotiſm and contempt of danger: regardleſs of the fire of the enemy, they ruſhed into the very middle of the battle, adminiſtering ſupport and refreſhment to the exhauſted and wounded, and animating, by their exhortations and example, all ranks to ſuch a diſplay of firmneſs and bravery as long ſecured this important city. When it is recollected, that the attacks of the French were numerous and varied, that they were conſtantly repeated with freſh, and generally with increaſing forces, and that the ſole defence of the city reſted with its ſpirited inhabitants and the army of Palafox; ſome idea may be formed of the difficulties they muſt have undergone and ſurmounted, and of the glory to which they are ſo juſtly entitled. The patriots had gained poſſeſſion of moſt of the ſea ports in the bay of Biſcay, and headed by the biſhop of St Anderp, repulſed the French in ſeveral attacks. The French force under General Moncey was alſo repulſed before Valencia, and the patriots were equally ſucceſsful in ſeveral other quarters; ſo that by the end of July there did not remain above 40,000 French forces within the Spaniſh territory.

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Arrival and
flight of
Joſeph Bonaparte.

In the meantime preparations were making at Madrid for the reception of the new ſovereign Joſeph; and Murat, under pretence of ill health, quitted the capital, to give way to the brother of his maſter. Joſeph Bonaparte arrived at Madrid in the latter end of July, with a guard of 10,000 men; but ſoon after his arrival the news of the defeat and capitulation of Dupont reached Madrid, and threw the new court into the utmoſt conſternation. They underſtood that the victorious army of Caſtanos was on its march towards the capital; and if he did not ſpeedily retire from ſo dangerous a poſition, King Joſeph dreaded either falling into the hands of the conqueror of Dupont, or of being intercepted in his retreat by the army of General Blake. In this ſituation he found himſelf under the neceſſity of quitting the capital which he had ſo lately entered, and before the end of the month he had reached Burgos in his precipitate flight towards the frontiers. Thus, within the ſpace of two months, did the people of Spain behold their country almoſt entirely freed from the preſence of the French; and this glorious and happy iſſue had been brought about by their own intrepidity. At a time when their ſituation was the moſt diſpiriting and forlorn;

ſorn; when their king had been compelled to forſake them, and to make over his right to the throne to a foreign potentate; when they beheld ſcarcely any troops ſurrounding them on all ſides, but thoſe of that potentate, they roſe in arms, and oppoſed themſelves, unſkilled as they were in war, and totally unprepared for it, to a man before whom the mightieſt empires in Europe had fallen.

187 Reverſes. The ſucceſſes of the Spaniſh arms, though brilliant and important, were but tranſient. The leaders of the inſurrection appear to have been but ill calculated to oppoſe the ſyſtem of tactics which had been ſo often practiſed with ſucceſs by the conqueror of Marengo, of Jena, and of Auſterlitz. Though the conqueſts of Auſtria and Pruſſia had been effected by the ſame ſyſtem which the French were now purſuing in Spain, the military men of this kingdom were incapable of analyzing them, or of adopting effectual meaſures of oppoſition or defence. In a ſeries of about 30 bulletins, publiſhed from the French army of Spain, comprehending from the beginning of November 1808 to the middle of January 1809, we read of nothing but the rapid movements and ſucceſſes of the French, and the defeat and annihilation of the beſt appointed armies of the inſurgents. In Gallicia, General Blake, after having withſtood the duke of Dantzick (Marſhal Ney), in ſeveral encounters, was at length defeated, and his army diſperſed. A diviſion of the army of Eſtremadura, under Count Belvider, which had marched from Madrid to ſupport the city of Burgos, was attacked and defeated by a diviſion of the French army under the dukes of Iſtria and Dalmatia; while the army of General Caſtanos was in a great meaſure diſperſed, after a ſevere conflict on the heights of Tudela. According to the French account, the army of Caſtanos conſiſted of 45,000 men. It was oppoſed by the duke of Montebello, and entirely defeated, with the loſs of nearly 4000 killed, and 5000 taken priſoners.

In the meantime Bonaparte had entered Spain, and taken the command of the French army. He advanced by rapid marches towards Madrid, and at the end of November his advanced guard reached the important paſs of Somoſierra. This paſs was defended by a body of 13,000 Spaniards, with ſixteen pieces of cannon. They were attacked by the French under the duke of Belluno, and after making a conſiderable ſtand, were entirely defeated. On the 2d of December Bonaparte arrived in the neighbourhood of Madrid, and on the 5th he was maſter of that capital.

188 Britiſh expeditions in ſupport of the Spaniſh patriots. While the Spaniſh patriots were thus purſuing their plan of oppoſition to French tyranny with various ſucceſs, the Britiſh cabinet were fitting out formidable expeditions to the coaſts of Spain and Portugal. The reſult of the expedition under Sir Harry Burrard and Sir Arthur Welleſley, the battle of Vimiera, the convention of Cintra, and the conſequent evacuation of Portugal by the French, in the month of Auguſt 1808, have been already noticed under Portugal, N° 49 and 50. After theſe tranſactions, the greater part of the Britiſh army under the command of Lieutenant-general Sir John Moore, proceeded on their march to the frontiers of Spain. The progreſs and operations of this army will be detailed afterwards. About the middle of the ſame month, a body of 13,000 Britiſh troops, under the command of Sir David Baird, arrived at Corunna, and proceeded through the interior of the country, intending to join Sir John Moor in the neighbourhood of Madrid. A brigade of 10,000 men under General Hope, reached that capital, and eſtabliſhed themſelves at the Eſcurial; but on the approach of Bonaparte, were under the neceſſity of retiring.

189 March of Sir John Moore to Sahagun. Experience has ſhown that in their military campaigns on the continent, Britiſh forces have to contend with numerous difficulties, ſurmountable only by the utmoſt prudence and vigilance on the part of the commanding officers, and by a conſiderable degree of ſkill and foreſight on that of the projectors of ſuch undertakings. Never perhaps were theſe difficulties more ſeverely felt than in the march of Sir John Moore from Portugal to the centre of the Spaniſh territory. It was found that in whatever direction he might proſecute his march, he would encounter either bad roads or ſcanty ſupplies of proviſions. In particular, the difficulty of tranſporting the artillery over the Portugueſe mountains was extreme; and the Portugueſe at Liſbon were either egregiouſly ignorant of the ſtate of the roads which led through their own country to the Spaniſh frontiers, or were unwilling to communicate the information which they really poſſeſſed. Under theſe circumſtances it was found neceſſary to divide the Britiſh army; and it was determined to ſend forward one diviſion conſiſting of 6000 men under the command of Lieutenant-General Hope, which was directed to march by Elvas, to enter Spain by Badajos, and to proceed along the Madrid road by way of Eſpinar. Another diviſion, conſiſting of two brigades under General Paget, was detached by way of Elvas and Alcantara, where it was to paſs the Tagus. Two brigades under General Beresford moved through Portugal by way of Coimbra and Almeyda towards Salamanca, while three brigades under General Fraſer marched towards the frontiers of Spain by Abrantes and Almeyda.

Burgos had been recommended by the Spaniſh government as the point of union for the Britiſh troops, and Madrid and Valladolid were appointed for magazines. The Britiſh had been led to expect that they would find between 60,000 and 70,000 Spaniards aſſembled under General Blake and the marquis de la Romana in the provinces of Aſturias and Gallicia, and that a much greater number was ready to co-operate with them under the command of Caſtanos on the front and left of the principal French poſition. The Spaniards had been repreſented as unanimous in their enthuſiaſm for the cauſe of liberty, and as ready to treat the Britiſh troops as the ſaviours of their country. How far this information was correct, will be ſeen preſently.

In marching through the Portugueſe territory, the troops firſt encountered difficulties which they were not prepared to expect. The contractor at Liſbon, who had agreed to ſupply the diviſions with rations on the march, failed in his contract, and exceſſive inconvenience was experienced from the want of money. The diviſions under Generals Fraſer and Beresford were obliged to halt, and it was ſome time before they could again ſet forward. The proceedings of the central junta, on which all the movements both of the Britiſh and Spaniſh armies chiefly depended, were languid, tardy, and irreſolute; and before the Britiſh troops could aſſemble in any force in Spain, the principal armies of the patriots had been defeated and diſperſed in almoſt every quarter. On the 8th of November Sir John Moore reached Almeyda. The weather was at this time extremely unfavourable, and the troops were expoſed to almoſt inceſſant rain. They entered Spain on the 11th of November, and on the 13th Sir John arrived with his advanced guard at Salamanca, where he halted, intending to aſſemble there all the troops which were on their march through Portugal. While he remained at Salamanca, he was informed that a conſiderable French force had aſſembled and taken poſſeſſion of Valladolid, at the diſtance of only twenty leagues, by which one of the places that had been intended for magazines was loſt. At this time Sir John had with him only three brigades of infantry without artillery, and it would be at leaſt ten days before the whole of the diviſions could come up. He was thus expoſed to almoſt an immediate attack by the French without any effectual ſupport from the boaſted patriotiſm of the Spaniards.

The ſituation of affairs in Spain had now become extremely critical; and every account ſent to Sir John Moore by men of ſound judgment, was filled with convincing proofs that the Spaniſh government had concealed from their ally the very deſperate ſtate of their affairs. General Hope, by a long and tireſome march, had reached the neighbourhood of Madrid, whence he wrote a letter to Sir John, ſtating that every branch was affected by the disjointed and inefficient conſtruction of the government. On the 28th of November Sir John was advertiſed of the late defeat and diſperſion of Caſtanos, and of the little probability there was of his being able to march forward, ſo as to effect any thing of advantage. He therefore determined to fall back, though this determination was evidently in oppoſition to the wiſhes and advice of his officers. Freſh diſpatches, however, from the ſeat of government, diminiſhing the loſſes which had been ſuſtained by the patriots, and exaggerating the ardour with which the people were actuated, induced him to delay his retreat, eſpecially as he had now a complete, though ſmall corps, with cavalry and artillery, and could, by a movement to the left, eaſily effect a junction with Sir David Baird, while the diviſion under General Hope had, by rapid marches, arrived in the neighbourhood of Salamanca.

In addition to the miſrepreſentations by which the commanders of the Britiſh forces, and the Britiſh envoy at Aranjuez, had been deceived, they had now to contend with two deſigning men, who, it ſoon appeared, were in the French intereſt. Theſe were Don Morla, the late governor of Cadiz, and a M. Charmilly. By the machinations of theſe men, Mr Frere was led to adviſe, and Sir John Moore ſtrongly incited to undertake, bringing the whole of the Britiſh force to the neighbourhood of Madrid, where they would ſoon have been completely within the power of the enemy. Though by theſe arts Sir John was effectually miſled, he did not ſuffer himſelf to be drawn into ſo dangerous a ſnare. He, however, advanced beyond Salamanca, and ſent forward the reſerve and General Beresford's brigade towards Toro on the Douro, where they were to unite with the cavalry under Lord Paget, who had advanced thither from Aſtorga. On December 12th, Lord Paget, with the principal part of the cavalry, marched from Toro to Tordeſillas, while the brigade under General Stewart moved from Arivolo. In the vicinity of Tordeſillas, near the village of Rueda, the Britiſh forces were firſt oppoſed by the French, a ſmall party of whom were attacked and defeated.

While Sir John Moore was at Toro, he received intelligence that the duke of Dalmatia was at Saldana with a conſiderable body of French troops, that Junot, duke of Abrantes, was marching with another towards Burgos, and that a third under the duke of Treviſo was deſtined for Zaragoza. He was very deſirous that the firſt of theſe generals ſhould advance to meet him, and with this view he had come forward to Toro, which he reached on the 16th of December. He had hoped for effectual aſſiſtance from the corps commanded by the marquis de la Romana, but he ſoon found that this general could render him no ſupport. He had now reſolved to threaten the communication between France and Madrid; and, if a favourable opportunity offered, to attack the duke of Dalmatia's corps, or any of the covering diviſions that ſhould preſent themſelves. He foreſaw that this would neceſſarily draw upon him a large French force, and of courſe would prove an important diverſion in favour of the Spaniards; who would by this means have the opportunity of collecting in the ſouth, and reſtoring their affairs. The army was now near the French poſition. The cavalry under Lord Paget were puſhed ſo forward, that their patrols reached as far as Valladolid, and had frequent ſucceſsful ſkirmiſhes with the enemy. Colonel Otway met a detachment of French cavalry, charged them, and made the whole priſoners.

On the 18th of December, Sir John's head-quarters were at Caſtro Nuevo, and Sir David Baird's at Benevente, on the road to join him. On the 20th Sir John reached Majorga, where he was joined by Sir David Baird. The united Britiſh army now amounted to rather fewer than 26,000 men, of whom about 2000 were cavalry. The weather was extremely cold, and the ground covered with deep ſnow. Still the exertions of the troops were indefatigable, and the cavalry in particular attacked and defeated a conſiderable body of French horſe. On the 21ſt the army reached Sahagun, where Sir John eſtabliſhed his head-quarters, and determined to halt for ſome time, to refreſh his troops, after the fatigues which they had undergone.

Sir John had now arrived within a very ſhort diſtance from Saldana, where the duke of Dalmatia was poſted, with the flower of the French army; and preparations were made for an attack, which was waited for with all the ardour and impatience which diſtinguiſh Britiſh troops. In the mean time, however, repeated couriers arrived at head-quarters, the bearers of unpleaſant intelligence. Certain information was received, that a ſtrong French reinforcement had arrived at Carrion, a little to the right of Sahagun, that the French corps, which was marching to the ſouth, had halted at Talavera, and that the enemy were advancing from Madrid in conſiderable force. Sir John now ſaw that his motions had been watched by Bonaparte, and that all the arts of this experienced general had been preparing to entrap him. To advance was madneſs; to retreat, almoſt in the face of an enemy, was a meaſure of the utmoſt danger, but it was the only alternative.

190 His retreat.

On the 24th of December Sir John began ſilently and ſecretly to prepare for his retreat, and to provide, as far as poſſible, for the defence of thoſe parts of the

Spain.

country which were ſtill held by the patriots. With this latter view, he directed Sir David Baird to take the route towards Valencia de Don Juan, while the reſt of the army was to proceed by Caſtro Gonzalo. By this diviſion the magazines and ſtores which had been depoſited at Benevente and Zamora, were alſo effectually ſecured,

According to the arrangement made, General Fraſer, followed by General Hope, marched with their diviſions on the 24th December to Valderos and Majorga, and Sir David Baird proceeded with his to Valencia. To conceal this movement, Lord Paget was ordered to puſh on ſtrong patrols of cavalry cloſe to the advanced poſts of the enemy. The reſerve, with two light corps, did not retire from Sahagun till the morning of the 25th, following General Hope. Lord Paget was ordered to remain with the cavalry until evening, and then follow the reſerve. Theſe laſt were accompanied by Sir John. The retreat commenced in this deliberate manner. On the 26th of December, Sir David Baird reached the Eſlar, and paſſed the ferry with leſs difficulty than was expected. He took poſt, according to his orders, at Valencia, and wrote to the marquis of Romana, urging him to blow up the bridge of Manſilla. The other diviſions of infantry proceeded unmoleſted to Caſtro Gonzalo. On the 24th the advanced guard of Bonaparte's army marched from Tordeſillas, 120 miles from Madrid, and ſtrong detachments of cavalry had been puſhed forward to Villalpando and Majorga. On the 26th, Lord Paget fell in with one of thoſe detachments at the latter place. His lordſhip immediately ordered Colonel Leigh, with two ſquadrons of the 10th huſſars, to attack this corps, which had halted on the ſummit of a ſteep hill. One of Colonel Leigh's ſquadrons was kept in reſerve; the other rode briſkly up the hill; on approaching the top, where the ground was rugged, the colonel judiciouſly reined-in to refreſh the horſes, though expoſed to a ſevere fire from the enemy. When he had nearly gained the ſummit, and the horſes had recovered their breath, he charged boldly and overthrew the enemy; many of whom were killed and wounded, and above 100 ſurrendered priſoners. Nothing could exceed the coolneſs and gallantry diſplayed by the Britiſh cavalry on this occaſion. The 18th dragoons had ſignalized themſelves in ſeveral former ſkirmiſhes; they were ſucceſsful in ſix different attacks. Captain Jones, when at Palencia, had even ventured to charge 100 French dragoons with only 30 Britiſh; 14 of the enemy were killed, and ſix taken priſoners. The cavalry, the horſe-artillery, and a light corps, remained on the night of the 26th, at Caſtro Gonzalo; and the diviſions under Generals Hope and Fraſer marched to Benevente. On the 27th, the rear guard croſſed the Eſlar, and followed the ſame route, after completely blowing up the bridge.

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We ſhall not attempt any farther detail of this dangerous and calamitous retreat, in which our army ſuffered extremely, from the fatigues of conſtant marching, from the badneſs of the weather, and even from the brutality of the Spaniards, in whoſe cauſe they had embarked. Before they reached Aſtorga, it was found neceſſary to divide the army. A body of 3000 men, under Brigadier general Crawford, was detached on the road to Orenſe towards Vigo, while the main body, under the command of Sir John Moore, marched by Aſtorga and Lugo, on the road to Corunna. They left Aſtorga on the 30th of December, and on the 11th of January came in ſight of Corunna. The army had now reached the ſea port from which they were to embark, but adverſe winds had detained the tranſports, or the whole of the troops would have been ſpeedily and ſafely on board. Only a few ſhips lay in the harbour, and in theſe ſome ſick men and a few ſtragglers, under pretence of ſickneſs, had immediately embarked.

191 Cloſely lowed b the Fre

During the whole march from Sahagun to Corunna, the Britiſh army was cloſely followed by the French, under Bonaparte and the duke of Dalmatia; and the two armies were often ſo near each other, that the French patrols fell in, during the night, with the cavalry piquets of the Britiſh. The duke of Dalmatia had joined Bonaparte at Aſtorga, and had increaſed his force to nearly 70,000 men, while the whole force of the Britiſh did not exceed 26,000. When Sir John's army reached Lugo, it was found that three diviſions of the French were arranged in front, and it was thought adviſable, on the 8th of January, to offer the enemy battle. This offer, however, the French thought proper to decline, and the duke of Dalmatia ſtirred not from his poſt. When the army reached Corunna, the French were far in the rear, and it was hoped that the tranſports might arrive before the enemy could come up.

The retreat of the Britiſh, conſidering the circumſtances under which it was effected, was a brilliant and ſucceſsful achievement. Two hundred and fifty miles of country had been traverſed in 11 days, during the worſt ſeaſon of the year, through bad roads, over mountains, defiles, and rivers, and in almoſt daily contact with an enemy nearly three times their numbers. Though often engaged, the rear guard of the Britiſh had never been beaten, nor even thrown into confuſion. Many loſſes had indeed been ſuſtained, in baggage, artillery, and horſes, and many ſtragglers had fallen into the hands of the enemy; but neither Napoleon nor the duke of Dalmatia could boaſt of a ſingle military trophy taken from the retreating army. The greateſt danger was ſtill to be incurred; the poſition of Corunna was found to be extremely unfavourable; the tranſports had not arrived, and the enemy began to appear upon the heights. The ſituation of the army was by moſt of the officers thought ſo deſperate, that they adviſed the general to propoſe terms to the duke of Dalmatia, that they might be ſuffered to embark unmoleſted; but this advice Sir John, without heſitation, rejected.

On the 12th of January, the French were ſeen moving in conſiderable force on the oppoſite ſide of the river Mero. They took up a poſition near the village of Perillo, on the left flank of the Britiſh, and occupied the houſes along the river. In the mean time Sir John was inceſſantly occupied in preparing for the defence of his poſt, and in making every arrangement for the embarkation of the troops.

192 Poſition o he army

On the 13th, Sir David Baird marched out of Corunna with his diviſion, and took poſt on a riſing ground, where he determined to remain all night. A diviſion under General Hope was ſent to occupy a hill on the left, which commanded the road to Betanzos, forming a ſemicircle with Sir David Baird's diviſion on the right. General Fraſer's diviſion was drawn up near the road to Vigo, about half a mile from Corunna, and communicated

communicated with that under Sir David Baird, by means of the rifle corps attached to the latter, which formed a chain acroſs the valley. The reſerve under Major-general Paget occupied a village on the Betanzos road, about half a mile from the rear of General Hope. The higher grounds on the rear and flanks of the Britiſh were poſſeſſed by the French, a ſituation which gave the latter a conſiderable advantage.

In the evening the tranſports from Vigo hove in ſight; but the enemy was now ſo near, and had, during this day, ſhown ſo much diſpoſition to moleſt the Britiſh, that a general action was become inevitable. On the 15th, the enemy had advanced to a height where, the day before, a magazine, containing nearly 4000 barrels of gunpowder, had been blown up, and which was immediately oppoſite to the poſition of the Britiſh. On this day ſome ſkirmiſhes took place.

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On the 16th, every thing was prepared for a general action. Moſt of the artillery had been embarked, as it was found that, from the nature of the ground, much artillery could not be employed with advantage. During the 13th and 14th, the ſick, the diſmounted cavalry and horſes, were alſo nearly all embarked. On the morning of the 16th, the French on the hills were apparently quiet, and it was hoped that the embarkation might be effected in the courſe of that night; but about noon the enemy, who had in the morning received reinforcements, and had placed ſome guns in front of the right and left of his line, was obſerved to be getting under arms, to be moving troops towards his left flank, and forming various columns of attack at that extremity of the ſtrong and commanding poſition which he had taken on the 15th, in front of the Britiſh line. This indication of his intention was immediately ſucceeded by a rapid and determined attack on the diviſion under Sir David Baird, which formed the right wing, and was the weakeſt part of the line. The firſt effort of the enemy was met by Sir John Moore and Sir David Baird at the head of the 42d regiment, and the brigade under Lord William Bentinck. The village on the right became an object of obſtinate conteſt. While leading on his diviſion to ſupport this poſition, Sir David had his arm ſhattered with a grape ſhot.

Not long after, while Sir John Moore was riding from poſt to poſt, everywhere encouraging his troops, and pointing out the moſt advantageous opportunities for attack or defence, his conſpicuous ſituation had expoſed him to the fire of the enemy. A cannon-ball ſtruck his left ſhoulder, and beat him to the ground. He raiſed himſelf, and ſat up with an unaltered countenance, looking intently at the Highlanders, who were warmly engaged. Captain Hardinge threw himſelf from his horſe, and took him by the hand; then, obſerving his anxiety, he told him the 42d were advancing, upon which his countenance immediately brightened. His friend Colonel Graham now diſmounted to aſſiſt him; and, from the compoſure of his features, entertained hopes that he was not even wounded: but obſerving the horrid laceration and effuſion of blood, he rode off for ſurgeons. The general was carried from the field on a blanket, by a ſergeant of the 42d, and ſome ſoldiers. On the way he ordered Captain Hardinge to report his wound to General Hope, who aſſumed the command. Many of the ſoldiers knew that their two chiefs were carried off: yet they continued to fight with undiminiſhed courage; and, by the moſt determined bravery, not only repelled every attempt of the enemy to gain ground, but actually forced him to retire, though he had brought up freſh troops in ſupport of thoſe originally engaged.

The enemy finding himſelf foiled in every attempt to force the right of the poſition, endeavoured by numbers to turn it. A judicious and well-timed movement, which was made by Major-general Paget, with the reſerve, which corps had moved out of its cantonments to ſupport the right of the army, by a vigorous attack, defeated this intention. The major-general having puſhed forward the 95th (rifle corps) and 1ſt battalion 52d regiment, drove the enemy before him; and, in his rapid and judicious advance, threatened the left of the enemy's poſition. This circumſtance, with the poſition of Lieutenant-general Fraſer's diviſion (calculated to give ſtill farther ſecurity to the right of the line) induced the enemy to relax his efforts in that quarter. They were, however, more forcibly directed towards the centre, where they were again ſucceſsfully reſiſted by the brigade under Major-general Manningham, forming the left of Sir David Baird's diviſion, and a part of that under Major-general Leith, forming the right of the diviſion under General Hope. Upon the left the enemy at firſt contented himſelf with an attack upon our picquets, which, however, in general, maintained their ground. Finding, however, his efforts unavailing on the right and centre, he ſeemed determined to render the attack on the left more ſerious, and had ſucceeded in obtaining poſſeſſion of the village through which the great road to Madrid paſſes, and which was ſituated in front of that part of the line. From this point, however, he was ſoon expelled with conſiderable loſs, by a gallant attack of ſome companies of the 2d battalion of the 14th regiment, under Lieutenant-colonel Nicholls. Before five in the evening, the Britiſh had not only ſucceſsfully repelled every attack made upon the poſition, but had gained ground in almoſt all points, and occupied a more forward line than at the commencement of the action, whilſt the enemy confined his operations to a cannonade, and the fire of his light troops, with a view to draw off his other corps. At ſix the firing ceaſed. The different brigades were reaſſembled on the ground which they occupied in the morning, and the picquets and advanced poſts reſumed their original ſtations.

Notwithſtanding the decided and marked ſuperiority which at this moment the gallantry of the troops had given them over an enemy, who, from his numbers and the commanding advantages of his poſition, no doubt expected an eaſy victory, General Hope did not, on reviewing all circumſtances, conceive that he ſhould be warranted in departing from what he knew was the previous and fixed determination of the late commander of the forces, to withdraw the army on the evening of the 16th, for the purpoſe of embarkation, the previous arrangements for which had already been made by his order, and were in fact far advanced at the commencement of the action. The troops quitted their poſition about 10 at night, with a degree of order that did them credit. The artillery that remained unembarked, having been withdrawn, the troops followed in the order preſcribed, and marched to their reſpective points of embarkation in the town and neighbourhood of Corunna. The picquets remained at their poſts till five in

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the morning of the 17th, when they were alſo withdrawn with ſimilar order, and without the movement having been diſcovered by the enemy.

By the unremitted exertion of the captains of the royal navy, who had been entruſted with the ſervice of embarking the army, and in conſequence of the arrangements made by the agents for tranſports, the whole of the forces were embarked with an expedition which has been ſeldom equalled. The brigades under Major-generals Hill and Beresford were deſtined to remain till daylight, in order to watch the movements of the enemy. The brigade under General Beresford, which was alternately to form the rear-guard, occupied the land in front of Corunna, while that under General Hill was ſtationed on the promontory in the rear of the town by way of reſerve.

The enemy puſhed his light troops towards the town, ſoon after eight o'clock in the morning of the 17th, and ſhortly after occupied the heights of St Lucia, which commanded the harbour. But notwithſtanding this circumſtance, and the manifold defects of the place, there being no apprehenſion that the rear-guard could be forced, and the diſpoſition of the Spaniards appearing to be good, the embarkation of Major-general Hill's brigade was commenced and completed by three in the afternoon. After having fully explained, to the ſatisfaction of the Spaniſh governor, the nature of the movement, and having made every previous arrangement, General Beresford withdrew his corps from the land in front of the town ſoon after dark, and was, with all the wounded that had not previouſly been removed, ſafely embarked before one o'clock of the morning of the 18th.

In this action the Britiſh troops had come off with glory, and there can be no doubt, from the repulſe of the French forces, and their ſubſequent inactivity, that the honour of the victory belonged to the Britiſh. The victory had indeed coſt them dear. They had loſt one of their beſt generals; and probably nearly 1000 men had been killed or wounded during the action. It had been achieved at the termination of a long and haraſſing ſervice. The ſuperior numbers, and advantageous poſition of the enemy, not leſs than the actual ſituation of the Britiſh army, did not admit of any advantage being reaped from ſucceſs. The luſtre of the Britiſh arms had, however, been maintained under the moſt diſadvantageous circumſtances. The army which had entered Spain amidſt the faireſt proſpects, had no ſooner completed its junction, than owing to the multiplied diſaſters that diſperſed the native armies around it, it was left to its own reſources. The advance of the Britiſh troops from the Douro afforded the beſt hope, that the ſouth of Spain might be relieved; but this generous effort to ſave an unfortunate people, alſo afforded the enemy the opportunity of directing every effort of his numerous troops, and concentrating all his principal reſources for the deſtruction of the only regular force in the north of Spain. Theſe circumſtances had produced the neceſſity of rapid and haraſſing marches, which had diminiſhed the numbers, exhauſted the ſtrength, and impaired the equipment of the army. Notwithſtanding all theſe diſadvantages, and thoſe more immediately attached to a defenſive poſition, which the imperious neceſſity of covering the harbour of Corunna, for a time, had rendered indiſpenſable to aſſume, the native and undaunted valour of Britiſh troops was never more conſpicuous.

At daybreak on the 18th, the Engliſh convoy was under ſail, and on the 19th it had entirely left the Spaniſh coaſts.

194 Second expedition under Sir Arthur Welleſley

Notwithſtanding the ill ſucceſs which had thus attended the expedition under Sir John Moore, the ſpirit of patriotiſm which appeared ſtill to actuate the ſouthern provinces of Spain, and the hope that the common cauſe might there be ſupported to greater advantage, induced the Britiſh miniſtry to ſend another military force to the weſtern peninſula of Europe, to co-operate with the patriots who ſtill continued in arms. Accordingly a body of about 15,000 forces, under the command of Sir Arthur Welleſley, whoſe bravery and good conduct in the battle of Vimiera, had recommended him, in a particular manner, both to the miniſtry and the nation, was diſpatched towards the coaſt of Portugal, where Marſhal Beresford ſtill maintained a Britiſh force; while General Hill, with about 5000 infantry, and 400 cavalry, ſailed from Ireland with the ſame deſtination. General Hill arrived at Liſbon on the 4th of April, and ſoon after Sir Arthur landed with the main body. On the 7th of April the army moved forward towards the Douro, and croſſed that river during the night of the 11th, a little above Oporto. Here they fell in with a French detachment from the army of the duke of Dalmatia, which they routed and put to flight, after a ſhort but well-conteſted action.

After this action the duke of Dalmatia found it neceſſary to retreat. He paſſed through the defiles of Salamonde, and thus gained conſiderably on the Britiſh army, though he was obliged to leave behind him part of his artillery. On the 19th of May he was at Allaritz, and on the 20th he continued his retreat acroſs the Minho, which he paſſed at Orenſe, thus leaving Portugal once more in poſſeſſion of the Britiſh forces.

Sir Arthur Welleſley, after having remained for ſome time in the Portugueſe territory, to refreſh his men after the fatigues which they had undergone, advanced into Spain, and effected a junction with General Cueſta, who then commanded a conſiderable part of the remains of the patriotic army. In the latter end of July, the allied army had advanced to Talavera de la Reyna, in the neighbourhood of which they were encountered by a formidable French force, conſiſting of a corps commanded by Marſhal Victor, another under General Sebaſtiani, the guards of Joſeph Bonaparte, amounting to 8000 men, and the garriſon of Madrid. This large force was commanded by Joſeph Bonaparte in perſon, aſſiſted by Marſhals Jourdan and Victor, and General Sebaſtiani.

195 Battle of Talavera.

On the 27th of July, an attack was made by the French army on that of the allies, who had taken up their poſition at Talavera. The attack was vigorous, but was repelled with great ſpirit and ſucceſs, though not without conſiderable loſs on the part of the Britiſh.

The defeat of this attempt was followed about noon of the 28th by a general attack of the enemy's whole force, on the whole of that part of the poſition which was occupied by the Britiſh army. The general attack began by the march of ſeveral columns of infantry into the valley, with a view to attack the height occupied by Major general Hill. Theſe columns were immediately charged by the 1ſt German light dragoons, and

23d dragoons, under the command of General Anſon, and ſupported by General Fane's brigade of heavy artillery; and although the 23d dragoons ſuffered conſiderable loſs, the charge had the effect of preventing the execution of that part of the enemy's plan. At the ſame time an attack was directed upon Brigadier-general Alexander Campbell's poſition in the centre of the combined armies, and on the right of the Britiſh. This attack was moſt ſucceſsfully repulſed by Brigadier-general Campbell, ſupported by the king's regiment of Spaniſh cavalry, and two battalions of Spaniſh infantry; and the allies were left in poſſeſſion of the enemy's cannon.

An attack was alſo made at the ſame time on Lieutenant-general Sherbrooke's diviſion, which was on the left and centre of the firſt line of the Britiſh army. This attack was moſt gallantly repulſed by a charge with bayonets, by the whole diviſion; but the brigade of guards which were on the right, having advanced too far, were expoſed on their left flank to the fire of the enemy's battery, and of their retiring columns; and the diviſion was obliged to retire towards the original poſition, under cover of the ſecond line of General Cotton's brigade of cavalry, which had moved from the centre, and the 1ſt battalion 48th regiment. This regiment was removed from its original poſition on the heights, as ſoon as the advance of the guards was perceived, and formed in the plain; it advanced upon the enemy, and covered the formation of Lieutenant-general Sherbrooke's diviſion. Shortly after the repulſe of this general attack, in which apparently all the enemy's troops were employed, he commenced his retreat acroſs the Alberche, which was conducted in the moſt regular manner, and effected during the night, leaving in the hands of the Britiſh 20 pieces of cannon, ammunition, tumbrils, and ſome priſoners.

Though the French were defeated in this engagement, and, according to Sir Arthur Welleſley's account, muſt have loſt at leaſt 10,000 men, the loſs of the Britiſh was very great. By the official returns it is ſtated to exceed 5000, namely, in killed, 34 officers, 28 ſergeants, 2 drummers, and 735 rank and file; in wounded 195 officers, 165 ſergeants, 16 drummers, and 3537 rank and file; and in miſſing 9 officers, 15 ſergeants, 9 drummers, and 620 rank and file. The action, though brilliant, does not appear to have been attended with much advantage to the allies, as, from the reinforcements which the French army was daily receiving, Sir Arthur Welleſley (now Lord Wellington) was ſoon compelled to fall back towards the frontiers of Portugal, leaving behind him much of his baggage, and the whole of his ſick and wounded. It muſt be recorded to the honour of the French commander, into whoſe hands theſe unfortunate men had fallen, that, in conſequence of a repreſentation in their favour by Lord Wellington, he treated them with the utmoſt humanity, and afforded them every accommodation which the nature of their ſituation admitted.

Since the battle of Talavera, nothing of importance has tranſpired reſpecting the ſtate of affairs in Spain. It appears that the patriots ſtill continue to make a ſtand againſt their invaders; but it cannot be expected that their oppoſition ſhall be ultimately attended with ſucceſs. The reſources of the French are ſo numerous and extenſive, and the force which he is able to draw towards the Spaniſh peninſula, has been ſo much increaſed in conſequence of the peace lately concluded between France and Auſtria, that the liberties of Spain muſt, we fear, fall a ſacrifice, and that kingdom muſt contribute to ſwell the already exorbitant power of the houſe of Bonaparte (A).

196 Summary view of Spaniſh hiſtory.

We ſhall conclude the hiſtorical part of this article with a ſummary recapitulation of the principal revolutions which have taken place in Spain.

From the year 240 B. C. to the year 206 B. C. Spain was in ſome degree under the dominion of the Carthaginians. From the year 206 B. C. to the commencement of the fifth century of the Chriſtian era, it continued almoſt entirely in poſſeſſion of the Romans. The Goths reigned in Spain from the year 411 to 711; the Moors from the year 711 till 716, in part of the Aſturias; till 820 in Catalonia; till 750 in Sobrarba; till 923 in Leon; till 1073 in different parts of the two Caſtiles; till 1118 in Aragon; till 1236 in Cordova and Jaen; till 1248 in Seville; till 1264 in the kingdom of Valencia; till 1265 in that of Murcia; and even ſo late as 1492 in Granada. During the wars againſt the Moors, the Goths reigned in the Aſturias, Gallicia, and, finally, in the kingdom of Leon till 1038.

The houſe of Navarre, deſcended from the French houſe of Bigorre, which had previouſly reigned in Caſtile for 10 years, united with it the crown of Leon till the year 1126. This was ſucceeded by the family of Bourbon, deſcended from the royal family of France, which reigned over theſe countries till 1555. The houſe of Charlemagne, a French family deſcended from that prince, ruled over Catalonia from the year 802 till 1132. The French family of Bigorre firſt reigned in Sobrarba, and afterwards in Aragon from the year 750 to 1162; at that period the French family of Barcelona ſucceeded to the government, and united to the crown of Aragon that of Catalonia, and afterwards the kingdom of Valencia, over which it reigned till the year 1430. Theſe parts of Spain then came into the poſſeſſion of the princes of the French branch of Navarre, which reigned in Caſtile, and continued in their deſcendants to 1515; at which time the different ſtates of the Spaniſh monarchy were united under the government of Joanna the Fooliſh, who reigned over them till her death, which happened in 1555. The Auſtrian family then poſſeſſed the throne till 1700, ſince which time it has been occupied by a branch of the houſe of Bourbon, till the late revolution, by placing the Spaniſh monarchs in the power of the French, has given riſe to a new dynaſty of princes in the perſon of Joſeph Bonaparte.

197 Antiquities.

The earlieſt Spaniſh antiquities which can be with certainty aſcertained, belong to the Roman period; and of theſe the examples are extremely numerous. They abound in the provinces of Catalonia, Valencia, and thoſe which border on the Pyrenees. We cannot here enumerate, much leſs deſcribe, all the remains of Roman

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(A) This prediction is not yet verified. The French, excepting a ſmall army in Catalonia, have been totally expelled from Spain. Lord Wellington has entered France, and forced the French lines on their own ſoil (October 1813.)

antiquity mentioned by Swinburne, Townſend, De Laborde, and other travellers in Spain. The moſt remarkable are, the aqueduct at Segovia, in Old Caſtile, conſiſting of 159 arches, extending about 740 yards, and being at leaſt 94 feet high, where it croſſes the valley; the amphitheatre of the ancient *Saguntum*, near the modern Morviedro in Valencia, which was hewn out of the ſolid rock, and appears to have been capable of containing 10,000 ſpectators; a ſuperb Roman arch, ſupported by Corinthian pillars, and having a very lofty gateway, not far from Tarragona; a monument near the ſame place, ſuppoſed to be the tomb of the father and uncle of Scipio Africanus; and a conſiderable amphitheatre on an eminence near Seville. It is ſuppoſed that the ancient city of Italica, built by Scipio Africanus for the reception of his wounded ſoldiers, ſtood near this ſpot; but we are aſſured by Mr Swinburne, that no traces of it now remain.

Of the Gothic edifices, no certain remains are to be found; but the Mooriſh antiquities are numerous and ſplendid. Of theſe, the moſt remarkable are the palace of the Alhambra in the city of Granada, and the moſque of Cordova. Of the former we have already given an account under ALHAMBRA. The moſque, now the cathedral of Cordova, was begun by Abdroulrahman I. caliph of Cordova, and is computed to contain not fewer than 800 columns. The architecture of its doors, windows, and arches, eſpecially thoſe of the chapel of the Koran, at leaſt equals that of the Alhambra in grandeur of deſign, and beauty of execution, and exceeds that palace in variety of decoration. This ſuperb edifice has been minutely deſcribed by Mr Swinburne, in his Travels into Spain, Letter 35. Not far from Cordova ſtood the magnificent city of Zehra, built by Abdoulrahman III. and which is ſaid to have employed 25 years in building, and to have coſt more than 2,500,000l. of our preſent ſterling money. In this city was a palace containing 1173 columns, of African, Spaniſh, Italian, and Aſiatic marbles. This ſplendid palace, and the city in which it ſtood, were entirely deſtroyed during the wars by which Spain was deſolated in the middle ages.

198 Population of Spain. It has been computed, that under the dominion of the Romans, Spain contained a population of nearly 50,000,000 of people; but this calculation is, by De Laborde, diminiſhed to 20,000,000.

At the cloſe of the 14th century, the population is ſtated by moſt Spaniſh writers as follows:

In the ſtates of Caſtile,	11,000,000
States of Aragon,	7,700,000
Kingdom of Granada,	3,000,000
	21,700,000

On what De Laborde deems better authority, he reduces this number to 16,000,000.

In the reign of Ferdinand and Iſabella, at the end of the 15th century, the total population of Spain has generally been eſtimated at 20,000,000, but this too is reduced by Laborde to 14,000,000 or 15,000,000.

The population was reduced

in 1688 to	10,000,000
in 1700	8,000,000
1715	6,000,000
In 1768 it had riſen to	9,307,800
1788	10,143,975

According to the table of the provinces, collected chiefly from De Laborde, it amounted, at the end of the 18th century, to 10,308,505; by the laſt cenſus, taken in the years 1797 and 1798, the ſtatements of which have not been publiſhed, but were lately locked up in the office belonging to the miniſter of finance, it appears that the population, at the end of the 18th century, exceeded 12,000,000.

From theſe ſtatements we obſerve, that the population of Spain had gradually diminiſhed from its conqueſt by the Romans, to the reign of Philip V. in the beginning of the 18th century; but that during the laſt hundred years it has rapidly increaſed.

Various cauſes have been aſſigned for the remarkable depopulation that had taken place in the Spaniſh dominions. Perhaps the following by Dr Playfair are ſufficiently plauſible. "The peſtilential fevers and epidemical diſeaſes, which carried off one-third of the inhabitants in the year 1347, and have produced great mortality during the two laſt centuries; almoſt inceſſant ſtruggles for dominion, from 714 till the conqueſt of Granada, and union of the two crowns of Caſtile and Aragon; the expulſion of about 400,000 Jews by Ferdinand and Iſabella, and of 900,000 Moors, A. D. 1610; the diſcovery of South America in 1493, which has gradually drained the country of its inhabitants and its induſtry; the calamities of war, during two centuries, from the acceſſion of the emperor Charles V.; the form of government, and national prejudices, which diſcourage foreigners from ſettling in the kingdom, and are inimical to manufactures, commerce, and agriculture; the debauchery that prevails among all ranks; the great number of convents; the celibacy of the clergy; religious oppreſſion, and numerous feſtivals, which leſſen the number of working days, and ſo abridge the labour of the people."

Of the number above ſtated, the clergy are rekoned at leaſt 147,722: viz. of ſecular clergy, 60,240; of monks 49,270; of nuns and friars, 22,337, and of ſubaltern miniſters of the church 15,875. The numbers of the clergy have indeed diminiſhed by more than 27,000, during the laſt 30 years of the 18th century, as in the year 1768 they amounted to 176,057.

199 Number of towns, villages, &c. According to a calculation in the year 1776, the cities, towns, villages, and hamlets, amounted to 84459 (D); and public edifices and temples to 30,496.

It appears that there exiſt in Spain 2,628,557 individuals of both ſexes, who do not contribute, or at leaſt are not ſuppoſed to contribute, to the population. From this view, and the progreſs we have already ſtated, it will be eaſy to diſcover, by comparative calculations with the detailed ſtatements of population in other countries, the proportionate number of births, deaths, marriages, &c. which annually take place in Spain.

200 Government. The Spaniſh government, which was of a limited nature, during the dynaſties of the kings of Caſtile and Aragon, afterwards became an abſolute monarchy. At that

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(D) In the year 1788, the number of villages was eſtimated at 19,219; and that of pariſhes at 20,080.

ain. that period the royal prerogative was confined both by the expreſs tenor of the laws and the forms of their adminiſtration. The peculiar privileges of the two ſtates of Caſtile and Aragon continued to exiſt long after their reunion; but the royal authority was conſtantly taking umbrage at their exerciſe. The princes of the Auſtrian family did not openly attack them, but had recourſe to the more effectual method of ſecretly undermining them; and thus they were ſo far diminiſhed, that at the cloſe of the 17th century they amounted to little more than mere forms. The attachment of Aragon to the cauſe of the archduke Charles, induced the firſt ſovereign of the royal family of France to aboliſh them entirely. Philip V. having ſubdued Aragon, ſuppreſſed the ſtates-general, the laſt meeting having been held at Zaragoza in the year 1720, on which occaſion Queen Iſabella of Savoy preſided in the abſence of her huſband, who was at that time in Italy. Since that period no further power is left the *Cortez* of Caſtile and Aragon, but the privilege of nominating deputies to the ſtates-general of the kingdom, whenever they are ſummoned by the monarch.

The whole authority, previous to the late revolution, centered in the king and his miniſters; the national affairs were conducted by the different councils, appointed by the crown, which deliberated and formed their plans in the capital. Some of theſe poſſeſſed both legiſlative and executive power, and exerciſed the double function of adviſing the king and adminiſtering juſtice. The council of Caſtile, in this diſtribution of power, was paramount; its decrees being deciſive in the courts, but its judgments were under the controul of the king. The reſolutions were tranſmitted to the monarch by a certain number of members, under the title of the *Chamber of Caſtile*, whoſe influence was prodigiouſly great. This council was ſo denominated, becauſe the members choſen by the king formerly co-operated with miniſters in expediting the affairs of ſtate in the royal chamber, and for this purpoſe they attended the court wherever it was held.

Beſides the council of Caſtile, there was the royal and ſupreme council of the Indies, inveſted with the ſame powers, and exerciſing ſimilar functions with reſpect to the American colonies, as the council of Caſtile with reſpect to the European territory.

1 Re ues. It is not eaſy to aſcertain the amount of the revenues under the late government. They aroſe from a tax on imports and exports; from the chief objects of internal conſumption; from the monopolies of the crown; from landed eſtates; from tythes of church and abbey lands; from the ſale of indulgences; and from the trade with the American colonies. Their total amount has been variouſly ſtated. M. Jordan has computed it to exceed 7,000,000l. ſterling; by M. de Laborde, the revenues for the European continent alone, are calculated to exceed 8,000,000l. ſterling.

2 Mil ry ſtre th. It would be abſurd to attempt any eſtimate of the military ſtrength of Spain in its preſent ſtate of diſorganization and confuſion. During the latter part of the 18th century, the land forces in time of peace ſeldom exceeded 50,000 ill diſciplined troops; but in time of war, the army was capable of being augmented to a formidable force. In the year 1798 the ſtanding force of the Spaniſh monarchy amounted to 100,000 effective men.

Till of late the Spaniſh navy was highly reſpectable, both as to ſtrength and diſcipline. In the year 1778 the Spaniſh fleet conſiſted of 148 veſſels of all deſcriptions; and of theſe more than 60 were ſhips of the line. In 1788, the number of ſhips of the line amounted to 68, and that of large frigates to 47. In the preſent long conteſt among the powers of Europe, the navy of Spain has been greatly diminiſhed; and the only fleet of any importance now exiſting is that in the harbour of Cadiz.

203 Orders of knighthood. There are in Spain ſeveral orders of knighthood, or as they are called, military orders. The principal is that of the *Golden Fleece*, inſtituted in the year 1430, by Duke Philip the Good. The order of St Jago di Compoſtella was inſtituted by Ferdinand II. in the year 1175, and its badge is a red uniform croſs in twelve departments. The order of Calatrava, inſtituted by Sancho III. of Caſtile, has for its badge a red croſs in five departments. The order of Alcantara was inſtituted by Ferdinand II.; and its badge is a lily placed croſsways. The order of Monteſa, inſtituted in the year 1317, by James III. king of Aragon, is compoſed of 19 commanderies.

204 Coins. The money of Spain is either real or imaginary; the former ſerving for the purpoſe of exchange, the latter for keeping accounts and tranſacting buſineſs. Both theſe are common through the whole kingdom; but ſeveral kinds of both are to be found in the different provinces.

Two kinds of real money, both in gold and ſilver, are diſtinguiſhed in Spain; the old, that is, ſuch as were coined before the year 1772, and thoſe coined ſubſequent to that period. None of the former are uniform, but conſiſt of ſmall pieces of different ſizes unequally cut, and their currency is only by weight. The latter uniformly bear the head of the ſovereign on the obverſe, and on the reverſe ſide the arms of Spain; the ancient gold coins are more intrinſically valuable than the modern. The laſt only will be here deſcribed.

Modern Gold Coins.

Coins.	Value in Sterling money.
Durito Eſcudo chico de oro Veniento de oro	4s. 2d. (E)
Eſcudo de oro Doblon ſenzillo	8s. 4d.
Doblon de oro	16s. 8d.
Doblon de quatre Medio doblon de a ocho Media onza de oro	1l. 13s. 4d.
Doblon de ocho Onza de oro	3l. 6s. 8d.

Modern

(E) In computing the value of the Spaniſh coins in ſterling money, we have employed M. de Laborde's tables; in which their value is eſtimated in money tournois, computing the livre tournois at 10d. ſterling, and the ſol at $\frac{1}{2}$d. ſterling.

Modern Silver Coins.

Coins.	Value in ſterling money.
Real Real de vellon Medio real de plata	2½d.
Real de plata Media pecata	5d.
Pecata Real de a dos	10d.
Eſcudo Medio duro	2s. 1d.
Duro Pezoduro Real de à ocho	4s. 2d.

205 Weights and meaſures.

The Spaniſh weights and meaſures vary conſiderably in different parts of the kingdom, as almoſt every province has both peculiar to itſelf. The pound generally conſiſts of 16 ounces in that part of the kingdom formerly belonging to the crown of Caſtile, and of 12 ounces in thoſe annexed to the crown of Aragon; viz. in Aragon, in the kingdom of Valencia, and in Catalonia; but the ounce is not the ſame. We ſhall here only particularize the weights of Caſtile.

In the Caſtiles they reckon by charges, quintals, arobas, arreldes, pounds, ounces, and drams. The following table gives the proportional value of the Caſtilian weights.

		lb.	*oz.*
The charge contains	3 quintals	300	0
—— quintal	4 arobas	100	0
—— aroba	25 pounds	25	0
—— arrelde	4 pounds	4	0
—— pound	16 ounces	1	0
—— ounce	16 drams		1
—— dram	30 grains		$\frac{1}{16}$
—— grain			$\frac{1}{480}$

The meaſures are ſtill more complicated than the weights; and eſpecially the meaſures of capacity will require to be conſidered rather more in detail. We ſhall, as uſual, diſtinguiſh them into long meaſure, ſuperficial or land meaſure, and meaſures of capacity.

Long meaſure.—The ſtandard lineal meaſure in Spain is the royal foot, conſiſting of 153$\frac{41}{100}$ lines; and bearing to the Engliſh foot the proportion of about 153 to 144, or of 17 to 16. This foot, however, is not in general uſe, almoſt every province having its own foot, which is generally rather leſs than the royal foot. Thus, the foot in Caſtile is 8 lines leſs, and that of Valencia about 9½ lines leſs than the ſtandard.

Of royal feet 100 are equivalent to 102 feet 7 inches of Catalonia, to 107 feet of Valencia, to 115 feet 10 inches and 4 lines of Caſtile.

One hundred feet of Catalonia are equal to 92 feet 2 inches 3 lines of the royal foot, to 97 feet 5½ lines of Valencia, and 104 feet 11 inches 11 lines of Caſtile.

In Valencia 100 feet are equivalent to 93 feet 4 inches 10 lines of the royal foot, to 98 feet 9 inches of Catalonia; and 107 feet 2 inches 6 lines of Caſtile.

In Caſtile, 100 feet are equal to 86 feet 1 inch 5 lines of the royal foot; to 93 feet 4 inches 9½ lines of Valencia; and 92 feet 2 inches 3 lines of Catalonia.

Cloths and ſtuffs in Catalonia, are meaſured by *canas*, in other parts of the kingdom by *varas*; the cana is divided into 8 *pams*, the vara into four. The proportions which theſe bear to the royal foot will be ſeen from the following table:

	Feet.	Inche	nes.
Pam of Catalonia,	0	7	4
Cana of Catalonia,	4	10	8
Six pams make the Paris ell,			
Pam of Caſtile,	0	7	8
Vara of Caſtile,	2	6	8
Pam of the kingdom of Valencia,	2	9	4
Five pams and a little more than ⅕th, or one vara one pam and a little more than ⅕th, make a Paris ell.			
Pam of Aragon,	0	6	7⅜
Vara of the Aſturias,	2	5	9
Vara of Aragon,	2	2	5½
A little leſs than 6 pams, or one vara two pams, make a Paris ell.			
Pam of Gallicia for linen drapery,	0	9	2
Vara of Gallicia for ditto,	2	6	8

Land Meaſure.—Land in the provinces belonging to the crown of Caſtile is meaſured by *ungadas*, *fanegas*, *eſtadales*, *braſſes*, *varas*, *pas*, and *aranzadas*. Of theſe the ungada contains 50 fanegas, about 204$\frac{5}{10}$ feet; the fanega 400 eſtadales = about 4$\frac{8}{100}$ feet; the eſtadale two braſſes = about ten feet; the braſs two varas, or about 5 feet 1 inch 4 lines; the pas about 1⅔d of a vera, and the aranzada about 73 varas. This laſt is only uſed for meaſuring vineyards.

In Biſcay land is meaſured by *carros*, *plazas*, and *celemines*; and in Valencia by *yugadas*, *cahizadas*, *fanegas*, *braſſes*, and *pams*.

Meaſures of Capacity.—Corn is meaſured in the provinces belonging to the crown of Caſtile by *cahizas*, *fanegas*, *celemines*, and *quartillos*; and in Biſcay the ſame meaſures are uſed, with the exception of the cahiza. The cahiza contains 12 fanegas, and is = about 1½ lb. French; the fanega contains 12 celemines = 124 lb.; the celemine 4 quartillos = 10lb. 5⅓ ounces, and the quartillo = 2lb. 7¼ ounces.

In Catalonia grain is meaſured by *ſalmas*, *charges*, *quarteras*, *cortans*, and *picotis*. The ſalma contains 2 charges or 6 quintals = 546lb.; the charge contains 2 quarteras or 3 quintals = 273lb.; and the quartero 12 cortans or ½ quintal = 136lb. 8 oz.: the cortan contains 4 picotis or 13lb. of 12 oz. = 11lb. 6 oz.; and the picoti 3¼lb. of 12 oz. = 2lb. 13½ oz.

The meaſures for liquids vary exceedingly, according to the liquid they are intended to contain. Thus, at Madrid, honey is meaſured by *arobas* and *quartillos*, the quartillo being about 1½lbs. and the aroba containing 32 *quartillos*. Oil is meaſured in New Caſtile alſo by arobas and quartillos, but the quartillo is = 6¼ lbs.; and the aroba contains 4 quartillos, or 25 lbs. In Seville, oil is meaſured by the pipe and aroba, the pipe containing 34 arobas; while in Valencia it is meaſured by charges, arobas, and cantaros, the charge containing 12 arobas, and the cantaro equal 28lbs. 1 oz.

Wine in New Caſtile is meaſured by moyos, an imaginary meaſure, cantaras, azumbres, quartillos, and ſextarios.

tarios. The moyo contains 16 cantaras, the cantara 12 azumbres, the azumbre 4 quartillos, each equal to 1 lb. At Cadiz wine is meaſured by tonneaux, arobas, azumbres, and quartillos. The tonneaux contains 30 arobas, the aroba 8 azumbres, the azumbre 4 quartillos, each of which is equal to 1 lb. 1 oz. At Seville the meaſures for wine are cantaras, azumbres, and quartillos. The cantara contains 8 azumbres, the aroba the ſame, the azumbre 4 quartillos, each of which is equal to 17 ounces. In Valencia theſe meaſures are, botas or tonneaux, charges, arobas, or cantaras, and azumbres or cuentas; and in Catalonia, pipes, charges, quintals, arobas, quarteros, and quartos, of which the pipe contains 4 charges, the charge 3 quintals, the quintal 4 arobas, the aroba 22 quarteros, the quartero 4 quartos, and the quarto is equal to nearly 3 ounces of Catalonian meaſure.

6

The laws of Spain, which for a long time varied greatly in the different ſtates of the monarchy, are at preſent reduced to a conſiderable degree of uniformity. Navarre and Biſcay have retained their ancient laws and conſtitution; but the revolution which took place in Spain at the beginning of the 18th century, enabled Philip V. to introduce into Catalonia and the kingdoms of Aragon and Valencia the laws of Caſtile; which, excepting a few alterations, rendered neceſſary by local peculiarities, ſtill continue in full effect.

The laws of Caſtile, which are thus become thoſe of almoſt all Spain, are contained in the codes known by the titles of the *Fuero juzgo*, *Ley de las ſiete partidas*, *Ordenamiento real*, *Fuero real*, and *Recepilacion*; of theſe the laſt is a collection of occaſional edicts of the kings of Spain, and enjoys the higheſt authority.

The Roman law has no validity in Spain, and though it may be ſtudied by a few lawyers, as containing firſt principles univerſally applicable; yet it is never quoted in the courts, and is expreſsly excepted againſt by ſome of the old laws of Caſtile.

7 Ad iſtration ju tice

The conducting of a law ſuit in Spain is ſubject to very complicated forms; whence neceſſarily reſults a ſlowneſs of progreſs. The whole buſineſs is carried on by writers, a peculiar branch of the legal profeſſion. In the ſuperior tribunals, the management of cauſes is in like manner committed to a kind of ſubaltern magiſtrates, called reporters (*relatores*), who contrive to render their own department a ſituation of much greater emolument than that of the judge.

In all the branches of civil, military, eccleſiaſtical, and judicial adminiſtration, in Spain, is evident a ſpirit of mildneſs and paternal indulgence, which often degenerates into great abuſe. By multiplying courts for the adminiſtration of juſtice, and by eſtabliſhing the long ſeries of appeals from juriſdiction to juriſdiction, in order that each caſe may be heard and re-heard, and receive an equitable ſentence, the ſtill more important advantages of prompt deciſion are ſacrificed, and a door is opened for chicane.

It is univerſally acknowledged that the courts of exception are far too numerous; they enfeeble the authority of the eſtabliſhed judges, and withdraw a number of individuals from the ſuperintendance of magiſtrates who reſide among them, and are readily acceſſible, to conſign them to the care of diſtant and dilatory tribunals.

A conſiderable degree of jealouſy and oppoſition alſo ſubſiſts among many of the tribunals; hence they mutually weaken each other's authority, and the clients are conſigned over from court to court; ſo that lawſuits become intolerably protracted, and a family is held in ſuſpenſe for two or three generations. The conſequence of this is, that the rich wear out thoſe of inferior fortune.

Even the ordinary and regular forms of civil proceſs are ſlow and complicated. The huſbandman is called from his labour, the merchant from his commercial concerns, the artiſt from his work, and all from their domeſtic affairs. Nearly an equal tardineſs takes place in criminal proceſſes, ſo that witneſſes die, and means of proof are loſt, while the guilty often eſcape unpuniſhed; and thoſe who have been formally acquitted, are ſtill ſubject to a long detention in priſon, whence they are at length diſmiſſed without indemnity, and irretrievably ruined.

In conſequence of the great number of courts, the facility of appeal from one to the other, and the tediouſneſs of law ſuits; the multitude of judges, advocates, writers, and other ſubordinate officers employed in the adminiſtration of juſtice is prodigious. The number of perſons employed in the different law eſtabliſhments has been eſtimated at 100,000, which is nearly an hundredth part of the population of the country; and the very laſt general enumeration of the inhabitants of Spain makes the number of advocates amount to 5675, and of writers to 9351; beſides the judges and their ſecretaries, the attorneys and their clerks, and the innumerable hoſt of alguazils and inferior officers.

Another ſerious inconvenience in the adminiſtration of Spaniſh law, is the neceſſity of repoſing entire and blind confidence in a claſs of ſubaltern officers of the courts, called writers. This appears to be a branch of the profeſſion wholly peculiar to Spain; the writer exerciſing at the ſame time the functions of ſecretary, ſolicitor, notifier, regiſtrar, and being the ſole medium of communication between the client and the judge.

It is not cuſtomary in Spain to allow either of the parties concerned any copy of the documents requiſite for carrying on a ſuit, except by the expreſs order of the judge. All the writings on both ſides are collected together and bound up into a volume, which remains ſtatedly in the poſſeſſion of the writer, who entruſts it for a certain time to the attorneys of the parties for the inſtruction of advocates. The writer, to whoſe care the documents of any ſuit are committed, alſo regiſters the decrees and ſentences of the judges on the caſe, and notifies to the parties concerned, each ſtep of the proceſs, by reading to them the proper inſtrument; without, however, allowing them to have a copy of it.

The union of ſo many important functions in the ſame perſon, neceſſarily affords various opportunities for diſhoneſty; and the chance of being impoſed upon is ſtill further increaſed by an unwiſe regulation which obliges the defendant, in any action, to chooſe the ſame writer as is employed by the plaintiff.

It may be remarked that ſcarcely any other perſons are under equal temptations to diſhoneſty on account of the almoſt total impunity that they enjoy in conſequence of the following regulation. In all thoſe diſtricts where there are either a corregidor and ſuperior alcade, or two ſuperior alcades; each of theſe officers has an independent tribunal for the deciſion of law ſuits; and the right of pronouncing ſentence in any particular caſe belongs to him of the two at whoſe tribunal the firſt application was made. Now the eſtabliſhed ſalaries of theſe officers are ſo ſmall, that the largeſt part of their emoluments ariſes from their fees; this portion of their income depends wholly on the writers, who have the power of inſtituting ſuits in which of the two courts they pleaſe. The natural conſequence is, that the judges are induced to overlook and paſs by in ſilence thoſe malpractices of the writers which they cannot prevent without incurring a ſerious perſonal loſs. Finally, the authority of the writers is irrefragably eſtabliſhed by the entire controul that they execute over all cauſes. They alone receive the declarations and perſonal anſwers of the parties concerned; they alone receive the depoſitions of the witneſſes on each ſide; put what queſtions to them they pleaſe; and record the anſwers without the interpoſition, and even in the abſence, of the judges.

Another ſerious defect in the adminiſtration of juſtice in Spain, is, that the party condemned, however clearly unjuſt may have been his demand, or however weak may have been his defence, is ſcarcely ever obliged to pay his adverſary's coſts of ſuit; whence it perpetually happens, that the expences of gaining a juſt cauſe are much greater than the loſs of ſubmitting to an unjuſt demand; hence alſo it is in the power of a rich villain to oppreſs and ruin all thoſe who are unable to ſupport the expences of a law ſuit; which in Spain are enormous, and perhaps the more ſo, becauſe the eſtabliſhed charges are very light.

208 Religion. The religion of Spain is the Roman Catholic; which, in this country and Portugal, has been carried to a pitch of fanaticiſm unknown to the Italian ſtates, or even in the papal territory. The inquiſition, has in theſe unhappy kingdoms, been inveſted with exorbitant power, and has produced the moſt ruinous effects; having been formerly conducted with a ſpirit totally the reverſe of the mildneſs and charity of Chriſtianity. This evil has been recently ſubdued in a conſiderable degree; but one fanatic reign would ſuffice to revive it. A yet greater evil, which has ſprung from fanaticiſm, is the deſtruction of morals; for the monks being extremely numerous, and human paſſions ever the ſame, thoſe aſcetics atone for the want of marriage by the practice of adultery; and the huſbands, from dread of the inquiſition, are conſtrained to connive at this enormous abuſe. The conſcience is ſeared by the practice of abſolution, and the mind becomes reconciled to the ſtrangeſt of all phenomena, theoretic piety and practical vice united in bonds almoſt indiſſoluble.

According to the returns made to the government, the Spaniſh clergy then ſtood as follows.

Parochial clergy, called curas	16,689
Aſſiſtants, called tenientes curas	5,771
Sacriſtans or ſextons	10,873
Acolitos to aſſiſt at the altar	5,503
Ordinados de patrimonio, having a patrimony of three rials per day	13,244
Ordinados de menores, with inferior eccleſiaſtical orders	10,774
Beneficiados, or canons of cathedrals, and other beneficiaries	23,692
Monks	61,617
Carry forward	148,163
Brought over	148,163
Nuns	32,500
Beatas	1,130
Syndics to collect for the mendicants	4,127
Inquiſitors	2,705
	188,625

The archbiſhoprics were eight in number; and the biſhoprics 46. The moſt opulent ſee was that of Toledo, ſuppoſed to yield annually about 90,000l. The Mozarabic Miſſal, compoſed by St Iſidora for the Gothic church, after the converſion from Arianiſm to the Catholic faith, continued to be uſed in Spain till the Moors were ſubdued, when the Roman form was introduced.

20 Preſent ſtate of Spaniſh clergy. The Spaniſh clergy, in proportion to the population of the country, is leſs numerous than was the clergy of France prior to the revolution; even their wealth is leſs conſiderable, but better adminiſtered; and their contribution to the public revenue is much greater. As to the general conduct of the Spaniſh church, and its influence on the ſtate, we may remark that after all the perverted and malicious induſtry that has been exerted in the examination of this queſtion, the reſult has turned out highly favourable to the ſuperior orders of the Spaniſh clergy, who are, for the moſt part, free from thoſe irregularities which are charged on the clergy of other countries. The conſpicuous ſituations in the Spaniſh church are by no means conſidered as the patrimony of the rich and noble, but as the well-merited reward of irreproachable conduct. Whatever may be the rank of an eccleſiaſtic in the ſacerdotal hierarchy, he never habitually abſents himſelf from his proper place of reſidence, where he expends the revenue of his benefice in alms or public works. From the period of the reconqueſt of Spain from the Moors, moſt of the public eſtabliſhments owe their foundation to the clergy, by whom alſo whole towns have been rebuilt and raiſed from their ruins. The moſt beautiful aqueducts, fountains, and public walks in the cities, have been conſtructed at the expence of their biſhops; from them alſo the poor have received the moſt effectual relief in times of ſcarcity, epidemic diſeaſe, and war. The biſhop of Orenſe converted his epiſcopal palace into an almshouſe, where were lodged and ſupported 300 French eccleſiaſtics, condemned to tranſportation during the furies of the revolution; the prelate himſelf took his place at their table, and refuſed to partake of any indulgence that he could not alſo procure for his gueſts. Cardinal Orenzana, archbiſhop of Toledo, converted the alcazar of that city into an eſtabliſhment wherein are received 200 children, and 700 poor perſons of all ages. The biſhop of Cordova, during the ſcarcity of 1804, and for a long time afterwards, made a daily diſtribution of 1200 rations of bread to the poor inhabitants of his dioceſe. The aqueduct which conveys water to the city of Tarragona is the work of their archbiſhop, who has thus conferred upon the place the inappreciable benefits of cleanlineſs and health; to both of which it was long a ſtranger. Similar inſtances of public merit may be found in almoſt every dioceſe.

With regard to the religious orders, their conduct is certainly leſs exemplary, though by no means meriting the reproaches that have been ſo liberally caſt upon them.

them. The reforms that have taken place at various periods have ſtopped the progreſs of the abuſes introduced by length of time; and as the numbers of the monks have diminiſhed, their pernicious influence on public opinion has proportionably declined. Some progreſs has been made in the deſirable policy of uniting the different orders of the ſame rule into a ſingle order; and from the preſent prohibition to receive novices, it is probable that ſeveral orders are about to be totally ſuppreſſed.

The Spaniſh language is one of the great ſouthern dialects which ſpring from the Roman; but many of the words become difficult to the French or Italian ſtudent, becauſe they are derived from the Arabic uſed by the Moors. The ſpeech is grave, ſonorous, and of exquiſite melody, containing much of the flow and formal manner of the orientals.

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guage
litera-

The Spaniſh language is, in ſome reſpects, very rich; it abounds in compound words, in ſuperlatives, derivatives, augmentatives, diminutives, and frequentative verbs; it has many quite ſynonymous words, and others which well expreſs the different ſhades of meaning. In the technical terms of arts and ſciences it is, however, extremely poor; a few of theſe it has borrowed from the Latin, and almoſt all the reſt from the French.

On the whole, the Spaniſh is one of the fineſt of the European languages. It is dignified, harmonious, energetic, and expreſſive; and abounds in grand and ſonorous expreſſions, which unite into meaſured periods, whoſe cadence is very agreeable to the ear. It is a language well adapted to poetry; but it alſo inclines to exaggeration, and its vehemence eaſily degenerates into bombaſt. Though naturally grave, it eaſily admits of pleaſantry. In the mouth of well educated men it is noble and expreſſive; lively and pointed in that of the common people; ſweet, ſeductive, and perſuaſive, when uttered by a female. Amongſt the orators it is touching and impoſing, though rather diffuſe; at the bar and in the ſchools it is barbarous, and is ſpoken about the court in a conciſe and agreeable manner.

The literature of Spain is highly reputable, though little known to the other countries of Europe ſince the decline of Spaniſh power. The Bibliotheca Hiſpanica of Antonio will completely ſatisfy the curious reader on this ſubject. Among the fathers of literature in this country muſt be named Iſidore of Seville, many of whoſe works are extant, and inferior in merit to few of that epoch. Lives of ſaints, and chronicles, are alſo found among the earlieſt productions; and ſucceſſive writers may be traced to the 11th century, when they become numerous; but before mentioning ſome Spaniſh authorities poſterior to that period, it will be proper to recollect that Arabian learning flouriſhed under the caliphs of Cordova, and produced many illuſtrious names well known to the oriental ſcholar, as Aben Roe, or Averroes, Aben Zoar, Rhazes, &c. nor muſt it be forgotten that Aben Nazan wrote a book on the learning and authors of Spain. On this ſubject the inquiſitive are referred to the work of Caſiri.

In the 11th century, the Spaniſh authors began to increaſe in number, and the native language begins to appear. This was the epoch of the famous *Cid*, Roderic Didac de Bivar, whoſe actions againſt the Moors were celebrated in contemporary ſongs, and by a long poem written in the following century. After the 13th century, it would be idle to attempt enumerating all the Spaniſh authors, among whom are Alphonſo the Wiſe, who wrote the Libro del Teroſo, a treatiſe on the Three Parts of Philoſophy; and at whoſe command were compiled the famous Alphonſine Tables of Aſtronomy. Raymond Lully is ſaid to have written not fewer than 319 books, full of metaphyſical froth. In the 15th century appeared Juan de Mena, a poet of ſurpriſing powers, ſince which time a department of literature can ſcarcely be mentioned in which the Spaniards have not excelled. It would be unneceſſary to repeat the well-known names of Cervantes, Quevedo, Lopez de Vega, and others, whoſe works are known to all Europe. The hiſtory of Mexico has been celebrated as a compoſition; but in fact it is defective and erroneous. The name of Bayer in learning, and of Feyjos in general knowledge, have recently attracted deſerved reſpect; nor has the line of royal authors failed, an elegant tranſlation of Salluſt having been publiſhed by the heir apparent to the monarchy, the preſent Ferdinand VII *.

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Education.

As the rudiments of education are in Spain generally imparted by the monks, it can ſcarcely be expected that uſeful knowledge ſhould be common in that country. The accounts given on this ſubject by travellers, have thrown ſo little light on the ſtate of education in Spain, that it can be generally underſtood only by compariſon with other Catholic countries. In this compariſon Spain will be found inferior to France and Italy, but in many reſpects ſuperior to Auſtria and the German ſtates.

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Univerſities

The number of univerſities in Spain was formerly 24, but only the following 17 now remain, viz. that of Pampeluna, in Navarre; of Oviedo, in the Aſturias; of San Jago, in Gallicia; of Seville, and of Granada, in the provinces of the ſame name; of Hueſca and Zaragoza, in Aragon; of Avila, Oſma, and Valladolid, in Old Caſtile; of Toledo, Siguenza, and Alcala de Hamarez, in New Caſtile; of Cervera, in Catalonia; of Orihuela and Valencia, in Valencia; and of Salamanca, in the province of Leon. Of theſe the moſt celebrated, are the univerſities of Zaragoza, Toledo, Alcala, Cervera, and Salamanca.

The univerſity of Zaragoza has 22 profeſſors, and that of Toledo has 24; about 900 ſtudents attend the claſſes of the former, and nearly 3000 thoſe of the latter; yet neither of theſe eſtabliſhments is known in Europe, or regarded as of high reputation even in Spain.

The univerſity of Alcala, eſtabliſhed at a prodigious expence by Cardinal Ximenes, anſwered for nearly a century the views of its illuſtrious founder. This ſplendid inſtitution conſiſts of 31 general profeſſors, and 13 colleges, each of which has its particular eſtabliſhment of maſters and profeſſors, and of ſtudents, who receive gratuitous ſupport and inſtruction. At preſent, however, this univerſity is gone ſo entirely to decay, that ſcarcely a veſtige of its ancient ſplendour remains, and the whole number of ſtudents ſcarcely amounts to 500.

The univerſity of Cervera, founded at the commencement of the 18th century, with a magnificence truly royal, poſſeſſes 43 profeſſors, five colleges, about 900 ſtudents; but it partakes of the radical fault of all the Spaniſh univerſities; the courſe of ſtudy is incomplete and antiquated, and the very name of the inſtitution is ſcarcely known beyond the boundaries of Catalonia.

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* *Pinkerton's Geography*, vol. i.

The univerſity of Salamanca, the moſt ancient of any in Spain, has enjoyed a degree of celebrity which entitles it to a particular deſcription.

It was founded by Alphonſo IX. between the years 1230 and 1244, and was conſiderably enlarged by Ferdinand III. his grandſon. But its moſt magnificent patron was Alphonſo X. ſurnamed the Wiſe, ſon and ſucceſſor of the laſt-mentioned ſovereign. This prince richly endowed it, and drew up a ſet of ſtatutes for its government. He eſtabliſhed a profeſſorſhip of civil law, with a ſalary of 500 maravedies; a profeſſorſhip of canon law, with a ſalary of 300 maravedies; two profeſſorſhips of decretals with ſalaries of 500 maravedies; two profeſſors of natural philoſophy, and as many of logic, with ſalaries of 200 maravedies each; and two maſters of grammar, with ſalaries of 300 maravedies. It experienced alſo the liberality of many ſucceeding ſovereigns, and received from the popes a vaſt extent of privileges.

For many years this univerſity enjoyed a high reputation; its fame extended over all Europe; it was conſulted by kings and by popes, and its deputies were received into the general councils, where they well ſuſtained the character of the body which they repreſented. Students flocked to it not only from all the provinces of Spain and Portugal, and from the iſlands of Majorca and the Canaries, but alſo from the Weſt Indies and New Spain, and even from France, Flanders, and England. The number of ſtudents who attended the claſſes amounted nearly to 15,000. The whole of this vaſt eſtabliſhment conſiſted of 25 colleges, a library, and an hoſpital, called *Del Eſtudio*, intended for the amelioration of poor ſcholars.

The celebrity of Salamanca continued in full vigour during many ages; but, at length, as rival inſtitutions ſprang up, declined by ſlow degrees, ſo that by the year 1595, the number of ſtudents did not exceed 7000*.

213 State of the Spaniſh ſtage.

After the evacuation of Spain by the Romans, theatrical repreſentations were diſcontinued till they were reſtored by the Moors, and from them adopted by the Gothic Spaniards, who ſoon became paſſionately fond of the ſtage, a taſte which they have ever ſince preſerved.

They had at firſt neither theatres nor a ſtage, their dramas were acted in a court, a garden, or the open fields; the actors and ſpectators were mingled, and were equally expoſed to the injuries of the weather.

At a ſubſequent period the ſtage was marked out by a kind of boarded platform, and was ſurrounded by old clothes, drawn back, on occaſion, by means of cords, which formed the only decorations, and behind which the actors dreſſed. Their properties conſiſted only of crooks, ſome wigs and falſe beards, and a few white ſkins, trimmed with gold fringe.

Theatrical exhibitions became more regular and decent towards the end of the 16th century, when a new form was given to them by the exertions of Bartholemew Naharro, a middling dramatic poet. Theatres were then erected, but the greateſt part were upon treſſels, and two parallel pieces of canvas formed their ſcenes, which were ſometimes chequered with various colours, ſometimes covered with miſerable paintings, or adorned with foliage, trees, or flowers.

During all theſe periods, the prompter, with a candle in his hand, ſtationed himſelf on the ſtage by the ſide of the performers who were ſpeaking, and jumped from ſide to ſide whenever the actors changed their places. This cuſtom prevailed at the end of the 17th century, and even ſtill prevails among the ſtrolling companies of ſmall towns.

Theatres have at length, however, aſſumed a handſomer appearance in this country, and cuſtoms more conformable to the reſt of Europe. Handſome theatres have been multiplied, and their ſtages are now well arranged and decorated; all the great cities are well provided with them, and many of the ſmaller towns may boaſt of elegant and not ill furniſhed playhouſes.

The prompter no longer runs from one ſide of the ſtage to the other; he is placed in the middle before the ſcenes, in a kind of well, where he no longer offends the ſight and taſte of the ſpectator: but an old cuſtom which is ſtill obſerved, greatly injures the intereſt and effect of the repreſentation. The prompter, who has the piece before him, does not wait till the actor is at a loſs to prompt him, but recites the whole drama aloud, ſo that the actor appears to follow him in his declamation. By this means two voices are heard in the theatre pronouncing the ſame words, which are confounded, and often produce a diſcord, and the ſpectator who has firſt heard the piece recited, no longer takes an equal intereſt in the ſame verſes, phraſes, and words, which the actor afterwards declaims.

The Spaniſh theatres are divided into a *patio*, or area, and boxes called *balco* and *apoſentos*. The orcheſtra, where the muſicians are ſtationed, adjoins the ſtage; an incloſure between it and the pit is ſet round with arm chairs, and deſtined for the reception of the higher claſs: the *patio*, or pit, is placed behind, and filled with benches, and the *gradas* conſiſt of two rows of benches diſpoſed amphitheatrically on each ſide below the boxes, and ſometimes alſo acroſs the lower end of the theatre. This laſt diviſion is found only in a few theatres; in the others, the ſpace beneath the boxes is empty, and perſons ſtand in it. The *patio* and the *gradas* contain the common people, the moſt numerous, moſt noiſy, and moſt imperious part of the public.

There are commonly only two tiers of boxes, ſometimes three; they extend on each ſide from the ſtage to the end of the theatre. The form is the uſual one, but they are divided from each other by partitions, which completely ſhut them up on each ſide, a circumſtance which greatly injures the beauty of the general effect.

There is commonly at the end of the theatre fronting the ſtage, a large box with ſeats placed ſemicircularly behind one another, which is called the *cazuela*. No man is allowed to enter it, and only women muffled up in their *mantelas* are admitted.

There are ſeveral things very ſingular and amuſing in this cazuela. Women of every age and condition are there united; the married are confounded with the ſingle; the wives of the common people with thoſe of tradeſmen and the ladies of the court; the poor woman with the rich one who would not be at the trouble of dreſſing to appear in her box. Their appearance is moſt curious; they are all covered with their *mantelas*, a kind of white or black veil, and give the idea of a choir of nuns. It is the place for chattering, and between the acts there proceeds from the cazuela a confuſed noiſe like the hum of bees, which aſtoniſhes and diverts all who hear it for the firſt time. Scarcely is the performance ended, when the door of this box, its galleries, paſſages, and the ſtaircaſe leading to it, are

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* *De Laborde.*

Spain.

all beſieged by a great crowd of men of every condition; ſome attracted by curioſity; others coming to wait upon the women who are in it.

Notwithſtanding all that has been done for its improvement, the Spaniſh ſtage is ſtill far from the celebrity which it once poſſeſſed; and the people do not ſecond the efforts of their beſt writers. The acting is in a ſtill lower ſtate. The performers poſſeſs neither that dignity which characterizes great perſonages, and ennobles a ſubject without injuring its intereſt; nor that ſweet expreſſion of voice and geſture which goes to the heart, and awakens the ſentiments it expreſſes. In their acting every thing is violent or inanimate; every thing departs from nature. Their recitation is a feat of ſtrength, and is performed at the ſole expence of the lungs. Cries and ſhrieks are its moſt impreſſive part, and the moſt applauded by the majority of the audience. They put nothing in its proper place: all their action is exaggerated; when they threaten they roar; when they command they thunder; when they ſigh, it is with an effort which completely exhauſts the breath. They ſubſtitute anger for dignity, violence for ſpirit, inſipidity for gallantry. Their geſtures rarely correſpond with the ſentiments they ought to expreſs; but reſemble their recitation; and are uſually monotonous, capricious, ignoble, and almoſt always violent. The women, in their burſts of paſſion, become furies; warriors become villains; generals robbers; and heroes bravos. Nothing, as they manage it, is pathetic; nothing makes any impreſſion on the audience. The ſpectators, equally unmoved at the end of the piece, as at the beginning, ſee it, without having experienced a ſingle moment of intereſt or emotion *.

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ture.

As labour and culture are reckoned derogatory to the Spaniſh character, a ſufficient quantity of grain for the ſupport of the inhabitants is not raiſed, though ſocieties for the encouragement of agriculture have been eſtabliſhed in different parts of the kingdom. The principal products are wine, delicious fruits, oil, ſilk, honey, and wax. A conſiderable proportion of the mountains and valleys is paſtured by immenſe flocks of ſheep, whoſe wool is extremely fine and valuable. Eſtremadura is noted for its excellent paſtures; and the wool in Old Caſtile is reputed the fineſt in the kingdom. In Catalonia the hills are covered with foreſt and fruit trees. Valencia is celebrated for its ſilk, and for the exquiſite flavour of its melons. Murcia abounds in mulberry trees; and the ſouthern provinces yield the moſt delicious wines and fruits. Upon the whole, it has been obſerved of Spain, that few countries owe more to nature, and leſs to induſtry.

The ſoil in general repoſes on beds of gypſum, which is an excellent manure. The common courſe of huſbandry about Barcelona begins with wheat; which being ripe in June, is immediately ſucceeded by Indian corn, hemp, millet, cabbage, kidney beans, or lettuce. The ſecond year theſe ſame crops ſucceed each other as before. The next year they take barley, beans, or vetches; which coming off the ground before midſummer, are followed, as in the former years, by other crops, only changing them according to the ſeaſon, ſo as to have on the ſame ſpot the greateſt poſſible variety. Near Carthagena the courſe is wheat, barley, and fallow. For wheat they plough thrice, and ſow from the middle of November to the beginning of December; in July they reap from 10 to 100 for one, as the ſeaſon happens to be humid. The rich vale of Alicant yields a perpetual ſucceſſion of crops. Barley is ſown in September, reaped in April; ſucceeded by maize, reaped in September; and by a mixed crop of eſculents which follow. Wheat is ſown in November, and reaped in June; flax in September, pulled in May. In the vale of Valencia wheat yields from 20 to 40; barley from 18 to 24; oats from 20 to 30; maize 100; rice 40. The Spaniſh plough is generally light; and is drawn by oxen with the yoke over the horns; the moſt proper and natural mode, as the chief ſtrength of the animal centres in the head. For a very minute account of agriculture in Spain, ſee De Laborde's View, vol. iv. chap. 2.

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State of
the arts.

That prejudice which regards the mechanic arts as baſe, is not yet extinguiſhed in Spain: hence it happens that theſe arts are either neglected, or abandoned to ſuch unſkilful hands, as in general to render the Spaniards much behind their neighbours in the uſeful arts of life. The influence of this prejudice is leaſt in the province of Catalonia, where the laws, cuſtoms, and opinions are favourable to artizans; and it is accordingly in this province that the mechanic arts have made the greateſt progreſs. Foreign artiſts experience great difficulties in this country. They are not allowed to practice without gaining admiſſion into ſome incorporation or company, and this has almoſt always been refuſed them.

Some arts have, however, made conſiderable progreſs in Spain, eſpecially thoſe of gilding leather, and printing, which has lately acquired a great degree of perfection.

The fabrication of articles of gold and ſilver might become an important object in a country where theſe metals abound; but it is neglected, and the demand is almoſt entirely ſupplied from foreign markets. What little they perform in this way at home is uſually very ill executed, and exorbitantly dear. Madrid, however, begins to poſſeſs ſome good workmen in this way; encouragement would increaſe their number, and facilitate the means of improvement; but manual labour is there exceſſively dear. Hence the Spaniards prefer foreign articles of this kind, which, notwithſtanding the expence or carriage, the enormous duties which are paid on theſe articles, and the profits of the merchants, are ſtill cheaper than thoſe made at home.

216
Architecture.

The liberal arts are cultivated in this country with more aſſiduity and ſucceſs. The 16th century was the moſt brilliant period of the arts in Spain, as well as of the ſciences, of literature, and of the power and grandeur of the monarchy. A crowd of able architects appeared at once under Charles V. and Philip II. They erected numerous edifices, which will immortalize the reigns of theſe princes and the names of the artiſts. John de Herrera and Cepedes diſplayed the higheſt talents; Pedro de Uria conſtructed the magnificent bridge of Almaraz, in Eſtremadura; John-Baptiſt-Monegro of Toledo, aſſiſted in the building of the Eſcurial, and of the church of St Peter at Rome.

The ſtructures of that age are the fineſt in Spain, and perhaps the only ones in the country which deſerve to fix the attention of the ſkilful ſpectator. There are ſome among them which, in regularity, ſolidity, and magnificence, deſerve to be compared with the fineſt buildings of the Romans. The bridges of Badajoz over the Guadiana, and of Toledo, over the Manzanares, are of this period; as are alſo the grand houſe or palace, now the council-houſe at Madrid, and the beautiful edifices which adorn Toledo; the palace of Los Vargas; the hoſpital of St John the Baptiſt, and that of the Holy Croſs. During the ſame time, the *alcazar* of this city, built under Alphonſo X. was reſtored with the grandeur and magnificence which it ſtill diſplays; and the noble palace was erected, known under the name of the Houſe of Pilate, at Madrid.

That magnificent building the Eſcurial, which the Spaniards called the eighth wonder of the world, which uſed to lodge at once the king and his court, and 200 monks. This famous palace, which aſtoniſhes us by its maſs and extent, by the ſtrength of its ſtructure, the regularity of its proportions, and the ſplendour of its decorations, as much as by the repulſive appearance of its ſite and neighbourhood, alſo belongs to the ſame period, having been erected in the reign of Philip II.

The decline of architecture became as complete in the 17th century as its ſtate had been flouriſhing in the preceding age. From this period no architect occurs worthy of remembrance; and the buildings are monſtrous maſſes, deſtitute of order, taſte, and regularity. One only deſerves notice, the priſon of Madrid, called Carcel de Conte, the work of a happy genius, who knew how to profit by the bright examples of the preceding period.

About the middle of the 18th century, however, architecture began again to be cultivated with ſucceſs. The academy of San-Fernando, at Madrid, has already produced ſeveral able men in this branch, who purſue their art with credit. The handſome bridge built over the Xarama, between Aranjuez and Madrid, in the reign of Charles III. diſplays the talents of Mark de Vierna, his architect; the cuſtom-houſe of Valencia, and the temple-church of the ſame city, conſtructed on the plan of Michael Fernandez; the exchange of Barcelona; the triumphal arch which forms the gate of Alcala, at Madrid, and the ſnuff manufactory at Seville, do honour to the Spaniſh architecture of the preſent day.

217 Painting. Spain juſtly boaſts of many eminent ſculptors; but of all the liberal arts, painting is that which has been moſt cultivated in Spain, and in which its natives have beſt ſucceeded. The Spaniſh ſchool is much leſs known than it deſerves: it holds a middle place between the Italian and Flemiſh ſchools; it is more natural than the former, more noble than the latter, and partakes of the beauties of both. It has particularly excelled in ſacred ſubjects; and we recogniſe in the Spaniſh pictures the feelings uſually experienced by the people of the myſteries of religion. By none have devout ecſtaſy, fervour, and genuine piety, been ſo well expreſſed, or the myſtic paſſion given with ſo much truth. It is not in correctneſs of deſign, or nobleneſs of form, that the Spaniſh artiſts uſually excel, but in the pure imitation of nature, in grace, truth, effect, and the expreſſion of feelings.

The Spaniards have at length opened their eyes to the utility of the arts; they acknowledge them to be advantageous and deſerving of reſpect, and have begun to give them ſuch encouragement as is likely to promote a taſte for them, and to inſure their advancement. Government has done ſomething by affording protection and countenance to the new eſtabliſhments; but the ſtrongeſt impulſe has been given by individuals, or private aſſociations.

Spain now poſſeſſes an academy of painting, at Seville, and two academies of the fine arts, one at Madrid, and the other at Valencia. The firſt owes its origin to an aſſociation of the painters of Seville formed by themſelves, about the year 1660; Charles III. revived it, and eſtabliſhed there a ſchool of the fine arts. That of Madrid was founded by Philip V. The laſt was eſtabliſhed by the exertions of ſome private perſons, aſſiſted by the benefaction of Andrew Marjoral, archbiſhop of Valencia, and the protection of the municipal body. Charles III. came to its aſſiſtance 26 years after its eſtabliſhment, with an annual gift of nearly 700l. Theſe academies have for their object the ſtudy and improvement of painting, ſculpture, and architecture; they give public leſſons on theſe three arts, and diſtribute annual prizes among their pupils. That of Madrid, or San-Fernando, ſends its pupils to Rome at the expence of government, to complete their ſtudies.

Public and gratuitous ſchools for drawing have been eſtabliſhed within the laſt 20 years in different places; at Madrid, Cordova, Valencia, Seville, Zaragoza, Barcelona, &c. The laſt of theſe is ſupported by the merchants; that of Vergara was founded by the patriotic ſociety of Biſcay; and thoſe of Zaragoza and Cordova owe their birth to the zeal and generoſity of two individuals; the firſt to Don Martin Noy Cochear, the laſt to Don Antonio Cavallero, the preſent biſhop of Cordova. Thoſe of Madrid, Seville, and Valencia, depend on the academies of theſe cities.

218 Manufactures. The manufactures of Spain were more flouriſhing during the government of the Moors in that country, than they have been at any ſubſequent period. So completely had the kingdom declined in this reſpect at the end of the 16th century, when Philip V. aſcended the throne, that it is ſaid by De Laborde to have been abſolutely deſtitute of trade. The inteſtine wars which ravaged the kingdom during the firſt 14 years of that reign, and the low ſtate to which the national finances were reduced, prevented the government from paying attention to manufactures; and it was not till after tranquillity had been reſtored, and regulations adopted with reſpect to the public revenue, that the natives were induced to wear articles of their own manufacture. Since the reigns of Ferdinand VI. and Charles III. this part of the internal trade of the kingdom has greatly improved, and the manufactures of Spain are now once more on a reſpectable footing.

The Spaniſh manufactures enumerated by De Laborde, in his View of Spain, are thoſe of cloth and other woollen goods; ſilks; brocaded ſtuffs in gold and ſilver; linens and other articles formed from flax or hemp; cottons; leather, and other articles manufactured from ſkins and hides; paper; china and delft ware; brandies; beer; aquafortis; ſalt of lead; ſhears for the woollen trade; copper, iron, and braſs goods; glaſs and mirrors; ſoap; hats; articles for the marine; military implements; arms and ammunition; tobacco and ſnuff. Of theſe, the moſt important are, the woollen and ſilk manufactures; leather; brandy; military weapons; ſoap and tobacco.

The principal places for the woollen manufactures are, Aulot, Arens, Vich, and the convent of Gironne in Catalonia; Jaca, and the diſtrict of Cincavilla in Aragon, and Burgos in Old Caſtile, for woollen ſtockings; Barcelona, Zaragoza, and Burgos, for blankets; Junquera, Segovia, Burgos, and many others for baizes

and

Spain.

and flannels; Eſtella in Navarre, Eſcoray in Biſcay, Grazolerna in Seville, Toledo, &c. for coarſe cloths, which laſt article is manufactured in large quantities throughout the kingdom. The woollen ſtuffs fabricated in Spain, are in general of a very inferior quality, the wool being imperfectly ſcoured, and the dyeing ſo ill executed, that the colours are never permanent.

The chief manufactures for ſilken articles are thoſe for blonde lace throughout Catalonia, and at Almagro in La Mancha; for ſilk ſtockings, at Malaga, Zaragoza, Valencia, Talavera, and Barcelona; and for ſilk taffeties, ſerges, damaſks, and velvets, at Jaen, Granada, Murcia, Valencia, Malaga, Zaragoza, Toledo, Talavera, and Barcelona. The articles of this manufacture are in general ſtout and excellent; but they do not poſſeſs that brilliancy of appearance ſo remarkable in the French ſilks.

Tanning, currying, and dreſſing hides, ſkins, and all kinds of leather, are very general throughout Spain; but the ſkins and hides prepared at Arevaca and Pozuelo, are in greateſt repute. The greateſt quantity of ſole leather is manufactured in the provinces of Aragon and Catalonia; and in the latter province are made and exported a prodigious number of ſhoes.

The manufacture of brandy is confined chiefly to the ſtates belonging to the crown of Aragon, eſpecially at Torres in Aragon; at Selva, Mataro, &c. in Catalonia; and in Valencia.

Spain.

Spain has long been famous for its manufacture of military weapons; and it is well known that the ſwords, ſabres, hangers, and bayonets, made at Toledo and Barcelona, are of a very ſuperior temper. Large manufactories for fire-arms occur in the diſtrict of Guipuſcoa, and two royal founderies for braſs cannon, are eſtabliſhed at Barcelona and Seville.

There is only one manufactory for tobacco and ſnuff in Spain, viz. at Seville; but this is on a moſt extenſive ſcale, and is ſuppoſed to yield of annual profits about 800,000l. ſterling. Here are employed 202 mills, turned by 300 horſes or mules; and the various operations call for the daily labour of above 1400 perſons.

219 Commerce.

Conſidering the extent of ſea coaſt belonging to the kingdom of Spain, its commerce is but inconſiderable, and principally takes place between the mother-country and the American colonies. Spain, indeed, carries on a foreign trade with every country in Europe; but its principal tranſactions are, with England, Holland, Italy, and France. Its exports to theſe countries conſiſt almoſt entirely of raw produce, as, if we except oil, wine, brandy, ſhoes, ſalt, and a few coarſe cloths and ſilken articles, the trade in manufactured goods is almoſt wholly confined to the interior of the country. Its chief exports, and the amount yielded by each for the ſeveral provinces, as well as the whole amount of the export trade of Spain, to the reſt of Europe, will be ſeen in the following table.

Value of Exports from each Province in Pounds Sterling.

Goods exported.	*Catalonia.*	*Valencia.*	*Andaluſia.*	*Murcia.*	*Aragon.*	*Other Provinces.*	*Total.*
Nuts,	L. 26,000	L.	L.	L.	L.	L.8,336	L. 34,336
Oil,	26,667	-	208,333	-	-	-	235,000
Cork,	235,990	-	-	-	-	-	235,990
Wine,	2,667	103,333	508,333	31,250	-	-	645,583
Linens and cotton ſtuffs,	295,007	-	-	-	-	-	295,007
Silk handkerchiefs,	51,042	-	-	-	-	-	51,042
Paper,	73,333	-	-	-	-	-	73,333
Brandy,	262,500	125,000	-	-	-	-	387,500
Shoes and ſhoe ſoles,	22,024	-	-	-	-	-	22,024
Raiſins,	-	10,625	625,000	-	-	-	635,625
Dried figs,	-	5,333	34,375	-	-	-	39,708
Almonds,	-	6,563	-	-	-	-	6,563
Dates,	-	6,250	-	-	-	-	6,250
Barylla,	-	15,875	-	108,333	-	-	124,208
Kermes,	-	7,292	-	-	-	-	7,292
Salt,	-	9,250	833,333	-	-	-	842,583
Spart worked,	-	-	-	4,166	-	-	4,166
Silk,	-	-	-	229,166	38,333	-	267,499
Cutlery,	-	-	-	5,000	-	-	5,000
Ribbons,	-	-	-	2,083	-	-	2,083
Corn,	-	-	-	78,041	53,437	-	131,478
Saffron,	-	-	-	2,500	-	-	2,500
Wool,	-	-	-	-	48,750	641,682	690,432
Flax,	-	-	-	-	1,458	-	1,458
Coarſe cloths,	-	-	-	-	2,666	-	2,666
Silk and wool mixtures,	-	-	-	-	5,833	-	5,833
Worſted ſtockings,	-	-	-	-	540	-	540
Salt proviſions,	-	-	-	-	-	A large quantity from Gallicia.	
Oranges and lemons,	-	-	-	-	-		
Hemp,	-	-	-	-	79,063	-	79,063
Madder,	-	-	-	-	-	From Old Caſtile.	66,667
Brooms,	6,875	-	-	-	-	-	6,875
	1,002,105	289,521	2,209,374	460,539	230,080	716,685	4,908,304

The above table is confined almoſt entirely to the European exports. To theſe muſt be added the amount of Spaniſh exports to the American colonies, in order to acquire a juſt view of the total amount of the export commerce. The following table will ſhow the amount of the exports, both of home and foreign produce, from Spain to America in 1784, as eſtimated by Mr Townſend in pounds ſterling.

Ports.	Home produce.	Foreign produce.	Total.
Cadiz	1,438,912	2,182,531	3,621,443
Malaga	196,379	14,301	210,680
Seville	62,713	30,543	93,256
Barcelona	122,631	21,240	143,871
Corunna	64,575	39,962	104,537
Santander	36,715	90,173	126,888
Canaries	24,974		24,974
Tortoſa	7,669	289	7,958
Gijon	4,281	10,190	14,471
Total	L.1,958,849	L.2,389,229	L.4,384,878

Of theſe exports we are to regard chiefly thoſe of Spaniſh produce, and theſe Mr Townſend has probably eſtimated too high. M. de Laborde, on whoſe authority we are more diſpoſed to rely, ſtates the value of Spaniſh domeſtic merchandiſe exported to America in the year 1788, as amounting to 1,635,658l. ſterling, while in 1792, it amounted to 2,812,500l. ſterling, and on an average of five years, from 1788 to 1792, it amounted to 1,833,333l. ſterling. The amount of foreign merchandiſe exported in 1788, was 1,484,315l. ſterling. Adding the average to this laſt ſum, we have 3,317,648l. ſterling for the whole export trade to America. This added to 4,908,304l. ſterling, makes a grand total of 8,225,952l. ſterling for the whole export trade of Spain.

The Spaniſh imports are much more conſiderable than the exports. Before the preſent troubles, Spain imported from Holland, tapes, linen drapery, common lace, cutlery goods and paper; from Sileſia, linen drapery; from Germany, more particularly from Hamburgh, quantities of haberdaſhery; from England, calicoes, iron and ſteel goods, fine cloth, quantities of cod fiſh and ling; the value of the laſt articles is eſtimated at three millions of duros, five millions livres tournois, (208,333l. 13s. 4d.); from France, calicoes, linen drapery, ſilk ſtockings, ſilks, camlets, and other kinds of worſted ſtuffs, fine cloths, gilded articles, jewellery, iron goods, haberdaſhery, ſteel goods, and perfumery.

We have not ſatisfactory documents ſufficient to aſcertain the amount of theſe imports, but it was certainly much leſs than that of the imports from the American colonies. Theſe latter, according to Mr Townſend's ſtatement, amounted in 1784 to 12,635,173l. ſterling; to which, if we add nearly half a million for duty, we ſhall have a total of above thirteen millions ſterling for American imports alone. De Laborde eſtimates the total amount of American imports for the year 1788 at 8,382,330l. ſterling, of which Cadiz alone imported 6,617,873l. ſterling. If to the above amount we add 577,679l. for the duty at the ſame period, we ſhall have a total of 8,960,009l. ſterling againſt the mother country, deducting from this 3,317,648l. for the average exports, we have 5,642,361l. as the balance of trade in favour of the Spaniſh colonies.

220
Inland navigation.

Though there are in Spain many navigable rivers, few canals of communication have been conſtructed to improve the internal navigation of the country. The canal of Aragon, completed during the reign of Charles IV. muſt be highly beneficial to that province. Two canals, viz. that of Tueuſtre and the imperial canal, both of which begin at Navarre, run in various windings through Aragon, by turns receding from or approaching the river Ebro, where at length they terminate. Beſides the dykes, banks, ſluices, and bridges neceſſary in the courſe of theſe canals, an aqueduct has been conſtructed in the valley of Riozalen, 710 fathoms in length, and 17 feet thick at the baſe, in which the canal runs.

The canal of Caſtile, projected and begun in the laſt reign, has been almoſt abandoned. It was to commence at Segovia, ſixteen leagues north of Madrid, to follow the courſe of the Ereſma, that falls into the Douro, and to be continued as far north as Reynoſa; which is twenty leagues from St Ander, a ſea port. At Reynoſa is the communication with the canal of Aragon, that unites the Mediterranean to the bay of Biſcay. Above Palencia, a branch goes weſtward through Rio-Seco and Benevento to Zamora; making the canal of Caſtile, in its whole extent, 140 leagues; where it is completed, viz. between Reynoſa and Rio-Seco, its width at top is 56 feet, at bottom 20, and nine in depth.

In 1784, a canal was planned, which, from the foot of the mountains of Guadarama near the Eſcurial, ſhould proceed ſouthward to the Tagus; afterwards to the Guadiana, and terminate at the Guadalquiver above Andaxar. Some other attempts to improve the inland navigation of the country have been unſucceſsful.

221
General character of the Spaniards.

There is no nation in Europe which diſplays ſuch a variety of national character as Spain. In no two provinces are the manners and character exactly alike. It is therefore difficult to collect traits on which to found the national character of the Spaniards; and this character has been variouſly repreſented by different writers. From the tranſactions which have lately taken place between that people and the Britiſh nation, we confeſs ourſelves prejudiced againſt them; and we ſhall therefore, inſtead of ſketching their character according to our own preconceived notions, endeavour to delineate it as conciſely as poſſible from De Laborde, who is probably a ſufficiently competent judge.

The national pride, ſays this author, is every where the ſame. The Spaniard has the higheſt opinion of his nation and himſelf, and this he expreſſes with energy, in his geſtures, words, and actions. This opinion is diſcovered among all ranks in life, and all claſſes of ſociety. Its reſult is a kind of haughtineſs, ſometimes repulſive to him who is its object, but uſeful in giving to the mind a ſentiment of nobleneſs and ſelf-eſteem which fortifies it againſt all meanneſs.

In later times the Spaniards have not degenerated from the valour of their anceſtors. The Spaniſh ſoldier is ſtill one of the beſt in Europe, when placed under an experienced general, and brave and intelligent officers. He poſſeſſes a cool and ſteady valour; he long endures fatigue and hunger, and eaſily inures himſelf to labour.

The Spaniards are very reſerved, and rather wait for, than

than court the advances of a ſtranger. Yet in ſpite of their apparent gravity, they poſſeſs an inward gaiety, which frequently ſhines out when proper occaſions call it forth.

The Spaniard is very ſlow in all his operations; he often deliberates when he ought to act, and ſpoils affairs as much by temporiſing as the natives of other countries do by precipitation. This tardineſs would be but a ſlight defect, did it not proceed from a ſerious radical want, from the invincible indolence and hatred of labour which prevails among all ranks of ſociety.

That jealouſy which was formerly proverbial among the Spaniards, is now greatly diminiſhed; huſbands are much leſs ſuſpicious, and women much more acceſſible. Lattices have diſappeared; duennas exiſt only in romances; veils are exchanged for mantelas; houſes are thrown open, and the women have recovered a liberty by which they are leſs tempted to go aſtray than when their virtue was entruſted to locks and grates, and to the ſuperintendance of guards often faithleſs and eaſily corrupted.

In fine, the Spaniards are ſober, diſcreet, adroit, frank, patient in adverſity, ſlow in deciſion, but wiſe in deliberation; ardent in enterpriſe, and conſtant in purſuit. They are attached to their religion, faithful to their king, hoſpitable, charitable, noble in their dealings, generous, liberal, magnificent; good friends, and full of honour. They are grave in carriage, ſerious in diſcourſe, gentle and agreeable in converſation, and enemies to falſehood and evil ſpeaking.

222
Diverſities of character in the ſeveral provinces.

Such is the Spaniſh character as drawn by De Laborde. Its varieties in the ſeveral provinces are thus ſtated by the ſame author. The Old Caſtilians are ſilent, gloomy, and indolent, and are the moſt ſeverely grave of all the Spaniards; but they poſſeſs a ſteady prudence, an admirable conſtancy under adverſity, an elevation of ſoul, and an unalterable probity and uprightneſs. The character of the natives of New Caſtile is nearly the ſame, but more open, and leſs grave and taciturn. Indocility and conceit make part of the character of the people of Navarre; they are diſtinguiſhed by lightneſs and adroitneſs. The Biſcayans are proud, impetuous, and irritable; abrupt in diſcourſe and in action; haughty and independent, but induſtrious, diligent, faithful, hoſpitable, and ſociable. The Gallicians are gloomy, and live very little in ſociety; but they are bold, courageous, laborious, very ſober, and diſtinguiſhed for their fidelity. The Aſturians partake of the character of the Gallicians and Biſcayans; but they are leſs induſtrious than the former, leſs civilized, leſs ſociable, leſs amiable, and more haughty than the latter. The people of Eſtremadura are proud, haughty, vain, ſerious, indolent; but remarkably ſober, honourable, and much attached to their own province, which they ſeldom quit. The Murcians are lazy, liſtleſs, plotting, and ſuſpicious; attached neither to ſciences, arts, commerce, navigation, nor a military life. The Valencians are light, inconſtant, and indeciſive; gay, fond of pleaſure, little attached to each other, and ſtill leſs to ſtrangers, but affable, agreeable, and diligent. The Catalans are proud, haughty, violent in their paſſions, rude in diſcourſe and in action, turbulent, untractable, and paſſionately fond of independence; they are not particularly liberal, but active, induſtrious, and indefatigable; they are ſailors, huſbandmen, and builders, and reſort to all corners of the world to ſeek their fortunes. They are brave, intrepid, ſometimes raſh, obſtinate in adhering to their ſchemes, and often ſucceſsful in vanquiſhing, by their ſteady perſeverance, obſtacles which would appear inſurmountable to others.

223
Manners and cuſtoms.

The natives of almoſt every province have ſome diſtinguiſhing peculiarity in their dreſs, manners, and purſuits. Before the acceſſion of the houſe of Bourbon to the throne, the uſual dreſs of a Spaniſh nobleman conſiſted of a ſlouched hat, a long black or brown cloak, ſhort jerkin, and ſtrait breeches, with a long Toledo ſword; but French dreſſes are now introduced at court. The higher claſſes wear their hats under their arm. The common people wrap themſelves up to the eyes in a brown cloak, called *aleapo*, that reaches to the ground; and conceal their hair beneath a cotton cap, and a broad hat called a *ſombrero*. When a lady walk abroad, her head and upper part of her body are covered with a mantela; that is, a white or black veil, ſo that it is impoſſible ſhe ſhould be known. At home, the dreſs is a jacket and a petticoat of ſilk or cotton. The hair is generally a fine black; and powder is rare.

In romance, the ladies are celebrated for beauty, and ſome of them deſerve that character; yet beauty is not their general character. They are of a ſlender make, but with great art they ſupply the defects of nature. By an indiſcriminate uſe of paint, they diſfigure their complexion and ſhrivel their ſkin.

Several of the Spaniſh cuſtoms and habits, which ſeem ridiculous to foreigners, are gradually wearing out, and in proceſs of time will no doubt be corrected. The higher claſſes at breakfaſt uſe chocolate, and ſeldom tea. Dinner generally conſiſts of beef, veal, pork, mutton, and beans, boiled together. They are fond of garlic; and it is proverbial that olives, ſalad, and radiſhes, are food for gentlemen. The men drink little wine, and the women uſe water or chocolate. Both ſexes ſleep after dinner, and air themſelves in the cool of the evening. Their repaſts are compoſed of ſweatmeats, biſcuit, coffee and fruit, which ſervants diſtribute to the company; who keep their ſeats, and have little converſation.

Dancing and cards are favourite amuſements. Theatrical exhibitions are generally inſipid or ridiculous bombaſt, low wit, abſurdity, and buffoonery. The combats of the cavalleros and bull fights, are almoſt peculiar to this country. On theſe occaſions young gentlemen were uſed to ſhow their courage to their miſtreſſes; and were honoured and rewarded according to their ſucceſs. But theſe exhibitions were lately conducted with greater economy and parſimony; and mercenary champions ſtudied in the moſt ſecure and graceful manner to deſtroy the devoted animal. See *BULL-Fighting*.

The chief defect in all ranks is an averſion to labour and induſtry. The higher orders beſtow no attention on agriculture and commerce; they reſide for the moſt part at court and in the metropolis, reckoning it beneath their dignity to live in villas on their eſtates among their tenants. In their eſtimation, a labouring man quits the dignity of the Spaniſh character, and renders himſelf an object of contempt. Hence a liſtleſs indolence prevails. Thouſands waſte their time in total want of every incitement to action. Their intellectual powers lie dormant, and their views and exertions are confined within the narrow ſphere of mere exiſtence. The common people have no encouragement to induſtry; and muſt feel little

concern

concern for the welfare of a country where a few overgrown families engroſs every thing valuable, and never think of the condition of their vaſſals. The indigent Spaniard does not beſtir himſelf unleſs impelled by want, becauſe he perceives no advantage to be derived from induſtry. A ſtranger to intemperance and exceſs, his ſcanty fare is eaſily procured; and under a climate ſo propitious, few clothes are required. The hovel which he occupies, together with all its contents, has a mean, filthy, deſpicable appearance; and all that relates to him bears the impreſſion of wretchedneſs and miſery ‡.

There are certain cuſtoms which may be regarded as peculiar to the Spaniards, or which at leaſt are ſcarcely found in any other European country. The number of ſervants retained in the families of the higher ranks is prodigious; and even a tradeſman's wife, in narrow circumſtances, will frequently have four maid ſervants, though ſhe cannot, with propriety, employ more than two. The houſes of gentlemen, and eſpecially of grandees, ſwarm with them; and, not unfrequently, all the principal ſervants will have their wives and children lodged with them, and ſupported by their maſter. We have heard of one nobleman who was at the daily expence of 120l. merely for the maintenance of his numerous retainers.

The Spaniards are fond of meeting in the evening in parties, which are often very numerous. On theſe occaſions, the ladies as they arrive place themſelves in one room, and the gentlemen in another; or elſe the ladies range themſelves in a line along the ſide of the room, the lady of the houſe always taking the loweſt place next to the door, whilſt the men remain ſtanding, or ſeat themſelves on the oppoſite ſide. They remain ſeparated in this manner till the card parties are introduced. They play at loo, loto, and other games of a ſimilar kind. Thoſe who do not play, either look on, or embrace the opportunity of chatting with the perſon moſt intereſting to them. Others form little circles, where the converſation is uſually very animated. Theſe parties very much reſemble the French evening, and the Engliſh rout.

A *refreſco* ſometimes makes part of theſe entertainments, but only on particular occaſions, when the company is more than uſually numerous. But orgeat, lemonade, orangeade, ices of different kinds, ſweetmeats, and biſcuits, are diſtributed with uncommon profuſion; and chocolate ends the *funcion*, as all theſe entertainments are called.

Many precautions are taken in Spain againſt the heat. The rooms are watered ſeveral times a-day, and the windows are ſhaded on the outſide with awnings of cloth or ticking, or on the inſide by large and full curtains. In ſome places, as at Valencia, the glaſs is taken out of the windows at the approach of ſummer, and the doors of the apartments are all ſet open.

The beds in Spain are hard, being made of mattreſſes, laid on paillaſſes, reſting on a wooden bottom. The furniture of the houſes is uſually very ſimple, and the floors are covered with matting or printed cloth. The chairs have ruſh bottoms, and are uſually of different heights, thoſe for the ladies being one-third lower than thoſe for the gentlemen.

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Amuſements.

Among the principal amuſements of the Spaniards muſt be reckoned muſic and dancing. Though the Spaniards have a taſte for muſic, they are by no means proficients in that accompliſhment. Their principal inſtrument is the guitar, which is in the hands of every body. Different provinces have alſo their peculiar inſtruments. Thus the Gallicians uſe a dull and heavy bagpipe; the Catalonians a large flageolet, and a little drum or tabor; and the Biſcayans a ſhort flute, with four holes. Caſtanettes are alſo extremely common, and are employed with great dexterity and addreſs in the national dances.

The Spaniards are paſſionately fond of dancing, and they have certain dances which are peculiar to Spain. Of theſe the fandango is the moſt celebrated, and appears to be the moſt ancient. It is a very extraordinary dance, in which the whole body is thrown into a regular and harmonious convulſion, expreſſive of the moſt laſcivious ideas.

The paſſion of the Spaniards for theſe dances is carried to a height which can ſcarcely be imagined. No ſooner are the guitar and the ſinging to which they are danced heard in a ball room or theatre, than a murmur of delight ariſes on all ſides; all faces become animated; the feet, hands, and eyes of all preſent are put in motion: it is impoſſible to deſcribe the effect produced. Mr Townſend, an Engliſh traveller, affirms, that if a perſon were to come ſuddenly into a church or a court of juſtice playing the *fandango*, or the *colero*, prieſts, judges, lawyers, criminals, audience, one and all, grave and gay, young or old, would quit their functions, forget all diſtinctions, and all ſet themſelves a dancing.

The Spaniſh balls are directed by two perſons choſen among the viſitors, who are called *baſteneras*, and with the hat under the arm, and the cane in the hand, perform the office of maſters of the ceremonies. One is for the gentlemen, the other for the ladies. It is their buſineſs to appoint who is to dance, whether minuets or country dances: they are in general very attentive to the obſervance of precedence and etiquette, and have uſually the complaiſance to contrive that thoſe ſhall dance together to whom it is peculiarly agreeable to meet.

A ſingular cuſtom is obſerved at theſe balls, which appears new and ſtrange to a foreigner. The lady choſen to dance riſes, croſſes the room alone, and places herſelf where ſhe is to begin dancing, without waiting for her partner to lead her out; and after the dance is over, her partner makes his bow to her again in the middle of the room without taking any further concern about her, or handing her back to her place. But this cuſtom prevails only in the provinces.

The bull-fights noticed above were once not only a favourite but a faſhionable ſpectacle in Spain. Every city, and almoſt every ſmall town, had a place ſet apart for theſe darling combats; and hither all ranks and ages reſorted with the greateſt avidity, and witneſſed the proweſs of the combatants, and the torture of the wretched animals, whom they were hired to butcher, with the moſt ſavage expreſſions of delight. Theſe fights made a part of every feſtival, and, as ſoon as they were announced, the houſewife left her family, the tradeſman forſook his ſhop, the artiſt his work-room, the labourer his field, and joy and expectation were painted on every countenance. To the honour of the nation, theſe cruel ſports are at length aboliſhed, and Spain has thus ſet an example of humanity, which Britain, with all her civilization and refinement, need not bluſh to copy.

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‡ *Playfair's Geography*, vol. i. p. 68.

New-Spain. See Mexico.

SPALATRO, or Spalatto, a rich, populous, and ſtrong town of the republic of Venice, capital of Venetian Dalmatia, with a good harbour and an archbiſhop's ſee. Here are the ruins of the palace of Diocleſian, of which the late Mr Robert Adam publiſhed in 1764 a ſplendid account, enriched with 71 folio plates. In 1784, Spalatro was nearly depopulated by the plague. It is ſtrong by ſituation, being built on a peninſula, which is joined to terra firma by a neck of land half a mile over. It is ſeated on the gulf of Venice, 35 miles ſouth-eaſt of Sebenico, and 102 north-weſt of Raguſa. E. Long. 17. 31. N. Lat. 44. 4.

SPALLANZANI, Lazarus, a celebrated naturaliſt, was born at Scandiano, in the duchy of Modena, in January 1729. He began his ſtudies in his native country, and went to Reggio de Modena at 15 years of age, to proſecute them further. He was inſtructed in the *belles lettres* by the Jeſuits, who contended with the Dominicans in order to ſecure his attachment; but his thirſt for knowledge determined him to go to Bologna, where his relative Laura Baſſi, a woman highly celebrated for her genius, eloquence, and ſkill in natural philoſophy and mathematics, was one of the moſt diſtinguiſhed profeſſors of the Inſtitute and of Italy. Under this enlightened guide, he was taught to prefer the ſtudy of nature to that of her commentators, judging of the real value of the commentary by its reſemblance to the original. He availed himſelf of the wiſdom of that lady's counſels, the happy effects of which he very ſoon experienced. Spallanzani's taſte for philoſophy was not excluſive, for he carefully ſtudied his own language, became a proficient in the Latin tongue, and attached himſelf above every other to the Greek and French. By the advice of a father whom he ardently loved, he applied himſelf to juriſprudence; but being urged by Anthony Valliſnieri to renounce his vocation, by procuring the conſent of his father, he gave himſelf up to the ſtudy of mathematics with more zeal than ever, at the ſame time devoting himſelf to the ſtudy of languages, both living and dead.

It was not long before he was known all over Italy, and, what is ſeldom the caſe, his own country firſt put that value on his talents which they juſtly merited. He was choſen profeſſor of logic, metaphyſics, and Greek, in the univerſity of Reggio, in the year 1745, where he taught during ten years, devoting every moment of his leiſure time to the ſtudy and contemplation of the works of nature. The attention of Haller and Bonnet was fixed by his obſervations on the animalculæ of infuſions, the latter aſſiſting him in his laudable career, and ever after diſtinguiſhing him as one of the learned interpreters of nature.

Spallanzani was invited to the univerſity of Modena in the year 1760, and ſome years after he declined to accept of the offers made to him by the academy of Peterſburg, as well as ſimilar ones from Coimbra, Parma, and Ceſena, though extremely advantageous. He preferred his native ſpot, and therefore continued at Modena till the year 1768, and ſaw raiſed up by his care a generation of men conſtituting at that time the glory of Italy, among whom we find Venturi, Belloni, Luccheſini, and Angelo Mazzo.

While Spallanzani remained at Modena, he publiſhed his *Saggio di Oſſervazioni Microſcopiche concernente il Syſtema di Needham e Buffon*, in 1765, in which he eſtabliſhes, by a number of the moſt ingenious and ſolid experiments, the *animality of microſcopic animalculæ*. This work was ſent by the author to Bonnet, who drew from it a prediction reſpecting the future celebrity of Spallanzani, which he lived to ſee accompliſhed. This circumſtance gave birth to the moſt intimate friendſhip, which laſted to the cloſe of life, and conſtituted their chief happineſs. During the ſame year he publiſhed a truly original work, entitled *De Lapidibus ab aqua reſilientibus*, in which he proves, in oppoſition to the commonly received opinion, by the moſt ſatisfactory experiments, that what are called *ducks* and *drakes*, are not produced by the elaſticity of the water, but by the effect naturally reſulting from the change of direction experienced by the ſtone in its movement, after it has ſtruck the water, and that it has been carried over the hollow of the cup formed by the concuſſion.

When the univerſity of Padua was re-eſtabliſhed upon a larger ſcale, the Count de Firmian was directed by the empreſs Maria Thereſa, to invite Spallanzani to be profeſſor of natural hiſtory, to which his great reputation made him competent, although it was ſolicited by many celebrated characters; and he merited it by his ſucceſs, as immenſe crowds of ſtudents thronged to his lectures. He had a fine genius, and his knowledge was of vaſt extent; his method was ſimple, but rigorous in its nature, and what he knew he connected with principles firmly eſtabliſhed. He acquired the valuable art of interpreting nature by herſelf, which diffuſed ſuch a light over his lectures, that every thing became perſpicuous, which could be ſaid to afford any inſtruction. His diſcourſes were plain and animated, and the elegance and purity of his ſtyle charmed every hearer. He prepared his lectures a year before-hand, and it was his chief aim to render them uſeful in an eminent degree. His new obſervations made them always new and engaging. Many learned perſons who attended his lectures were not above becoming his ſcholars, in order to acquire a more extenſive knowledge of what they knew before, and to learn that which otherwiſe they might probably never have known. The *Contemplation de la Nature* of Bonnet was his text book, the vacancies of which he ably filled up, fully explained the ideas, and eſtabliſhed the theories by his own experiments. This work was tranſlated by him into the Italian language, and he added much to its value by notes of his own, the firſt volume of which he publiſhed in 1769, and the ſecond the following year.

His connection with Bonnet tended, in a great meaſure, to influence his genius, which yielded to the ſevere method of inveſtigation adopted by the philoſopher of Geneva. He was proud of being the pupil of ſuch an illuſtrious character, upon whoſe writings he inceſſantly beſtowed every leiſure moment, and thus became anxious to learn from Nature herſelf the proofs of Bonnet's ſentiments reſpecting the generation of organized bodies, the pleaſing nature of which reſearch captivated his attention for a conſiderable time.

The firſt two volumes of this work, entitled *Opuſculi di Fiſica Animale e Vegetabile*, were publiſhed in the year 1776, containing the explanation of part of the microſcopic obſervations which were previouſly given to the world.

If it muſt be admitted that the art of accurate obſer-

Spallanzani.

Spallanzani.

tion is by far the moſt difficult, it cannot be denied that it is at the ſame time the moſt neceſſary, and requires the moſt brilliant talents and abilities, which were poſſeſſed by Spallanzani in a remarkable degree, as is fully evinced by all his reſearches and all his admirable writings.

The polite manner in which he conducted his diſpute with Needham reſpecting the phenomena of generation, ſecured for him a high degree of applauſe. On this occaſion he treated of the influence of cold upon animals, and proved that the torpidity of ſome during winter, does not depend on the impreſſion the blood may receive from it, ſince a frog deprived of blood, becomes torpid when reduced to the ſame cold ſtate by being immerſed in ice, and ſwims as formerly when reſtored to a proper degree of warmth.

Spallanzani travelled through Switzerland and the Griſons in the year 1779, after which he went to Geneva, ſpending a month with his friends, by whom his converſation was as much admired as his maſterly writings. From this place he returned to Pavia, and in 1780 publiſhed two more volumes of his *Diſſertazione di Fiſica Animale e Vegetabile*, wherein he unfolded the ſecrets of the interpretation of two very intricate phenomena, concerning the economy of animals and vegetables. He was led to this ſtudy from ſome experiments made by him upon *digeſtion*, for his lectures; and he repeated the experiments of Reaumur on gallinaceous birds, remarking that the trituration which in this caſe is favourable to digeſtion, could not be a very powerful means. He perceived that the gizzard of thoſe birds, by which the ſtones of fruit are pulverized, did not digeſt the powder thus formed, it being neceſſary that it ſhould undergo a new operation in the ſtomach, previous to its becoming chyle for the production of the blood and other humours.

This ſubject may be regarded as one of the moſt difficult in phyſiology, becauſe the obſerver is always under the neceſſity of acting and looking in the midſt of darkneſs; the animal muſt be managed with care, that the derangement of the operations may be avoided; and when the experiments are completed with great labour, it is requiſite that the conſequences be well diſtinguiſhed. Spallanzani in this work is truly enchanting, analyſing facts with ſcrupuloſity, in order to aſcertain their cauſes with certainty; comparing Nature with his experiments, in order to form a correct judgment reſpecting them; laying hold of every thing eſſential to them in his obſervations, and meaſuring their ſolidity by the increaſe or diminution of ſuppoſed cauſes.

Mr John Hunter appears to have been greatly hurt by this work, which led him to publiſh, in the year 1785, *Some Obſervations upon Digeſtion*, in which he threw out ſome bitter ſarcaſms againſt the Italian naturaliſt, who took ample revenge by publiſhing this work in the Italian language, and addreſſing to Caldani in 1788, *Una Lettera Apologetica in Riſpoſta alle Oſſervazione del Signor Giovanni Hunter*. In this he expoſed with great moderation, but at the ſame time with logic which nothing could reſiſt, the miſtakes and errors of the Britiſh phyſiologiſt, leaving the power of a reply altogether hopeleſs.

The generation of animals and plants is treated of in the ſecond volume of this laſt-mentioned work, in which he proves the pre-exiſtence of germs to fecundation, by experiments as ſatisfactory as ſurpriſing; ſhewing alſo the exiſtence of tadpoles in the females of five different ſpecies of frogs, in ſalamanders, and toads, before their fecundation. He likewiſe recounts the ſucceſs of ſome artificial fecundations upon the tadpoles of thoſe five ſpecies, and even upon a quadruped.

In the year 1781, he took the advantage of the academical vacation, for the purpoſe of making a journey, in order to add to the cabinet of Pavia. He ſet out for Marſeilles in the month of July that year, where he began a new hiſtory of the ſea, which preſented him with many new and curious facts on numerous genera of the natives of the ocean. He went alſo to Finale, Genoa, Maſſa, and Carrara, to make obſervations on the quarries of marble, held by ſtatuaries in ſuch eſtimation. He then returned to Spezzia, and brought from thence to Pavia a vaſt number of fiſhes, which he depoſited in the cabinet of that city, wholly collected by himſelf. With the ſame view and ſucceſs he viſited the coaſts of Iſtria in 1782, and the Apennine mountains the ſubſequent year, taking notice of the dreadful hurricanes, and the aſtoniſhing vapours by which that year became ſo noted in meteorology. The emperor Joſeph, on examining this cabinet, preſented Spallanzani with a gold medal. In 1785, he was offered the chair of natural hiſtory by the univerſity of Padua, vacant by the death of Anthony Valliſnieri; but in order to prevent his acceptance of it, his ſalary was doubled by the archduke, and he went to Conſtantinople with Chevalier Zuliani, who had been appointed ambaſſador from the Venetian republic. He ſet out on the 21ſt of Auguſt, and reached the Turkiſh metropolis on the 11th of October, where he remained during eleven months. His attention was fixed by the phyſical and moral phenomena of this country, which were new even to Spallanzani. He ſtrayed along the borders of the two ſeas, and aſcended the mountains in the vicinity; he paid a viſit to the iſland of Chalki, diſcovering to the Turks a copper mine, the exiſtence of which they had never once conjectured. He diſcovered an iron mine not far from Conſtantinople, in the iſland of Principi, of which the Turks were equally ignorant, and prepared to return for Italy on the 16th of Auguſt 1786.

A voyage by ſea was undoubtedly the ſafeſt, but the dangers to which he would be expoſed by land were regarded as nothing when contraſted with the idea of being beneficial to ſcience and to man. Having reached Bochareſt, Mauroceni the friend of ſcience, received Spallanzani with marks of diſtinction, preſented him with many rarities which the country produced, and gave him horſes for travelling, with an eſcort of 30 troopers, to the utmoſt confines of his own dominions. Our philoſopher paſſed by Hermanſtadt in Tranſylvania, and reached Vienna on the 7th of December, where he remained during five days, and had two long conferences with the emperer Joſeph II. was much eſteemed by the nobility of that city, and reſpectfully viſited by many literary characters. When he arrived at Pavia, the ſtudents went out of the city gates to meet him, and teſtified their joy at his return by repeated acclamations. He was almoſt inſtantly drawn to the auditory, and compelled to aſcend the chair from which he had been accuſtomed to deliver his faſcinating lectures; but their demonſtrations of joy and ſhouts of applauſe made him requeſt of them to give over, and indulge him with that repoſe in his own houſe which was now ſo abſolutely neceſſary. His ſtudents this year exceeded 500.

So extenſive was the fame of Spallanzani become by this time, that envy was determined, if poſſible, to wound his reputation. If his diſcoveries were too new, ſolid, and original, to be ſucceſsfully diſputed, that vile paſſion, or rather *fiend*, began to queſtion his integrity and uprightneſs reſpecting the adminiſtration of the cabinet of Pavia; but this iniquitous attempt to tarniſh his honour, only made it ſhine forth with redoubled ſplendour. The juridical examination of the tribunals made his integrity appear even purer than before; and it muſt be mentioned to his honour, that he had the fortitude to forget this event; his enemies in general confeſſed their miſtake, renounced their unprovoked animoſity, and ſtill hoped to regain a friendſhip of which they had proved themſelves ſo unworthy.

In the voyage of Spallanzani we meet with what may be denominated a new volcanology. We are there inſtructed how to meaſure the intenſity of volcanic fires, and in his analyſis of the lava, almoſt to touch the particular gas which tears thoſe torrents of ſtone in fuſion from the bowels of the earth, and raiſes them to the top of Mount Etna. This delightful work is cloſed by ſome important enquiries into the nature of Swallows, the mildneſs of their diſpoſitions, the rapidity of their flight, diſcuſſing the celebrated problem reſpecting their remaining torpid during the winter ſeaſon, proving that artificial cold, much more intenſe than what is ever naturally experienced in our climates, does not reduce theſe birds to the torpid ſtate.

Things apparently impoſſible were often diſcovered by Spallanzani. In the year 1795 he made one of this deſcription, which he gave to the world in his *Lettere ſopra il ſopetto d'un nuovo ſenſo nei Pippiſtrelli.* In that work we are informed that bats, if deprived of ſight, act with the ſame preciſion in every inſtance as thoſe which have their eyes; that they ſhun in the ſame manner the moſt trivial obſtacles, and alſo know where to fix themſelves when their flight is terminated. Several philoſophers confirmed theſe aſtoniſhing experiments, from which a ſuſpicion aroſe, that theſe animals muſt have a new ſenſe, as it appeared to Spallanzani that the other known ſenſes could not compenſate for the want of ſight; but he was afterwards inclined to think, in conſequence of Profeſſor Jurine's experiments on the organ of hearing in bats, that in this particular inſtance the ſenſe of hearing might poſſibly ſupply the want of ſight.

The literary career of this celebrated naturaliſt was terminated by a letter to Giobert, entitled *Sopra la piante chiuſe ne vaſi dentro l'aqua e l'aria, eſpoſte a l'immediata lume ſolare e a l'ombra.* Theſe numerous works, which met with the higheſt approbation, do not comprehend the whole of his multifarious labours; for the phenomena of reſpiration had occupied his attention a conſiderable time; their points of reſemblance and diſſimilitude in many ſpecies of animals; and he had nearly finiſhed his voyage to Conſtantinople, as well as collected many valuable materials for a hiſtory of the ſea, when his life and labours were unfortunately terminated.

He was ſeized with a retention of urine on the 4th of February 1799, and next morning was deprived of the regular uſe of his faculties, only enjoying a ſound mind during very ſhort intervals. Tourdes and Profeſſor Scarpa did every thing to ſave him, which could be produced by the joint exertions of genius, experience, and friendſhip, but in vain. He died on the 17th; but we know not what credit is due to the aſſertion, that he edified thoſe around him during his laſt moments by his *piety*. Be that as it may, while his works exiſt to ſpeak for themſelves, impartial poſterity will regard him as a very extraordinary man. Theſe works have been tranſlated into almoſt every European language, and he was admitted a member of the academies and learned ſocieties of London, Stockholm, Gottingen, Holland, Lyons, Bologna, Turin, Padua, Mantua, and Geneva, and he received from Frederick the Great the diploma of member of the academy of Berlin.

SPAN, a meaſure taken from the ſpace between the thumb and the tip of the little finger when both are ſtretched out. The ſpan is eſtimated at three handsbreadths or nine inches.

SPANDRELL, the ſolid work on each haunch of an arch, to keep it from ſpreading.

SPANHEIM, EZEKIEL, a learned writer in the 17th century, was born at Geneva in 1629; and in 1642 went to Leyden to ſtudy. Here he diſtinguiſhed himſelf to great advantage; and his reputation ſpreading, Charles Louis elector palatine ſent for him to be tutor to his only ſon. This taſk our author diſcharged to the entire ſatisfaction of the elector; by whom he was alſo employed in divers negotiations at foreign courts. He afterwards entered into the ſervice of the elector of Brandenburg, who in 1680 ſent him envoy extraordinary to the court of France, and ſoon after made him a miniſter of ſtate. After the peace of Ryſwic, he was again ſent on an embaſſy to France where he continued from the year 1697 to 1702. The elector of Brandenburg having during that interval aſſumed the title of *King of Pruſſia*, conferred on him the title and dignity of a baron. In 1702 he left France; and went ambaſſador to England, where he had been ſeveral times. Here he died in 1710, aged 81 years. It is ſurpriſing, that in diſcharging the duties of a public miniſter with ſo much exactneſs, and amidſt ſo many different journeys, he could find time enough to write the ſeveral books publiſhed by him. It may be ſaid of him, that he acquitted himſelf in his negotiations like a perſon who had nothing elſe in his thoughts; and that he wrote like a man who had ſpent his whole time in his ſtudy. The principal of his works are, 1. *De præſtantia et uſu numiſmatum antiquorum*; the beſt edition of which is in two volumes folio. 2. Several letters or diſſertations on ſcarce and curious medals. 3. A preface and notes to the edition of the emperor Julian's works, printed at Leipſic in 1696, folio.

SPANIEL, in *Zoology*. See CANIS, MAMMALIA *Index*.

SPAR, in *Mineralogy*, a name given chiefly to ſome of the cryſtallized combinations of lime, as the carbonate and the fluate; the former being called ſimply *lime ſpar*, the latter fluor ſpar, or Derbyſhire ſpar, from the name of the place where it is found in greateſt abundance. See MINERALOGY.

SPARGANIUM, BUR-REED, a genus of plants belonging to the claſs of monœcia, and to the order of triandria; and in the natural ſyſtem ranged under the 3d order, *Calamariæ*. See BOTANY *Index*.

SPARLING, or SPIRLING, a ſmall fiſh belonging to the genus *Salmo*. See ICHTHYOLOGY, p. 99.

SPARMANNIA, a genus of plants belonging to the claſs of polyandria, and to the order of monogynia. See BOTANY *Index*.

SPARROW. See FRINGILLA, ORNITHOLOGY *Index*.

SPARROW-*Hawk*. See FALCO, ORNITHOLOGY *Index*.

SPARROW-*Graſs*. See ASPARAGUS, BOTANY and GARDENING *Index*.

SPARRY-acid. See *FLUORIC-Acid*, CHEMISTRY *Index*.

SPARTA, or LACEDÆMON, the capital of the country of Laconia in Greece, an ancient and moſt renowned ſtate, the inhabitants of which have been in all ages celebrated for the ſingularity of their laws and character.—The hiſtory of Sparta for many ages is entirely fabulous; and the authentic accounts commence only with the celebrated lawgiver Lycurgus, who flouriſhed about 870 B. C. See the article LYCURGUS.

1 The hiſtory of Sparta moſtly fabulous till the time of Lycurgus.

After his death, the firſt important tranſaction which we find mentioned in the Spartan hiſtory is the Meſſenian war, which commenced in the year 752 B. C. and ended in the total reduction of the Meſſenian territory, as related under the article MESSENIA. During this period, according to ſome authors, a great change took place in the government of Sparta. This was the creation of the ephori, which is aſcribed to one of the kings named *Theopompus*. This man perceiving that there was a neceſſity for leaving magiſtrates to execute the laws, when the kings were obliged to be in the field, appointed the magiſtrates above mentioned, who afterwards made ſo great a figure in the ſtate (ſee EPHORI). One great privilege of the ephori was, that they did not riſe up at the preſence of the kings, as all other magiſtrates did: another was, that if the kings offended againſt the laws, the ephori took cognizance of the offence, and inflicted a ſuitable puniſhment. From the firſt election of the ephori, the year was denominated, as at Athens from the firſt election of the archons.

The conqueſt of Meſſenia gave Sparta the ſuperiority over the reſt of the ſtates, excepting only that of Athens, which for a long time continued to be a very troubleſome rival: but the conteſts between theſe two rival ſtates have been ſo fully related under the article ATTICA, that nothing more is requiſite to be added in this place.—In the time of the Perſian war, Leonidas the Spartan king, diſtinguiſhed himſelf in ſuch a manner as to become the admiration not only of that but of every ſucceeding age. It being reſolved in a general council to defend the ſtraits of Thermopylæ againſt the Perſians, 7000* foot were put under the command of Leonidas; of whom, however, only 300 were Spartans. Leonidas did not think it practicable to defend the paſs againſt ſuch multitudes as the Perſian king commanded; and therefore privately told his friends, that his deſign was to devote himſelf to death for his country.

2 Leonidas undertakes to defend the ſtraits of Thermopylæ againſt the Perſians.

Xerxes advancing near the ſtraits, was ſtrangely ſurpriſed to find that the Greeks were reſolved to diſpute his paſſage; for he had always flattered himſelf, that on his approach they would betake themſelves to flight, and not attempt to oppoſe his innumerable forces. However, Xerxes ſtill entertaining ſome hopes of their flight, waited four days without undertaking any thing, on purpoſe to give them time to retreat. During this time, he uſed his utmoſt endeavours to gain and corrupt Leonidas, promiſing to make him maſter of all Greece if he would come over to his intereſt. His offers being rejected with contempt and indignation, the king ordered him by a herald to deliver up his arms. Leonidas, in a ſtyle and with a ſpirit truly laconical, anſwered, "Come thyſelf, and take them." Xerxes, at this reply, tranſported with rage, commanded the Medes and Ciſſians to march againſt them, take them all alive, and bring them to him in fetters. The Medes, not able to ſtand the ſhock of the Greeks, ſoon betook themſelves to flight: and in their room Hydarnes was ordered to advance with that body which was called *Immortal*, and conſiſted of 10,000 choſen men; but when theſe came to cloſe with the Greeks, they ſucceeded no better than the Medes and Ciſſians, being obliged to retire with great ſlaughter. The next day the Perſians, reflecting on the ſmall number of their enemies, and ſuppoſing ſo many of them to be wounded that they could not poſſibly maintain a ſecond fight, reſolved to make another attempt; but could not by any efforts make the Greeks give way: on the contrary, they were themſelves put to a ſhameful flight. The valour of the Greeks exerted itſelf on this occaſion in a manner ſo extraordinary, that Xerxes is ſaid to have three times leaped from his throne, apprehending the entire deſtruction of his army.

3 The Perſians repulſed with great ſlaughter.

Xerxes having loſt all hopes of forcing his way through troops that were determined to conquer or die, was extremely perplexed and doubtful what meaſures he ſhould take in this poſture of affairs; when one Epialtes, in expectation of a great reward, came to him, and diſcovered a ſecret paſſage to the top of the hill which overlooked and commanded the Spartan forces. The king immediately ordered Hydarnes thither with his ſelect body of 10,000 Perſians; who marching all night, arrived at break of day, and poſſeſſed themſelves of that advantageous poſt. The Phocæans, who defended this paſs, being overpowered by the enemy's numbers, retired with precipitation to the very top of the mountain, prepared to die gallantly. But Hydarnes, neglecting to purſue them, marched down the mountain with all poſſible expedition, in order to attack thoſe who defended the ſtraits in the rear. Leonidas being now appriſed that it was impoſſible to bear up againſt the enemy, obliged the reſt of his allies to retire: but he ſtaid himſelf, with the Theſpians, Thebans, and 300 Lacedæmonians, all reſolved to die with their leader; who being told by the oracle, that either Sparta ſhould be deſtroyed or the king loſe his life, determined without the leaſt heſitation to ſacrifice himſelf for his country. The Thebans indeed remained againſt their inclination, being detained by Leonidas as hoſtages; for they were ſuſpected to favour the Perſians. The Theſpians, with their leader Demophilus, could not by any means be prevailed upon to abandon Leonidas and the Spartans. The augur Megiſtias, who had foretold the event of this enterpriſe, being preſſed by Leonidas to retire, ſent home his only ſon; but remained himſelf, and died by Leonidas. Thoſe who ſtaid did not feed themſelves with any hopes of conquering or eſcaping, but looked upon Thermopylæ as their graves; and when Leonidas, exhorting them to take ſome nouriſhment, ſaid, that they

ſhould

4 They are ſhown a way over the hill to ſurround the Greeks.

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* See *Anacharſis's Travels*, vol. i. p. 468.

ſhould all ſun together with Pluto, with one accord they ſet up a ſhout of joy, as if they had been invited to a banquet.

5
Leonidas killed with all his men.

Xerxes, after pouring out a libation at the riſing of the ſun, began to move with the whole body of his army, as he had been adviſed by Epialtes. Upon their approach, Leonidas advanced to the broadeſt part of the paſſage, and fell upon the enemy with ſuch undaunted courage and reſolution, that the Perſian officers were obliged to ſtand behind the diviſions they commanded, in order to prevent the flight of their men. Great numbers of the enemy falling into the ſea, were drowned; others were trampled under foot by their own men, and a great many killed by the Greeks; who knowing they could not avoid death upon the arrival of thoſe who were advancing to fall upon their rear, exerted their utmoſt efforts. In this action fell the brave Leonidas; which Abrocomes and Hyperanthes, two of the brothers of Xerxes, obſerving, advanced with great reſolution to ſeize his body, and carry it in triumph to Xerxes. But the Lacedæmonians, more eager to defend it than their own lives, repulſed the enemy four times, killed both the brothers of Xerxes, with many other commanders of diſtinction, and reſcued the body of their beloved general out of the enemy's hands. But in the mean time, the army that was led by the treacherous Epialtes, advancing to attack their rear, they retired to the narroweſt place of the paſſage, and drawing altogether except the Thebans, poſted themſelves on a riſing ground. In this place they made head againſt the Perſians, who poured in upon them on all ſides, till at length, not vanquiſhed, but oppreſſed and overwhelmed by numbers, they all fell, except one who eſcaped to Sparta, where he was treated as a coward and traitor to his country; but afterwards made a glorious reparation in the battle of Platæa, where he diſtinguiſhed himſelf in an extraordinary manner. Some time after, a magnificent monument was erected at Thermopylæ, in honour of thoſe brave defenders of Greece, with two inſcriptions; the one general, and relating to all thoſe who died on this occaſion, importing, that the Greeks of Peloponneſus, to the number only of 4000, made head againſt the Perſian army, conſiſting of 3,000,000. The other related to the Spartans in particular, and was compoſed by the poet Simonides, to this purport: "Go, paſſenger, and acquaint the Spartans that we died here in obedience to their juſt commands." At thoſe tombs a funeral oration was yearly pronounced in honour of the dead heroes, and public games performed with great ſolemnity, wherein none but the Lacedæmonians and Theſpians had any ſhare, to ſhow that they alone were concerned in the glorious defence of Thermopylæ.

A dreadful earthquake in Sparta.

At the end of the 77th Olympiad, a moſt dreadful earthquake happened at Sparta, in which, according to Diodorus, 20,000 perſons loſt their lives; and Plutarch tells us, that only five houſes were left ſtanding in the whole city. On this occaſion the Helotes or ſlaves, whom the Spartans had all along treated with the utmoſt cruelty, attempted to revenge themſelves, by taking up arms, and marching directly to the ruins of the city, in hopes of cutting off at once thoſe who had eſcaped from the earthquake. But in this they were prevented by the prudence of the Spartan king Archidamus; for he, obſerving that the citizens were more deſirous of preſerving their effects than taking care of their own lives, cauſed an alarm to be ſounded, as if he had known that an enemy was at hand. On this the citizens armed themſelves in haſte with ſuch weapons as they could come at; and having marched a little way from the city, met the Helotes, whom they ſoon compelled to retire. The latter, however, knowing that they had now no mercy to expect from thoſe who had already treated them with ſuch cruelty, reſolved to defend themſelves to the laſt. Having therefore ſeized a ſea-port town in Meſſenia, they from thence made ſuch incurſions into the Spartan territories, that they compelled thoſe imperious maſters to aſk aſſiſtance from the Athenians. This was immediately granted; but when the Spartans ſaw that the ſkill of the Athenians in beſieging towns was much greater than their own, they became jealous, and diſmiſſed their allies, telling them that they had now no farther occaſion for their ſervices. On this the Athenians left them in diſguſt; and as the Helotes and Meſſenians did not chooſe to come to an engagement with a Spartan army in the field, but took ſhelter in their fortified places, the war was protracted for ten years and upwards. At laſt the Helotes were reduced to their former miſery; and the Meſſenians were obliged to leave Peloponneſus, on pain of being made ſlaves alſo. Theſe poor people were then received by the Athenians, who granted them Naupactus for their reſidence, and afterwards brought them back to a part of their own country, from whence in the courſe of the Peloponneſian war they had driven the Spartans.

7
War with the Helotes.

8
With the Athenians and Perſians.

In the year 431 B. C. the Peloponneſian war commenced; of which a full account has been given under the article ATTICA, N° 116—165. It ended moſt unfortunately for the Athenians; their city being taken and diſmantled, as related in the article above mentioned. Thus were the Spartans raiſed to the higheſt pitch of glory; and in the reign of Ageſilaus, they ſeemed to be on the point of ſubverting the Perſian empire, as related under the article PERSIA, N° 34. But here their good fortune and their views of empire were ſuddenly checked. Ageſilaus had carried on the war in Aſia with the greateſt ſucceſs; and as he would hearken to no terms of accommodation, a Perſian governor named *Tithrauſtes*, having firſt attempted in vain to bribe the king, diſpatched Timocrates the Rhodian with 50 talents into Greece, in order to try whether he could there meet with any perſons leſs incorruptible than the Spartan monarch. This agent found many who inclined to accept his offers; particularly in Thebes, Corinth, and Argos. By diſtributing the money in a proper manner, he inflamed the inhabitants of theſe three cities againſt the Spartans; and of all others the Thebans came into his terms with the greateſt readineſs. They ſaw that their antagoniſts would not of their own accord break with any of the ſtates of Greece, and did not chooſe to begin the war themſelves, becauſe the chiefs of the Perſian faction were unwilling to be accountable for the event. For this reaſon they perſuaded the Locrians to invade a ſmall diſtrict which lay in diſpute betwixt the Phocians and themſelves. On this the Phocians invaded Locris; the Locrians applied to the Thebans, and the Phocians to the Spartans. The latter were glad of an opportunity of breaking with the Thebans; but met with a much warmer reception than they expected. Their old general Lyſander, who had
reduced

9
A general combination againſt Sparta.

10
Peace of Antalcidas.

reduced Athens, was defeated and killed, with the loſs of 1000 men: on which diſaſter Ageſilaus was recalled, and obliged to relinquiſh all hopes of conquering the Perſians. His return changed the fortune of the war ſo much, that all the ſtates began to grow weary of a conteſt from which nobody derived any advantage except the king of Perſia. In a ſhort time a treaty was concluded, known in hiſtory by the name of the *peace of Antalcidas*. The terms of this treaty were highly diſadvantageous and diſhonourable to the Greeks *; for even the Spartans, though ſucceſsful in Greece, had loſt a great battle at ſea with the Perſian fleet under Conon the Athenian, which entirely broke their power in Aſia.

11
Hoſtilities recommenced.

12
The power of Sparta entirely broken.

By the peace of Antalcidas, the government of Bœotia was taken from the Thebans, which they had for a long time enjoyed; and by this they were ſo much provoked, that at firſt they abſolutely refuſed to accede to the treaty; but as Ageſilaus made great preparations to invade them, they thought proper at laſt to comply. However, it was not long before a new war commenced, which threatened the total ſubverſion of the Spartan ſtate. As, by the peace of Antalcidas, the king of Perſia had in a manner guaranteed the ſovereignty of Greece to Sparta, this republic very ſoon began to exerciſe its power to the utmoſt extent. The Mantineans were the firſt who felt the weight of their reſentment, although they had been their allies and confederates. In order to have a pretence for making war againſt them, they commanded them to quit their city, and to retire into five old villages which, they ſaid, had ſerved their forefathers, and where they would live in peace themſelves, and give no umbrage to their neighbours. This being refuſed, an army was ſent againſt them to beſiege their city. The ſiege was continued through the ſummer with very little ſucceſs on the part of the Spartans; but having during the winter ſeaſon dammed up the river on which the city ſtood, the water roſe to ſuch a height, as either to overflow or throw down the houſes; which compelled the Mantineans to ſubmit to the terms preſcribed to them, and to retire into the old villages. The Spartan vengeance fell next on the Phliaſians and Olynthians, whom they forced to come into ſuch meaſures as they thought proper. After this they fell on the Thebans, and, by attempting to ſeize on the Piræum, drew the Athenians alſo into the quarrel. But here their career was ſtopped: the Thebans had been taught the art of war by Chabrias the Athenian; ſo that even Ageſilaus himſelf took the command of the Spartan army in vain. At ſea they were defeated by Timotheus the ſon of Conon; and by land the battle of Leuctra put an end to the ſuperiority which Sparta had held over Greece for near 500 years. See LEUCTRA.

13
Agis and
Cleome
attempt
vain to r
ſtore it.

After this dreadful defeat, the Spartans had occaſion to exert all their courage and reſolution. The women and neareſt relations of thoſe who were killed in battle, inſtead of ſpending their time in lamentations, ſhook each other by the hand, while the relations of thoſe who had eſcaped from the battle hid themſelves among the women; or if they were obliged to go abroad, they appeared in tattered clothes, with their arms folded, and their eyes fixed on the ground. It was a law among the Spartans, that ſuch as fled from battle ſhould be degraded from their honours, ſhould be conſtrained to appear in garments patched with divers colours, to wear their beards half-ſhaved, and to ſuffer any to beat them who pleaſed, without reſiſtance. At preſent, however, this law was diſpenſed with; and Ageſilaus by his prudent conduct kept up the ſpirits of the people, at the ſame time that by his ſkill in military affairs he checked the progreſs of the enemy. Yet, during the lifetime of Epaminondas the Theban general, the war went on greatly to the diſadvantage of the Spartans; but he being killed at the battle of Mantinea, all parties became quickly deſirous of peace. Ageſilaus did not long ſurvive; and with him, we may ſay, periſhed the glory of Sparta. Soon after this all the ſtates of Greece fell under the power of Alexander the Great; and the Spartans, as well as the reſt, having become corrupt, and loſt their martial ſpirit, became a prey to domeſtic tyrants, and to foreign invaders. They maintained their ground, however, with great reſolution againſt the celebrated Pyrrhus king of Epirus; whom they repulſed for three days ſucceſſively, though not without aſſiſtance from one of the captains of Antigonus. Soon after this, one of the kings of Sparta named *Agis*, perceiving the univerſal degeneracy that had taken place, made an attempt to reſtore the laws and diſcipline of Lycurgus, by which he ſuppoſed the ſtate would be reſtored to its former glory. But though at firſt he met with ſome appearance of ſucceſs, he was in a ſhort time tried and condemned by the ephori as a traitor to his country. Cleomenes, however, who aſcended the throne in 216 B. C. accompliſhed the reformation which Agis had attempted in vain. He ſuppreſſed the ephori; cancelled all debts; divided the lands equally, as they had been in the time of Lycurgus; and put an end to the luxury which prevailed among the citizens. But at laſt he was overborne by the number of enemies which ſurrounded him; and being defeated in battle by Antigonus, he fled to Egypt, where he put an end to his own life. With him periſhed every hope of retrieving the affairs of Sparta: the city for the preſent fell into the hands of Antigonus; after which a ſucceſſion of tyrants took place; till at laſt all diſturbances were ended by the Romans, who reduced MACEDON and GREECE to provinces of their empire, as has been related under theſe articles.

14
Inſtituti
of Lycur-
gus.

It remains now only to ſay ſomething concerning the character, manners, and cuſtoms of the Spartans, which, as they were founded on the laws of Lycurgus, may beſt be learned from a view of theſe laws.

15
His laws
concerni
religion.

The inſtitutions of Lycurgus were divided into 12 tables. The firſt comprehended ſuch of the Spartan laws as regarded religion. The ſtatues of all the gods and goddeſſes were repreſented in armour, even to Venus herſelf; the reaſon of which was, that the people might conceive a military life the moſt noble and honourable, and not attribute, as other nations did, ſloth and luxury to the gods. As to ſacrifices, they conſiſted of things of very ſmall value; for which Lycurgus himſelf gave this reaſon, That want might never hinder them from worſhipping the gods. They were forbidden to make long or raſh prayers to the heavenly powers, and were injoined to aſk no more than that they might live honeſtly and diſcharge their duty. Graves were permitted to be made within the bounds of the city, contrary to the cuſtom of moſt of the Greek nations; nay, they buried cloſe by their temples, that all degrees

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* See *Perſia*, Nº 37.

parta.

of people might be made familiar with death, and not conceive it ſuch a dreadful thing as it was generally eſteemed elſewhere: on the ſame account, the touching dead bodies, or aſſiſting at funerals, made none unclean, but were held to be as innocent and honourable duties as any other. There was nothing thrown into the grave with the dead body; magnificent ſepulchres were forbidden; neither was there ſo much as an inſcription, however plain or modeſt, permitted. Tears, ſighs, outcries, were not allowed in public, becauſe they were thought diſhonourable in Spartans, whom their lawgiver would have to bear all things with equanimity. Mourning was limited to 11 days; on the 12th the mourner ſacrificed to Ceres, and threw aſide his weeds. In favour of ſuch as were ſlain in the wars, however, and of women who devoted themſelves to a religious life, there was an exception allowed as to the rules before mentioned; for ſuch had a ſhort and decent inſcription on their tombs. When a number of Spartans fell in battle, at a diſtance from their country, many of them were buried together under one common tomb; but if they fell on the frontiers of their own ſtate, then their bodies were carefully carried back to Sparta, and interred in their family ſepulchres.

16
cerning
diviſion
nd.

II. Lycurgus divided all the country of Laconia into 30,000 equal ſhares: the city of Sparta he divided into 9000, as ſome ſay; into 6000, as others ſay; and as a third part will have it, into 4500. The intent of the legiſlator was, that property ſhould be equally divided among his citizens, ſo that none might be powerful enough to oppreſs his fellows, or any be in ſuch neceſſity, as to be therefrom in danger of corruption. With the ſame view he forbade the buying or ſelling theſe poſſeſſions. If a ſtranger acquired a right to any of theſe ſhares, he might quietly enjoy it, provided he ſubmitted to the laws of the republic. The city of Sparta was unwalled; Lycurgus truſting it rather to the virtue of its citizens than to the art of maſons. As to the houſes, they were very plain; for their ceilings could only be wrought by the axe, and their gates and doors only by the ſaw; and their utenſils were to be of a like ſtamp, that luxury might have no inſtruments among them.

7
e citi-
chil-
&c.

III. The citizens were to be neither more nor leſs than the number of city lots; and if at any time there happened to be more, they were to be led out in colonies. As to children, their laws were equally harſh and unreaſonable; for a father was directed to carry his new-born infant to a certain place, where the graveſt men of his tribe looked upon the infant; and if they perceived its limbs ſtraight, and thought it had a wholeſome look, they then returned it to its parents to be educated; otherwiſe it was thrown into a deep cavern at the foot of the mountain Taygetus. This law ſeems to have had one very good effect, viz. making women very careful, when they were with child, of either eating, drinking, or exerciſing, to exceſs: it made them alſo excellent nurſes; for which they were in mighty requeſt throughout Greece. Strangers were not allowed to reſide long in the city, that they might not corrupt the Spartans by teaching them new cuſtoms. Citizens were alſo forbidden to travel, for the ſame reaſon, unleſs the good of the ſtate required it. Such as were not bred up in their youth according to the law, were not allowed the liberty of the city, becauſe they held it unreaſonable, that one who had not ſubmitted to the laws in his youth ſhould receive the benefit of them when a man. They never preferred any ſtranger to a public office; but if at any time they had occaſion for a perſon not born a Spartan, they firſt made him a citizen, and then preferred him.

Sparta.

18
Of celibacy and marriage.

IV. Celibacy in men was infamous, and puniſhed in a moſt extraordinary manner; for the old bachelor was conſtrained to walk naked, in the depth of winter, through the market-place: while he did this, he was obliged to ſing a ſong in diſparagement of himſelf; and he had none of the honours paid him which otherwiſe belonged to old age, it being held unreaſonable, that the youth ſhould venerate him who was reſolved to leave none of his progeny behind him, to revere them when they grew old in their turn. The time of marriage was alſo fixed; and if a man did not marry when he was of full age, he was liable to an action; as were ſuch alſo as married above or below themſelves. Such as had three children had great immunities; ſuch as had four were free from all taxes whatſoever. Virgins were married without portions; becauſe neither want ſhould hinder a man, nor riches induce him, to marry contrary to his inclinations. When a marriage was agreed on, the huſband committed a kind of rape upon his bride. Huſbands went for a long time, ſecretly and by ſtealth, to the beds of their wives, that their love might not be quickly and eaſily extinguiſhed. Huſbands were allowed to lend their wives; but the kings were forbidden to take this liberty. Some other laws of the like nature there were, which as they were evidently againſt modeſty, ſo they were far from producing the end for which Lycurgus deſigned them; ſince, though the men of Sparta were generally remarkable for their virtue, the Spartan women were as generally decried for their boldneſs and contempt of decency.

19
Education of their children.

V. It was the care of Lycurgus, that, from their very birth, the Lacedæmonians ſhould be inured to conquer their appetites: for this reaſon he directed, that nurſes ſhould accuſtom their children to ſpare meals, and now and then to faſting; that they ſhould carry them, when 12 or 13 years old, to thoſe who ſhould examine their education, and who ſhould carefully obſerve whether they were able to be in the dark alone, and whether they had got over all other follies and weakneſſes incident to children. He directed, that children of all ranks ſhould be brought up in the ſame way; and that none ſhould be more favoured in food than another, that they might not, even in their infancy, perceive any difference between poverty and riches, but conſider each other as equals, and even as brethren, to whom the ſame portions were aſſigned, and who, through the courſe of their lives, were to fare alike: the youths alone were allowed to eat fleſh: older men ate their black broth and pulſe; the lads ſlept together in chambers, and after a manner ſomewhat reſembling that ſtill in uſe in Turkey for the Janizaries: their beds, in the ſummer, were very hard, being compoſed of the reeds plucked by the hand from the banks of the Eurotas: in winter their beds were ſofter, but by no means downy, or fit to indulge immoderate ſleep. They ate altogether in public; and in caſe any abſtained from coming to the tables, they were fined. It was likewiſe ſtrictly forbidden for any to eat or drink at home before they came to the common meal; even then

each

each had his proper portion, that every thing might be done there with gravity and decency. The black broth was the great rarity of the Spartans, which was compoſed of ſalt, vinegar, blood, &c. ſo that, in our times, it would be eſteemed a very unſavoury ſoup. If they were moderate in their eating, they were ſo in their drinking alſo; thirſt was the ſole meaſure thereof; and never any Lacedæmonian thought of drinking for pleaſure: as for drunkenneſs, it was both infamous and ſeverely puniſhed; and, that young men might perceive the reaſon, ſlaves were compelled to drink to exceſs, that the beaſtlineſs of the vice might appear. When they retired from the public meal, they were not allowed any torches or lights, becauſe it was expected, that men who were perfectly ſober ſhould be able to find their way in the dark: and, beſides, it gave them a facility of marching without light; a thing wonderfully uſeful to them in time of war.

20
Of their diet, clothing, &c.

VI. As the poor ate as well as the rich, ſo the rich could wear nothing better than the poor: they neither changed their faſhion nor the materials of their garments; they were made for warmth and ſtrength, not for gallantry and ſhow: and to this cuſtom even their kings conformed, who wore nothing gaudy in right of their dignity, but were contented that their virtue ſhould diſtinguiſh them rather than their clothes. The youths wore a tunic till they were twelve years old; afterwards they had a cloak given them, which was to ſerve them a year: and their clothing was, in general, ſo thin, that a Lacedæmonian veſt became proverbial. Boys were always uſed to go without ſhoes; but when they grew up, they were indulged with them, if the manner of life they led required it; but they were always inured to run without them, as alſo to climb up and ſlip down ſteep places with bare feet: nay, the very ſhoe they uſed was of a particular form, plain and ſtrong. Boys were not permitted to wear their hair; but when they arrived at the age of twenty, they ſuffered their hair and beard to grow. Baths and anointing were not much in uſe among the Lacedæmonians; the river Eurotas ſupplied the former, and exerciſe the latter. In the field, however, their ſumptuary laws did not take place ſo ſtrictly as in the city; for when they went to war, they wore purple habits; they put on crowns when they were about to engage the enemy; they had alſo rings, but they were of iron; which metal was moſt eſteemed by this nation. Young women wore their veſts or jerkins only to their knees, or, as ſome think not quite ſo low; a cuſtom which both Greek and Roman authors cenſure as indecent. Gold, precious ſtones, and other coſtly ornaments, were permitted only to common women; which permiſſion was the ſtrongeſt prohibition to women of virtue, or who affected to be thought virtuous. Virgins went abroad without veils, with which married women, on the contrary were always covered. In certain public exerciſes, in which girls were admitted as well as boys, they were both obliged to perform naked. Plutarch apologiſes for this cuſtom, urging, that there could be no danger from nakedneſs to the morals of youth whoſe minds were fortified and habituated to virtue. One of Lycurgus's principal views in his inſtitutions, was to eradicated the very ſeeds of civil diſſenſion in his republic. Hence proceeded the equal diviſion of eſtates injoined by him; hence the contempt of wealth, and the neglect of other diſtinctions, as particularly birth, he conſidering the people of his whole ſtate as one great family; diſtinctions which, in other commonwealths, frequently produce tumults and confuſions that ſhake their very foundation.

21
Obedien
to their
periors.

VII. Though the Spartans were always free, yet it was with this reſtriction, that they were ſubſervient to their own laws, which bound them as ſtrictly in the city, as ſoldiers, in other ſtates, were bound by the rules of war in the camp. In the firſt place, ſtrict obedience to their ſuperiors was the great thing required in Sparta. This they looked upon as the very baſis of government; without which neither laws nor magiſtrates availed much. Old age was an indubitable title to honour in Sparta: to the old men the youth roſe up whenever they came into any public place; they gave way to them when they met them in the ſtreets, and were ſilent whenever their elders ſpoke. As all children were looked upon as the children of the ſtate, ſo all the old men had the authority of parents: they reprehended whatever they ſaw amiſs, not only in their own, but in other people's children: and by this method Lycurgus provided, that as youth are everywhere apt to offend, they might be nowhere without a monitor. The laws went ſtill further: if an old man was preſent where a young one committed a fault, and did not reprove him, he was puniſhed equally with the delinquent. Amongſt the youths there was one of their own body, or at moſt two years older than the reſt, who was ſtyled *iren:* he had authority to queſtion all their actions, to look ſtrictly to their behaviour, and to puniſh them if they did amiſs; neither were their puniſhments light, but, on the contrary, very ſevere; whereby the youth were made hardy, and accuſtomed to bear ſtripes and rough uſage. Silence was a thing highly commended at Sparta, where modeſty was held to be a moſt becoming virtue in young people; nor was it reſtrained only to their words and actions, but to their very looks and geſtures; Lycurgus having particularly directed, that they ſhould look forward, or on the ground, and that they ſhould always keep their hands within their robes. A ſtupid inconſiderate perſon, one who would not liſten to inſtruction, but was careleſs of whatever the world might ſay of him, the Lacedæmonians treated as a ſcandal to human nature; with ſuch a one they would not converſe, but threw him off as a rotten branch and worthleſs member of ſociety.

22
Learnin

VIII. The plainneſs of their manners, and their being ſo very much addicted to war, made the Lacedæmonians leſs fond of the ſciences than the reſt of the Greeks. A ſoldier was the only reputable profeſſion in Sparta; a mechanic or huſbandman was thought a low fellow. The reaſon of this was, that they imagined profeſſions which required much labour, ſome conſtant poſture, being continually in the houſe, or always about a fire, weakened the body and depreſſed the mind: whereas a man brought up hardily, was equally fit to attend the ſervice of the republic in time of peace, and to fight its battles when engaged in war. Such occupations as were neceſſary to be followed for the benefit of the whole, as huſbandry, agriculture, and the like, were left to their ſlaves the Helotes; but for curious arts, and ſuch as ſerved only to luxury, they would not ſo much as ſuffer them to be introduced in their city; in conſequence of which, rhetoricians, augurs,

gurs, bankers, and dealers in money, were ſhut out. The Spartans admitted not any of the theatrical diverſions among them; they would not bear the repreſentation of evil even to produce good; but other kinds of poetry were admitted, provided the magiſtrates had the peruſal of pieces before they were handed to the public.

Above all things, they affected brevity of ſpeech, and accuſtomed their children, from their very infancy, never to expreſs themſelves in more words than were ſtrictly neceſſary; whence a conciſe and ſententious oratory is to this day ſtyled *Laconic*. In writing they uſed the ſame conciſeneſs; of which we have a ſignal inſtance in a letter of Archidamus to the Eleans, when he underſtood that they had ſome thoughts of aſſiſting the Arcadians. It ran thus: "Archidamus to the Eleans: It is good to be quiet." And therefore Epaminondas thought that he had reaſon to glory in having forced the Spartans to abandon their monoſyllables, and to lengthen their diſcourſes.

The greateſt part of their education conſiſted in giving their youth right ideas of men and things: the iren or maſter propoſed queſtions, and either commended the anſwers that were made him, or reproved ſuch as anſwered weakly. In theſe queſtions, all matters, either of a trivial or abſtruſe nature, were equally avoided; and they were confined to ſuch points as were of the higheſt importance in civil life; ſuch as, Who was the beſt man in the city? wherein lay the merit of ſuch an action? and, Whether this or that hero's fame was well-founded? Harmleſs raillery was greatly encouraged; and this, joined to their ſhort manner of ſpeaking, rendered laconic replies univerſally admired.

Muſic was much encouraged; but in this, as in other things, they adhered to that which had been in favour with their anceſtors; nay, they were ſo ſtrict therein, that they would not permit their ſlaves to learn either the tune or the words of their moſt admired odes; or, which is all one, they would not permit them to ſing them if they had learned them. Though the youth of the male ſex were much cheriſhed and beloved, as thoſe that were to build up and continue the future glory of the ſtate, yet in Sparta it was a virtuous and modeſt affection, untinged with that ſenſuality which was ſo ſcandalous at Athens. The good effects of this part of Lycurgus's inſtitutions were ſeen in the union that reigned among his citizens; and which was ſo extraordinary, that even in caſes of competition, it was hardly known that rivals bore ill-will to each other; but, on the contrary, their love to the ſame perſon begat a ſecondary friendſhip among themſelves, and united them in all things which might be for the benefit of the perſon beloved.

Some authors have accuſed this great lawgiver of encouraging theft in his inſtitutions; which, they ſay, was not held ſcandalous among the Spartans, if it were ſo dexterouſly managed as that the perſon was not detected in it. But this is certain, and ſeems to be a ſtrong contradiction of the heinous charge, that when a theft was diſcovered, it was puniſhed with the utmoſt ſeverity: a perſon even ſuſpected of it would endure the heavieſt puniſhments rather than acknowledge it, and be branded with ſo baſe a crime.

23 ercifes. IX. The exerciſes inſtituted by law fall under the ninth table. In theſe all the Greeks were extremely careful, but the Lacedæmonians in a degree beyond the reſt; for if a youth, by his corpulence, or any other means, became unfit for theſe exerciſes, he underwent public contempt at leaſt, if not baniſhment.—Hunting was the uſual diverſion of their children; nay, it was made a part of their education, becauſe it had a tendency to ſtrengthen their limbs, and to render thoſe who practiſed it ſupple and fleet: they likewiſe bred up dogs for hunting with great care. They had a kind of public dances, in which they exceedingly delighted, and which were common alike to virgins and young men: indeed, in all their ſports, girls were allowed to divert themſelves with the youths: inſomuch, that, at darting, throwing the quoit, pitching the bar, and ſuch like robuſt diverſions, the women were as dexterous as the men. For the manifeſt oddity of this proceeding, Lycurgus aſſigned no other reaſon, than that he ſought to render women, as well as men, ſtrong and healthy, that the children they brought forth might be ſo too. Violent exerciſes, and a laborious kind of life, were only enjoined the youth; for when they were grown up to men's eſtate, that is, were upwards of 30 years old, they were exempted from all kinds of labour, and employed themſelves wholly either in affairs of ſtate or in war. They had a method of whipping, at a certain time, young men in the temple of Diana, and about her altar; which, however palliated, was certainly unnatural and cruel. It was eſteemed a great honour to ſuſtain theſe flagellations without weeping, groaning, or ſhowing any ſenſe of pain; and the thirſt of glory was ſo ſtrong in theſe young minds, that they very frequently ſuffered death without ſhedding a tear or breathing a ſigh. A deſire of overcoming all the weakneſſes of human nature, and thereby rendering his Spartans not only ſuperior to their neighbours, but to their ſpecies, runs through many of the inſtitutions of Lycurgus; which principle, if well attended to, thoroughly explains them, and without attending to which it is impoſſible to give any account of them at all.

X. Gold and ſilver were, by the conſtitutions of Lycurgus, made of no value in Sparta. He was ſo well apprized of the danger of riches, that he made the very poſſeſſion of them venal; but as there was no living without ſome ſort of money, that is, ſome common meaſure or ſtandard of the worth of things, he directed an iron coinage, whereby the Spartans were ſupplied with the uſeful money, and at the ſame time had no temptation to covetouſneſs afforded them; for a very ſmall ſum was ſufficient to load a couple of horſes, and a great one muſt have been kept in a barn or warehouſe. The introduction of all foreign money was alſo prohibited, that corruption might not enter under the name of commerce. The moſt ancient method of dealing, viz. by barter, or exchange of one commodity for another, was preſerved by law in Sparta long after it had gone into diſuſe every where elſe. Intereſt was a thing forbidden in the Spartan commonwealth; where they had alſo a law againſt alienation of lands, accepting preſents from foreigners, even without the limits of their own country, and when their authority and character might well ſeem to excuſe them. 24 Money, &c.

XI. Such of the laws of Sparta as related to courts of juſtice may be brought under the 11th table. Thirty years muſt have paſſed over the head of him who had a right to concern himſelf in juridical proceedings. 25 Courts of juſtice.

Young men were thought unfit for them; and it was even held indecent, and of ill report, for a man to have any fondneſs for law-ſuits, or to be buſying himſelf at the tribunals, when he had no affairs there of his own. By theſe rules Lycurgus thought to ſhut out litigiouſneſs, and to prevent that multiplicity of ſuits which is always ſcandalous in a ſtate. As young people were not permitted to inquire about the laws of other countries, and as they were hindered from hearing judicial proceedings in their courts, ſo they were likewiſe forbidden to aſk any queſtions about, or to endeavour to diſcover, the reaſons of the laws by which themſelves were governed. Obedience was their duty; and to that alone they would have them kept. Men of abandoned characters, or who were notoriouſly of ill fame, loſt all right of giving their votes in reſpect of public affairs, or of ſpeaking in public aſſemblies; for they would not believe that an ill man in private life could mean his country better than he did his neighbour.

26
Military ſervice.

XII. Till a man was 30 years old, he was not capable of ſerving in the army, as the beſt authors agree: though ſome think that the military age is not well aſcertained by ancient writers. They were forbidden to march at any time before the full-moon; the reaſon of which law is very hard to be diſcovered, if indeed it had any reaſon at all, or was not rather founded on ſome ſuperſtitious opinion, that this was a more lucky conjuncture than any other. They were likewiſe forbidden to fight often againſt the ſame enemy; which was one of the wiſeſt maxims in the political ſyſtem of Lycurgus: and Ageſilaus, by offending againſt it, deſtroyed the power of his country, and loſt her that authority which for many ages ſhe maintained over the reſt of Greece; for, by continually warring againſt the Thebans, to whom he had an inveterate hatred, he at laſt beat them into the knowledge of the art of war, and enabled them, under the command of Epaminondas, to maintain for a time the principality of Greece. Maritime affairs they were forbidden to meddle with, though the neceſſity of things compelled them, in proceſs of time, to tranſgreſs this inſtitution, and by degrees to transfer to themſelves the dominion of the ſea as well as of the land: but, after the Peloponneſian war, they again neglected naval affairs from a perſuaſion that ſailors and ſtrangers corrupted thoſe with whom they converſed. As they never fortified Sparta, they were not ready to undertake ſieges: fighting in the field was their proper province, and, while they could overcome their enemies there, they rightly conceived that nothing could hurt them at home. In time of war they relaxed ſomewhat of their ſtrict manner of living, in which they were ſingular. The true reaſon for this was, in all probability, that war might be leſs burdenſome to them; for, as we have more than once obſerved, a ſtrong deſire to render them bold and warlike was the reigning paſſion of their legiſlator. They were forbidden to remain long encamped in the ſame place, as well to hinder their being ſurpriſed, as that they might be more troubleſome to their enemies, by waſting every corner of their country. They ſlept all night in their armour; but their outguards were not allowed their ſhields, that, being unprovided of defence, they might not dare to ſleep. In all expeditions they were careful in the performance of religious rites; and, after their evening meal was over, the ſoldiers ſung together hymns to their gods. When they were about to engage, the king ſacrificed to the muſes, that, by their aſſiſtance, they might be enabled to perform deeds worthy of being recorded to lateſt times. Then the army advanced in order to the ſound of flutes, which played the hymn of Caſtor. The king himſelf ſung the pæan, which was the ſignal to charge. This was done with all the ſolemnity imaginable; and the ſoldiers were ſure either to conquer or die: indeed they had no other choice; for if they fled they were infamous, and in danger of being ſlain, even by their own mothers, for diſgracing their families. In this conſiſted all the excellency of the Spartan women, who, if poſſible, exceeded in bravery the men, never lamenting over huſbands or ſons, if they died honourably in the field; but deploring the ſhame brought on their houſe, if either the one or the other eſcaped by flight. The throwing away a ſhield alſo induced infamy; and, with reſpect to this, mothers, when they embraced their departing ſons, were wont to caution them, that they ſhould either return armed as they were, or be brought back ſo when they were dead; for, as we have obſerved, ſuch as were ſlain in battle were nevertheleſs buried in their own country. When they made their enemies fly, they purſued no longer than till victory was certain; becauſe they would ſeem to fight rather for the honour of conquering, than of putting their enemies to death. According to their excellent rules of war, they were bound not to ſpoil the dead bodies of their enemies; but in proceſs of time, this, and indeed many other of their moſt excellent regulations, fell into deſuetude. He who overcame by ſtratagem, offered up an ox to Mars; whereas he who conquered by force, offered up only a cock; the former being eſteemed more manly than the latter. After 40 years ſervice, a man was, by law, no longer required to go into the field; and conſequently, if the military age was 30, the Spartans were not held invalids till they were 70.

SPARTIANUS, Ælius, a Latin hiſtorian, who wrote the lives of Adrian, Caracalla, and four other Roman emperors. He lived under the reign of Diocleſian, about the year 290.

SPARTIUM, Broom, a genus of plants belonging to the claſs of diadelphia, and order of decandria; and in the natural ſyſtem arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

The flower buds are in ſome countries pickled, and eaten as capers; and the ſeeds have been uſed as a bad ſubſtitute for coffee. The branches are uſed for making beſoms, and tanning leather. They are alſo uſed inſtead of thatch to cover houſes. The old wood furniſhes the cabinet-maker with beautiful materials for vaneering. The tender branches are in ſome places mixed with hops for brewing, and the macerated bark may be manufactured into cloth.

Journal de Phyſique.

The *junceum*, or Spaniſh broom, grows naturally in the ſouthern provinces of France, as well as in other parts of the ſouth of Europe. It grows in the pooreſt ſoils, on the ſteepeſt declivities of the hills, in a ſtony ſoil, where hardly any other plant could vegetate. In a few years it makes a vigorous ſhrub; inſinuating its roots between the interſtices of the ſtones, it binds the ſoil, and retains the ſmall portion of vegetable earth ſcattered over theſe hills, which the autumnal rains would otherwiſe

wiſe waſh away. It is moſt eaſily raiſed from ſeed, which is uſually ſown in January, after the ground has received a ſlight dreſſing.

The ſhrub ſerves two uſeful purpoſes. Its branches yield a thread of which linen is made, and in winter ſupport ſheep and goats.

In manufacturing thread from broom, the youngeſt plants are cut in the month of Auguſt, or after harveſt, and gathered together in bundles, which at firſt are laid in the ſun to dry: they are then beaten with a piece of wood, waſhed in a river or pond, and left to ſteep in the water for about four hours. The bundles thus prepared are taken to a little diſtance from the water, and laid in a hollow place made for them, where they are covered with fern or ſtraw, and remain thus to ſteep for eight or nine days; during which time, all that is neceſſary, is to throw a little water once a-day on the heap, without uncovering the broom. After this, the bundles are well waſhed, the green rind of the plant or epidermis comes off, and the fibrous part remains; each bundle is then beaten with a wooden hammer upon a ſtone, to detach all the threads, which are at the ſame time carefully drawn to the extremity of the branches. After this operation, the faggots are untied, and ſpread upon ſtones or rocks till they are dry. The twigs muſt not be peeled till they are perfectly dry; they are then dreſſed with the comb, and the threads are ſeparated according to the fineneſs, and ſpun upon a wheel.

The linen made of this thread ſerves various purpoſes in rural economy. The coarſeſt is employed in making ſacks and other ſtrong cloths for carrying grain or ſeeds. Of the fineſt is made bed, table, and body linen. The peaſants in ſeveral places uſe no other, for they are unacquainted with the culture of hemp or flax, their ſoil being too dry and too barren for raiſing them. The cloth made with the thread of the broom is very uſeful; it is as ſoft as that made of hemp; and it would perhaps look as well as that made of flax if it was more carefully ſpun. It becomes white in proportion as it is ſteeped. The price of the fineſt thread, when it is ſold, which ſeldom happens, is generally about a ſhilling a pound.

The other uſe to which this broom is applied, is to maintain ſheep and goats during winter. In the mountains of Lower Languedoc theſe animals have no other food from November to April, except the leaves of trees preſerved. The branches of this broom therefore are a reſource the more precious, that it is the only freſh nouriſhment which at that ſeaſon the flocks can procure, and they prefer it at all times to every other plant. In fine weather the ſheep are led out to feed on the broom where it grows; but in bad weather the ſhepherds cut the branches, and bring them to the ſheep folds. There is, however, an inconvenience attending the continued uſe of this food. It generally produces inflammation in the urinary paſſages. But this inconvenience is eaſily removed by cooling drink, or a change of food, or by mixing the broom with ſomething elſe.

It is perhaps needleſs to add, that it differs much from the broom that is common everywhere in the north of Europe, though this too, in many places, is uſed for food to cattle. Both of them produce flowers that are very much reſorted to by bees, as they contain a great quantity of honey juice. And this ſhould be another inducement to the cultivation of the Spaniſh broom.

SPARUS, Gilthead, a genus of fiſhes belonging to the order of *thoracici*. See Ichthyology *Index*. The ſparus auratus, or gilthead, was well known to the Romans, who did not eſteem them unleſs they were fed with Lucrine oyſters, as Martial informs us,

> *Non omnis laudem pretiumque* AURATA *meretur,*
> *Sed qui ſolus erit concha Lucrina cibus.*
>
> Lib. xiii. Ep. 90.

SPASM, a convulſion. See Medicine, N° 278.

SPATHA, in *Botany*, a ſheath; a ſpecies of calyx which burſts lengthwiſe, and protrudes a ſtalk ſupporting one or more flowers, which commonly have no perianthium or flower-cup.

SPATHACEÆ (from *ſpatha*, "a ſheath"), the name of the ninth order in Linnæus's Fragments of a Natural Method, conſiſting of plants whoſe flowers are protruded from a ſpatha or ſheath. See Botany *Index*.

SPATHELIA, a genus of plants belonging to the claſs of pentandria, and to the order of trigynia. See Botany *Index*.

SPAW. See Spa.

SPAWN, in *Natural Hiſtory*, the eggs of fiſhes or frogs.

SPAVENTO. See Scanto.

SPAVIN, in the manege, a diſeaſe in horſes, being a ſwelling or ſtiffneſs, uſually in the ham, occaſioning a lameneſs. See Farriery *Index*.

SPAYING, or Spading, the operation of caſtrating the females of ſeveral kinds of animals, as ſows, bitches, &c. to prevent any further conception, and promote their fattening. It is performed by cutting them in the mid flank, on the left ſide, with a ſharp knife or lancet, taking out the ovaries, and cutting them off, and ſo ſtitching up the wound, anointing the part with tar, and keeping the animal warm for two or three days. The uſual way is to make the inciſion aſlope, two inches and a half long; that the fore-finger may be put in towards the back, to feel for the ovaries, which are two kernels as big as acorns on both ſides of the uterus, one of which is drawn to the wound, and thus both taken out.

SPEAKER *of the Houſe of Commons*, a member of the houſe elected by a majority of votes thereof to act as chairman or preſident in putting queſtions, reading briefs, or bills, keeping order, reprimanding the refractory, adjourning the houſe, &c. See Parliament.

SPEAKING, the art or act of expreſſing one's thoughts in articulate ſounds or words. See Grammar, Language, Reading, and Oratory, Part iv.

Speaking-Trumpet. See Trumpet.

SPEAR-Mint. See Mentha, Botany *Index*.

Spear-Wort. See Ranunculus, Botany *Index*.

SPECIAL, ſomething that is particular, or has a particular deſignation; from the Latin *ſpecies*, in oppoſition to the *general*, from *genus*.

SPECIES, in *Logic*, a relative term, expreſſing an idea which is compriſed under ſome general one called a *genus*. See Logic, N° 68.

Species, in *Commerce*, the ſeveral pieces of gold, ſilver, copper, &c. which having paſſed their full preparation and coinage, are current in public. See Money.

Species, in *Algebra*, are the letters, ſymbols, marks, or characters, which repreſent the quantities in any operation or equation. This ſhort and advantageous way of notation was chiefly introduced by Vieta, about the year 1590; and by means of it he made many diſcoveries in algebra, not before taken notice of.

Species, in *Optics*, the image painted on the retina by the rays of light reflected from the ſeveral points of the ſurface of an object, received by the pupil, and collected in their paſſage through the cryſtalline, &c.

It has been a matter of diſpute among philoſophers, whether the ſpecies of objects which give the ſoul an occaſion of ſeeing, be an effuſion of the ſubſtance of the body; a mere impreſſion which they make on all bodies under certain circumſtances; or whether they are not ſome more ſubtile body, ſuch as light. The moderns have decided this point by the invention of artificial eyes, in which the ſpecies of objects are received on paper, in the ſame manner as in the natural eye.

SPECIFIC, in *Philoſophy*, that which is peculiar to any thing, and diſtinguiſhes it from all others.

Specifics, in *Medicine*. By ſpecifics is not meant ſuch as infallibly and in all patients produce ſalutary effects. Such medicines are not to be expected, becauſe the operations and effects of remedies are not formally inherent in them, but depend upon the mutual action and reaction of the body and medicine upon each other; hence the various effects of the ſame medicine in the ſame kind of diſorders in different patients, and in the ſame patient at different times. By ſpecific medicines we underſtand ſuch medicines as are found to be more uniform in their effects than others in any particular diſorder.

Specific Gravity, is a term much employed in the diſcuſſions of modern phyſics. It expreſſes the weight of any particular kind of matter, as compared with the weight of the ſame bulk of ſome other body of which the weight is ſuppoſed to be familiarly known, and is therefore taken for the ſtandard of compariſon. The body generally made uſe of for this purpoſe is pure water.

The ſpecific gravity of bodies is a very intereſting queſtion both to the philoſopher and to the man of buſineſs. The philoſopher conſiders the weights of bodies as meaſures of the number of material atoms, or the quantity of matter which they contain. This he does on the ſuppoſition that every atom of matter is of the ſame weight, whatever may be its ſenſible form. This ſuppoſition, however, is made by him with caution, and he has recourſe to ſpecific gravity for aſcertaining its truth in various ways. This ſhall be conſidered by and by. The man of buſineſs entertains no doubt of the matter, and proceeds on it as a ſure guide in his moſt intereſting tranſactions. We meaſure commodities of various kinds by tons, pounds, and ounces, in the ſame manner as we meaſure them by yards, feet, and inches, or by buſhels, gallons, and pints; nay, we do this with much greater confidence, and prefer this meaſurement to all others, whenever we are much intereſted to know the exact proportions of matter that bodies contain. The weight of a quantity of grain is allowed to inform us much more exactly of its real quantity of uſeful matter than the moſt accurate meaſure of its bulk. We ſee many circumſtances which can vary the bulk of a quantity of matter, and theſe are frequently ſuch as we cannot regulate or prevent; but we know very few indeed that can make any ſenſible change in this weight without the addition or abſtraction of other matter. Even taking it to the ſummit of a high mountain, or from the equator to the polar region, will make no change in its weight as it is aſcertained by the balance, becauſe there is the ſame real diminution of weight in the pounds and ounces uſed in the examination.

Notwithſtanding the unavoidable change which heat and cold make in the bulk of bodies, and the permanent varieties of the ſame kind of matter which are cauſed by different circumſtances of growth, texture, &c. moſt kinds of matter have a certain conſtancy in the denſity of their particles, and therefore in the weight of a given bulk. Thus the purity of gold, and its degree of adulteration, may be inferred from its weight, it being purer in proportion as it is more denſe. The denſity, therefore, of different kinds of tangible matter becomes characteriſtic of the kind, and a teſt of its purity; it marks a particular appearance in which matter exiſts, and may therefore be called, with propriety, Specific.

But this denſity cannot be directly obſerved. It is not by comparing the diſtances between the atoms of matter in gold and in water that we ſay the firſt is 19 times denſer than the laſt, and that an inch of gold contains 19 times as many material atoms as an inch of water; we reckon on the equal gravitation of every atom of matter whether of gold or of water; therefore the weight of any body becomes the indication of its material denſity, and the weight of a given bulk becomes ſpecific of that kind of matter, marking its kind, and even aſcertaining its purity in this form.

It is evident that, in order to make this compariſon of general uſe, the ſtandard muſt be familiarly known, and muſt be very uniform in its denſity, and the compariſon of bulk and denſity muſt be eaſy and accurate. The moſt obvious method would be to form, with all nicety, a piece of the ſtandard matter of ſome convenient bulk, and to weigh it very exactly, and keep a note of its weight: then, to make the compariſon of any other ſubſtance, it muſt be made into a maſs of the ſame preciſe bulk, and weighed with equal care; and the moſt convenient way of expreſſing the ſpecific gravity would be to conſider the weight of the ſtandard as unity, and then the number expreſſing the ſpecific gravity is the number of times that the weight of the ſtandard is contained in that of the other ſubſtance. This compariſon is moſt eaſily and accurately made in fluids. We have only to make a veſſel of known dimenſions equal to that of the ſtandard which we employ, and to weigh it when empty, and then when filled with the fluid. Nay, the moſt difficult part of the proceſs, the making a veſſel of the preciſe dimenſions of the ſtandard, may be avoided, by uſing ſome fluid ſubſtance for a ſtandard. Any veſſel will then do; and we may enſure very great accuracy by uſing a veſſel with a ſlender neck, ſuch as a phial or matraſs; for when this is filled to a certain mark in the neck, any error in the eſtimation by the eye will bear a very ſmall proportion to the whole. The weight of the ſtandard fluid which fills it to this mark being carefully aſcertained, is kept in remembrance. The ſpecific gravity of any other fluid is had by weighing the contents of this veſſel when filled with it, and dividing

dividing the weight by the weight of the ſtandard. The quotient is the ſpecific gravity of the fluid. But in all other caſes this is a very difficult problem: it requires very nice hands, and an accurate eye, to make two bodies of the ſame bulk. An error of one hundredth part in the linear dimenſions of a ſolid body makes an error of a 30th part in its bulk; and bodies of irregular ſhapes and friable ſubſtance, ſuch as the ores of metals, cannot be brought into convenient and exact dimenſions for meaſurement.

From all theſe inconveniences and difficulties we are freed by the celebrated Archimedes, who, from the principles of hydroſtatics diſcovered or eſtabliſhed by him, deduced the accurate and eaſy method which is now univerſally practiſed for diſcovering the ſpecific gravity and denſity of bodies. (See ARCHIMEDES and HYDRODYNAMICS). Inſtead of meaſuring the bulk of the body by that of the diſplaced fluid (which would have been impoſſible for Archimedes to do with any thing like the neceſſary preciſion), we have only to obſerve the loſs of weight ſuſtained by the ſolid. This can be done with great eaſe and exactneſs. Whatever may be the bulk of the body, this loſs of weight is the weight of an equal bulk of the fluid; and we obtain the ſpecific gravity of the body by ſimply dividing its whole weight by the weight loſt: the quotient is the ſpecific gravity when this fluid is taken for the ſtandard, even though we ſhould not know the abſolute weight of any given bulk of this ſtandard. It alſo gives us an eaſy and accurate method of aſcertaining even this fundamental point. We have only to form any ſolid body into an exact cube, ſphere, or priſm, of known dimenſions, and obſerve what weight it loſes when immerſed in this ſtandard fluid. This is the weight of the ſame bulk of the ſtandard to be kept in remembrance; and thus we obtain, by the bye, a moſt eaſy and accurate method for meaſuring the bulk or ſolid contents of any body, however irregular its ſhape may be. We have only to ſee how much weight it loſes in the ſtandard fluid; we can compute what quantity of the ſtandard fluid will have this weight. Thus ſhould we find that a quantity of ſand, or a furze buſh, loſes 250 ounces when immerſed in pure water, we learn by this that the ſolid meaſure of every grain of the ſand, or of every twig and prickle of the furze, when added into one ſum, amounts to the fourth part of a cubic foot, or to 432 cubic inches.

To all theſe advantages of the Archimedean method of aſcertaining the ſpecific gravity of bodies, derived from his hydroſtatical doctrines and diſcoveries, we may add, that the immediate ſtandard of compariſon, namely, water, is, of all the ſubſtances that we know, the fitteſt for the purpoſe of an univerſal ſtandard of reference. In its ordinary natural ſtate it is ſufficiently conſtant and uniform in its weight for every examination where the utmoſt mathematical accuracy is not wanted; all its variations ariſe from impurities, from which it may at all times be ſeparated by the ſimple proceſs of diſtillation: and we have every reaſon to think that when pure, its denſity, when of the ſame temperature, is invariable.

Water is therefore univerſally taken for the unit of that ſcale on which we meaſure the ſpecific gravity of bodies, and its weight is called 1. The ſpecific gravity of any other body is the real weight in pounds and ounces, when of the bulk of one pound or one ounce of water. It is therefore of the firſt importance, in all diſcuſſions reſpecting the ſpecific gravity of bodies, to have the preciſe weight of ſome known bulk of pure water. We have taken ſome pains to examine and compare the experiments on this ſubject, and ſhall endeavour to aſcertain this point with the preciſion which it deſerves. We ſhall reduce all to the Engliſh cubic foot and avoirdupois ounce of the Exchequer ſtandard, on account of a very convenient circumſtance peculiar to this unit, viz. that a cubic foot contains almoſt preciſely a thouſand ounces of pure water, ſo that the ſpecific gravity of bodies expreſſes the number of ſuch ounces contained in a cubic foot.

We begin with a trial made before the houſe of commons in 1696 by Mr Everard. He weighed 2145.6 cubic inches of water by a balance, which turned ſenſibly with 6 grains, when there were 30 pounds in each ſcale. The weights employed were the troy weights, in the depoſit of the Court of Exchequer, which are ſtill preſerved, and have been moſt ſcrupulouſly examined and compared with each other. The weight was 1131 ounces 14 pennyweights. This wants juſt 11 grains of a thouſand avoirdupois ounces for 1728 cubic inches, or a cubic foot; and it would have amounted to that weight had it been a degree or two colder. The temperature indeed is not mentioned; but as the trial was made in a comfortable room, we may preſume the temperature to have been about 55° of Fahrenheit's thermometer. The dimenſions of the veſſel were as accurate as the nice hand of Mr Abraham Sharp, Mr Flamſtead's aſſiſtant at Greenwich, could execute, and it was made by the Exchequer ſtandard of length.

This is confided in by the naturaliſts of Europe as a very accurate ſtandard experiment, and it is confirmed by many others both private and public. The ſtandards of weight and capacity employed in the experiment are ſtill in exiſtence, and publicly known, by the report of the Royal Society to parliament in 1742, and by the report of a committee of the houſe of commons in 1758. This gives it a ſuperiority over all the meaſures which have come to our knowledge.

The firſt experiment, made with proper attention, that we meet with, is by the celebrated Snellius, about the year 1615, and related in his *Eratoſthenes Batavus*. He weighed a Rhinland cubic foot of diſtilled water, and found it 62.79 Amſterdam pounds. If this was the ordinary weight of the ſhops, containing 7626 Engliſh troy grains, the Engliſh cubic foot muſt be 62 pounds 9 ounces, only one ounce more than by Everard's experiment. If it was the Mint pound, the weight was 62 pounds 6 ounces. The only other trials which can come into competition with Mr Everard's are ſome made by the Academy of Sciences at Paris. Picart, in 1691, found the Paris cubic foot of the water of the fountain d'Arcueil to weigh 69.588 pounds, *poids de Paris*. Du Hamel obtained the very ſame reſult; but Mr Monge, in 1783, ſays that filtered rain-water of the temperature 12° (Reaumur) weighs 69.3792. Both theſe meaſures are conſiderably below Mr Everard's, which is 62.5, the former giving 62.053, and the latter 61.868. M. Lavoiſier ſtates the Paris cubic foot at 70 pounds, which makes the Engliſh foot 62.47. But there is an inconſiſtency

ſiſtency among them which makes the compariſon impoſſible. Some changes were made in 1688, by royal authority, in the national ſtandards, both of weight and length; and the academicians are exceedingly puzzled to this day in reconciling the differences, and cannot even aſcertain with perfect aſſurance the lineal meaſures which were employed in their moſt boaſted geodetical operations.

Such variations in the meaſurements made by perſons of reputation for judgment and accuracy engaged the writer of this article ſome years ago to attempt another. A veſſel was made of a cylindrical form, as being more eaſily executed with accuracy, whoſe height and diameter were 6 inches, taken from a moſt accurate copy of the Exchequer ſtandard. It was weighed in diſtilled water of the temperature 55° ſeveral times without varying 2 grains, and it loſt 42895 grains. This gives for the cubic foot 998.74 ounces, deficient from Mr Everard's an ounce and a quarter; a difference which may be expected, ſince Mr Everard uſed the New River water without diſtillation.

We hope that theſe obſervations will not be thought ſuperfluous in a matter of ſuch continual reference, in the moſt intereſting queſtions both to the philoſopher and the man of buſineſs; and that the determination which we have given will be conſidered as ſufficiently authenticated.

Let us, therefore, for the future take water for the ſtandard, and ſuppoſe that, when of the ordinary temperature of ſummer, and in its ſtate of greateſt natural purity, viz. in clean rain or ſnow, an Engliſh cubic foot of it weighs a thouſand avoirdupois ounces of 437.5 troy grains each. Divide the weight of any body by the weight of an equal bulk of water, the quotient is the ſpecific gravity of that body; and if the three firſt figures of the decimal be accounted integers, the quotient is the number of avoirdupois ounces in a cubic foot of the body. Thus the ſpecific gravity of the very fineſt gold which the refiner can produce is 19.365, and a cubic foot of it weighs 19365 ounces.

But an important remark muſt be made here. All bodies of homogeneous or unorganiſed texture expand by heat, and contract by cooling. The expanſion and contraction by the ſame change of temperature is very different in different bodies. Thus water, when heated from 60° to 100°, increaſes its volume nearly $\frac{1}{167}$ of its bulk, and mercury only $\frac{1}{243}$, and many ſubſtances much leſs. Hence it follows, that an experiment determines the ſpecific gravity only in that very temperature in which the bodies are examined. It will therefore be proper always to note this temperature; and it will be convenient to adopt ſome very uſeful temperature for ſuch trials in general: perhaps about 60° of Fahrenheit's thermometer is as convenient as any. It may always be procured in theſe climates without inconvenience. A temperature near to freezing would have ſome advantages, becauſe water changes its bulk very little between the temperature 32° and 45°. But this temperature cannot always be obtained. It will much conduce to the facility of the compariſon to know the variation which heat produces on pure water. The following table, taken from the obſervations of Dr Blagden and Mr Gilpin (Phil. Tranſ. 1792) will anſwer this purpoſe.

Temperature of Water	Bulk of Water.	Specific Gravity.
30		
35	99910	1.00090
40	99070	1.00094
45	99914	1.00086
50	99932	1.00068
55	99962	1.00038
60	100000	1.00000
65	100050	0.99950
70	100106	0.99894
75	100171	0.99830
80	100242	0.99759
85	100320	0.99681
90	100404	0.99598
95	100501	0.99502
100	100602	0.99402

Thoſe gentlemen obſerved the expanſion of water to be very anomalous between 32° and 45°. This is diſtinctly ſeen during the gradual cooling of water to the point of freezing. It contracts for a while, and then ſuddenly expands. But we ſeldom have occaſion to meaſure ſpecific gravities in ſuch temperature.

The reader is now ſufficiently acquainted with the principles of this hydroſtatical method of determining the ſpecific gravity of bodies, and can judge of the propriety of the forms which may be propoſed for the experiment.

The ſpecific gravity of a fluid may be determined either by filling with it a veſſel with a narrow neck, or by weighing a ſolid body that is immerſed in it. It is hard to ſay which is the beſt way. The laſt is not ſubject to any error in filling, becauſe we may ſuſpend the ſolid by a fine wire, which will not diſplace any ſenſible quantity of the fluid; and if the ſolid is but a little heavier than the fluid, the balance being loaded only with the exceſs, will be very ſenſible to the ſmalleſt want of equilibrium. But this advantage is perhaps compenſated by an obſtruction to the motion of the ſolid up or down in the fluid, ariſing from viſcidity. When the weight in the oppoſite ſcale is yet too ſmall, we ſlowly add more, and at laſt grain by grain, which gradually brings the beam to the level. When it is exactly level, the weight in the ſcale is ſomewhat too great; for it not only balances the preponderance of the ſolid, but alſo this viſcidity of the fluid. But we may get rid of this error. Add a ſmall quantity more; this will bring the beam over to the other ſide. Now put as much into the ſcale on the ſame ſide with the ſolid; this will not reſtore the beam to its level. We muſt add more till this be accompliſhed; and this addition is the meaſure of the viſcidity of the fluid, and muſt be ſubtracted from the weight that was in the other ſcale when the beam came *firſt* to a level. This effect of viſcidity is not inſenſible, with nice apparatus, even in the pureſt water, and in many fluids it is very conſiderable—and, what is worſe, it is very changeable. It is greatly diminiſhed by heat; and this is an additional reaſon for making

making thoſe trials in pretty warm temperatures. But for fluids of which the viſcidity is conſiderable, this method is by no means proper; and we muſt take the other, and weigh them in a veſſel with a narrow neck. Mercury muſt alſo be treated in this way, becauſe we have no ſolid that will ſink in it but gold and platina.

It is not ſo eaſy as one would imagine to fill a veſſel preciſely to the ſame degree upon every trial. But if we do not operate on too ſmall quantities, the unavoidable error may be made altogether inſignificant, by having the neck of the veſſel very ſmall. If the veſſel hold a pound of water, and the neck do not exceed a quarter of an inch (and it will not greatly retard the operation to have it half this ſize), the examinator muſt be very careleſs indeed to err one part in two thouſand; and this is perhaps as near as we can come with a balance. We muſt always recollect that the capacity of the veſſel changes by heat, and we muſt know this variation, and take it into the account. But it is affectation to regard (as Mr Homberg would make us believe that he did) the diſtenſion of the veſſel by the preſſure of the fluid. His experiments of this kind have by no means the conſiſtency with each other that ſhould convince us that he did not commit much greater errors than what aroſe from diſtenſion.

In examining either ſolids or fluids, we muſt be careful to free their ſurface, or that of the veſſel in which the fluid is to be weighed, from air, which frequently adheres to it in a peculiar manner, and, by forming a bubble, increaſes the apparent bulk of the ſolid, or diminiſhes the capacity of the veſſel. The greateſt part of what appears on thoſe occaſions ſeems to have exiſted in the fluid in a ſtate of chemical union, and to be ſet at liberty by the ſuperior attraction of the fluid for the contiguous ſolid body. Theſe air bubbles muſt be carefully bruſhed off by hand. All greaſy matters muſt be cleared off for the ſame reaſon: they prevent the fluid from coming into contact.

We muſt be no leſs careful that no water is imbibed by the ſolid, which would increaſe its weight without increaſing its bulk. In ſome caſes, however, a very long maceration and imbibition is neceſſary. Thus, in examining the ſpecific gravity of the fibrous part of vegetables, we ſhould err exceedingly if we imagined it as ſmall as appears at firſt. We believe that in moſt plants it is at leaſt as great as water, for after long maceration they ſink in it.

It is almoſt needleſs to ſay that the niceſt and moſt ſenſible balances are neceſſary for this examination. Balances are even conſtructed on purpoſe, and fitted with ſeveral pieces of apparatus, which make the examination eaſy and neat. We have deſcribed (ſee BALANCE) Mr Graveſande's as one of the moſt convenient of any. His contrivance for obſerving the fractions of a grain is extremely ingenious and expeditious, eſpecially for detecting the effect of viſcidity.

The hydrometer, or areometer, is another inſtrument for aſcertaining the ſpecific gravity of fluids. This very pretty inſtrument is the invention of a lady, as eminent for intellectual accompliſhments as ſhe was admired for her beauty. Hypatia, the learned daughter of the celebrated mathematician Theon of Alexandria, became ſo eminent for her mathematical knowledge, that ſhe was made public profeſſor of the ſcience in the firſt ſchool in the world. She wrote a commentary on the works of Apollonius and of Diophantus, and compoſed Aſtronomical Tables; all of which are loſt. Theſe rare accompliſhments, however, could not ſave her from the fury of the fanatics of Alexandria, who cut her in pieces for having taken an offenſive part in a diſpute between the governor and patriarch.—We have deſcribed ſome of the moſt approved of theſe inſtruments in the article HYDROMETER, and ſhall in this place make a few obſervations on the principles of their conſtruction, not as they are uſually made, accommodated to the examination of particular liquors, but as indicators of pure ſpecific gravity. And we muſt premiſe, that this would, for many reaſons, be the beſt way of conſtructing them. The very ingenious contrivances for accommodating them to particular purpoſes are unavoidably attended with many ſources of error, both in their adjuſtment by the maker and in their uſe; and all that is gained by a very expenſive inſtrument is the ſaving the trouble of inſpecting a table. A ſimple ſcale of ſpecific gravity would expoſe to no error in conſtruction, becauſe all the weights but one, or all the points of the ſcale but one, are to be obtained by calculation, which is incomparably more exact than any manual operation, and the table can always be more exact than any complex obſervation. But a ſtill greater advantage is, that the inſtruments would by this means be fitted for examining all liquors whatever, whereas at preſent they are almoſt uſeleſs for any but the one for which they are conſtructed.

Hydrometers are of two kinds. The moſt ſimple and the moſt delicate are juſt a ſubſtitute for the hydroſtatical balance. They conſiſt of a ball (or rather an egg or pear-ſhaped veſſel, which moves more eaſily through the fluid) A (fig. 1.) having a foot projecting down from it, terminated by another ball B, and a ſlender ſtalk or wire above, carrying a little diſh C. The whole is made ſo light as to float in the lighteſt fluid we are acquainted with; ſuch as vitriolic or muriatic ether, whoſe ſpecific gravity is only 0.73. This number ſhould be marked on the diſh, indicating that this is the ſpecific gravity of the fluid in which the inſtrument floats, ſinking to the point D of the ſtem. The ball B is made heavy, and the foot is of ſome length, that the inſtrument may have ſtability, and ſwim erect, even if conſiderably loaded above; and, for the ſame reaſon, it muſt be made very round, otherwiſe it will lean to a ſide. When put into a heavier liquor, its buoyancy will cauſe it to float with a part of the ball above the ſurface. Weights are now put into the ſcale C, till the inſtrument ſink to D. The weight put into the ſcale, added to the weight of the inſtrument, is the weight of the diſplaced fluid. This, compared with the weight of the whole when the inſtrument is ſwimming in pure water, gives the ſpecific gravity of the fluid. All trouble of calculation may be avoided by marking the weights with ſuch numbers as ſhall indicate the ſpecific gravity at once. Thus having loaded the inſtrument ſo as to ſink it to D in pure water, call the whole weight 1000; then weigh the inſtrument itſelf, and ſay, "as the weight when ſwimming in water is to its preſent weight, ſo is 1000 to a 4th proportional." This is the ſpecific gravity of the liquor which would float the unloaded inſtrument. Suppoſe this to be 730. The hydrometer would juſt float in muriatic ether, and this ſhould be marked on the ſide. Now make a ſet of ſmall

Plate cccxcix. fig. 1.

weights, and mark them, not by their weights in grains, but in ſuch units that 270 of them ſhall be equal to the weight which fits the inſtrument for pure water.

Suppoſe that, in order to float this inſtrument in a certain brandy, there are required 186 in theſe ſmall weights. This added to 730 gives 916 for the ſpecific gravity, and ſhows it to be preciſely exciſe proof ſpirit. Nine weights, viz. 256, 128, 64, 32, 16, 8, 4, 2, 1, will ſuffice for all liquors from ether to the ſtrongeſt worts. And that the trouble in changing the weights may be greatly leſſened, let a few circles *a*, *b*, *c*, *d*, *e*, be marked on the top of the ball. When we ſee it float unloaded at the circle C for inſtance, we know it will require at leaſt 128 to ſink it to D on the ſtem.

If the weights to be added above are conſiderable, it raiſes the centre of gravity ſo much, that a ſmall want of equilibrium, by laying the weights on one ſide, will produce a great inclination of the inſtrument, which is unſightly. Inſtead therefore of making them looſe weights, it is proper to make them round plates, with a ſmall hole in the middle, to go on a pin in the middle of the ſcale. This will keep the inſtrument always upright. But unleſs the hydrometer is of a conſiderable ſize, it can hardly be made ſo as to extend from the lighteſt to the heavieſt fluid which we may have occaſion to examine, even though we except mercury. Some of the mineral acids are conſiderably more than twice the weight of ether. When there is ſuch a load at top, the hydrometer is very apt to overſet, and inclines with the ſmalleſt want of equilibrium. Great ſize is inconvenient even to the philoſopher, becauſe it is not always in his power to operate on a quantity of fluid ſufficient to float the inſtrument. Therefore two, or perhaps three, are neceſſary for general examination. One may reach from ether to water; another may ſerve for all liquors of a ſpecific gravity between one and one and a half; and the third, for the mineral acids, may reach from this to two. If each of theſe be about two ſolid inches in capacity, we may eaſily and expeditiouſly determine the ſpecific gravity within one ten thouſandth part of the truth: and this is preciſion enough for moſt purpoſes of ſcience or buſineſs.

The chief queſtions are, 1. To aſcertain the ſpecific gravity of an unknown fluid. This needs no farther explanation. 2. To aſcertain the proportion of two fluids which are known to be in a mixture. This is done by diſcovering the ſpecific gravity of the mixture by means of the hydrometer, and then deducing the proportion from a compariſon of this with the ſpecific gravities of the ingredients.

In this mode of examination the bulk is always the ſame; for the hydrometer is immerged in the different fluids to the ſame depth. Now if an inch, for example, of this bulk is made up of the heavieſt fluid, there is an inch wanting of the lighteſt; and the change made in the weight of the mixture is the difference between the weight of an inch of the heavieſt, and of an inch of the lighteſt ingredients. The number of inches therefore of the heavieſt fluid is proportional to the addition made to the weight of the mixture. Therefore let B and b be the bulks of the heavieſt and lighteſt fluids in the bulk β of the mixture; and let D, d, and δ be the denſities, or the weights, or the ſpecific gravities (for they are in one ratio) of the heavy fluid, the light fluid, and the mixture (their bulk being that of the hydrometer). We have $\beta = B + b$. The addition which would have been made to the bulk β, if the lighteſt fluid were changed entirely for the heavieſt, would be $D - d$; and the change which is really made is $\delta - d$. Therefore $\beta : b = D - d : \delta - d$. For ſimilar reaſons we ſhould have $\beta : B = D - d : D - \delta$; or, in words, "*the difference between the ſpecific gravities of the two fluids, is to the difference between the ſpecific gravities of the mixture and of the lighteſt fluid, as the bulk of the whole to the bulk of the heavieſt contained in the mixture;*" and "the *difference of the ſpecific gravities of the two fluids, is to the difference of the ſpecific gravities of the mixture and of the heavieſt fluids, as the bulk of the whole to that of the lighteſt contained in the mixture.*" This is the form in which the ordinary buſineſs of life requires the anſwer to be expreſſed, becauſe we generally reckon the quantity of liquors by bulk, in gallons, pints, quarts. But it would have been equally eaſy to have obtained the anſwer in pounds and ounces; or it may be had from their bulk, ſince we know their ſpecific gravities.

The hydrometer more commonly uſed is the ancient one of Hypatia, conſiſting of a ball A (fig. 2.) made ſteady by an addition B, below it like the former, but having a long ſtem CF above. It is ſo loaded that it ſinks to the top F of the ſtem in the lighteſt of all the fluids which we propoſe to meaſure with it, and to ſink only to C in the heavieſt. In a fluid of intermediate ſpecific gravity it will ſink to ſome point between C and F.

In this form of the hydrometer the weight is always the ſame, and the immediate information given by the inſtrument is that of different bulks with equal weight. Becauſe the inſtrument ſinks till the bulk of the diſplaced fluid equals it in weight, and the additions to the diſplaced fluid are all made by the ſtem, it is evident that equal bulks of the ſtem indicate equal additions of volume. Thus the ſtem becomes a ſcale of bulks to the ſame weight.

The only form in which the ſtem can be made with ſufficient accuracy is cylindrical or priſmatical. Such a ſtem may be made in the moſt accurate manner by wire-drawing, that is, paſſing it through a hole made in a hardened ſteel plate. If ſuch a ſtem be divided into equal parts, it becomes a ſcale of bulks in arithmetical progreſſion. This is the eaſieſt and moſt natural diviſion of the ſcale; but it will not indicate denſities, ſpecific gravities, or weights of the ſame bulk in arithmetical progreſſion. The ſpecific gravity is as the weight divided by the bulk. Now a ſeries of diviſors (the bulks), in arithmetical progreſſion, applied to the ſame dividend (the bulk and weight of the hydrometer as it floats in water), will not give a ſeries of quotients (the ſpecific gravities) in arithmetical progreſſion: they will be in what is called *harmonic progreſſion*, their differences continually diminiſhing. This will appear even when phyſically conſidered. When the hydrometer ſinks a tenth of an inch near the top of the ſtem, it diſplaces one tenth of an inch of a light fluid, compared with that diſplaced by it when it is floating with all the ſtem above the ſurface. In order therefore that the diviſions of the ſtem may indicate equal changes of ſpecific gravity, they muſt be in a ſeries of harmonic progreſſionals increaſing. The point at which the inſtrument floats in pure water ſhould be marked 1000, and thoſe above it 999, 998, 997, &c.; and

PECIFIC GRAVITY.

SPINNING MACHINERY.

PLATE CCCCXCIX.

Fig.1.

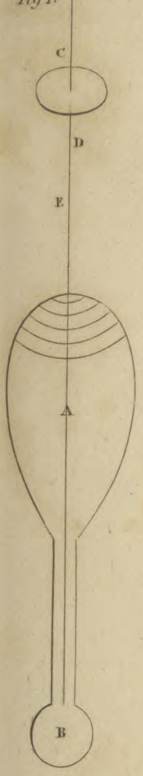


Fig.2.

Fig.1.

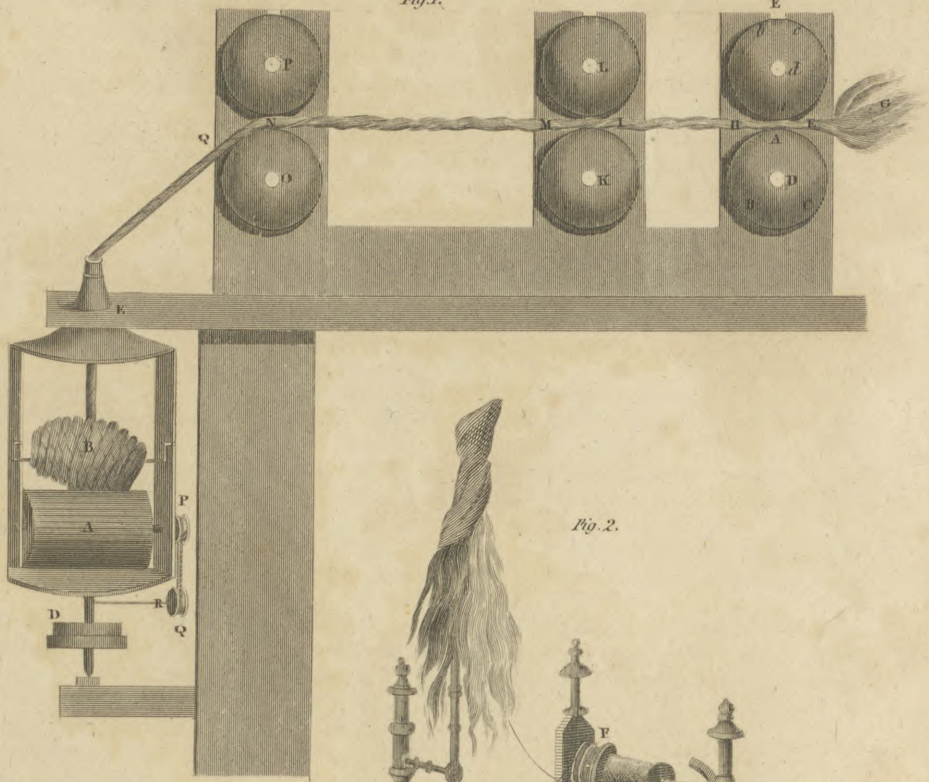
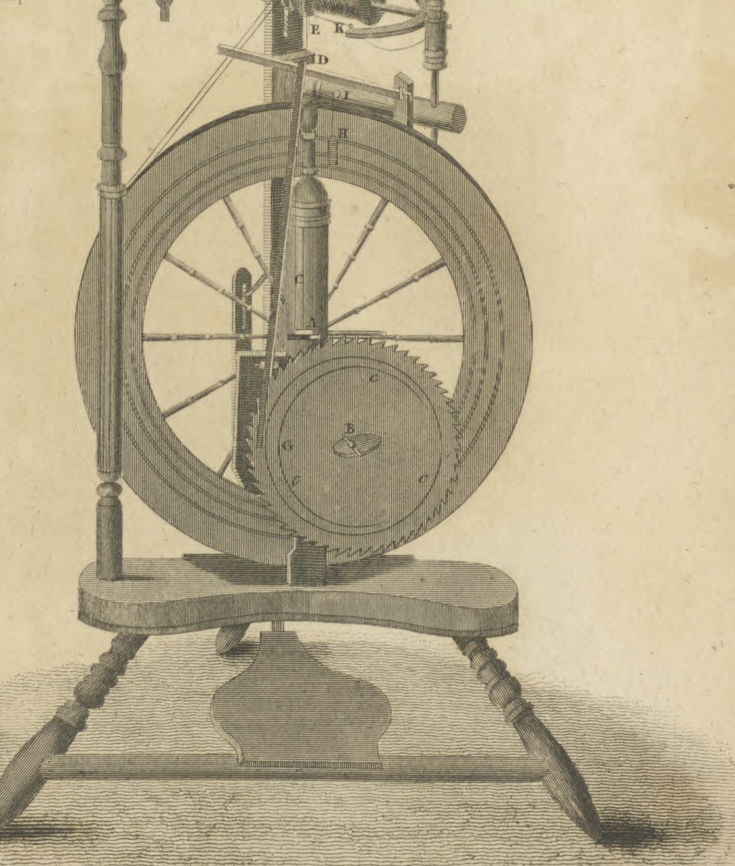


Fig.2.



SPIRITUOUS LIQUORS

Fig.1.

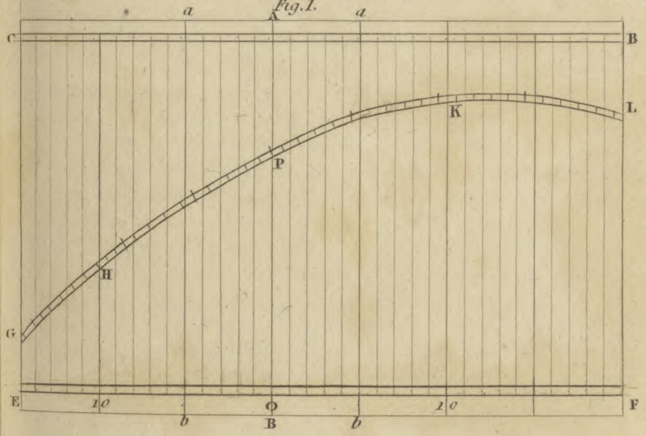
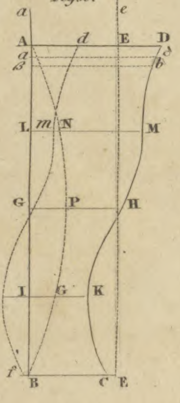


Fig.2.



Engraved by W. & D. Lizars Edinburgh.

thoſe below the water mark muſt be numbered 1001, 1002, 1003, &c. Such a ſcale will be a very appoſite picture of the denſities of fluids, for the denſity or vicinity of the diviſions will be preciſely ſimilar to the denſity of the fluids. Each interval is a bulk of fluid of the ſame weight. If the whole inſtrument were drawn out into wire of the ſize of the ſtem, the length from the water mark would be 1000.

Such are the rules by which the ſcale muſt be divided. But there muſt be ſome points of it determined by experiment, and it will be proper to take them as remote from each other as poſſible. For this purpoſe let the inſtrument be accurately marked at the point where it ſtands, in two fluids, differing as much in ſpecific gravity as the inſtrument will admit. Let it alſo be marked where it ſtands in water. Then determine with the utmoſt preciſion the ſpecific gravities of theſe fluids, and put their values at the correſponding points of the ſcale. Then the intermediate points of the ſcale muſt be computed for the different intervening ſpecific gravities, or it muſt be divided from a pattern ſcale of harmonic progreſſionals in a way well known to the mathematical inſtrument-makers. If the ſpecific gravities have been accurately determined, the value 1000 will be found to fall preciſely in the water mark. If we attempt the diviſion entirely by experiment, by making a number of fluids of different ſpecific gravities, and marking the ſtem as it ſtands in them, we ſhall find the diviſions turn out very anomalous. This is however the way uſually practiſed; and there are few hydrometers, even from the beſt maker, that hold true to a ſingle diviſion or two. Yet the method by computation is not more troubleſome; and one ſcale of harmonic progreſſionals will ſerve to divide every ſtem that offers. We may make uſe of a ſcale of equal parts for the ſtem, with the aſſiſtance of two little tables. One of theſe contains the ſpecific gravities in harmonic progreſſion, correſponding to the arithmetical ſcale of bulks on the ſtem of the hydrometer; the other contains the diviſions and fractions of a diviſion of the ſcale of bulks, which correſpond to an arithmetical ſcale of ſpecific gravities. We believe this to be the beſt method of all. The ſcale of equal parts on the ſtem is ſo eaſily made, and the little table is ſo eaſily inſpected, that it has every advantage of accuracy and diſpatch, and it gives, by the way, an amuſing view of the relation of the bulks and denſities.

We have hitherto ſuppoſed a ſcale extending from the lighteſt to the heavieſt fluid. But unleſs it be of a very inconvenient length, the diviſions muſt be very minute. Moreover, when the bulk of the ſtem bears a great proportion to that of the body, the inſtrument does not ſwim ſteady; it is therefore proper to limit the range of the inſtrument in the ſame manner as thoſe of the firſt kind. A range from the denſity of ether to that of water may be very well executed in an inſtrument of very moderate ſize, and two others will do for all the heavier liquors; or an equal range in any other denſities as may ſuit the uſual occupations of the experimenter.

To avoid the inconveniences of a hydrometer with a very long and ſlender ſtem, or the neceſſity of having a ſeries of them, a third ſort has been contrived, in which the principles of both are combined. Suppoſe a hydrometer with a ſtem, whoſe bulk is $\frac{1}{10}$th of that of the ball, and that it ſinks in ether to the top of the ſtem; it is evident that in a fluid which is $\frac{1}{10}$th heavier, the whole ſtem will emerge; for the bulk of the diſplaced fluid is now $\frac{1}{10}$th of the whole leſs, and the weight is the ſame as before, and therefore the ſpecific gravity is $\frac{1}{10}$th greater.

Thus we have obtained a hydrometer which will indicate, by means of diviſions marked on the ſtem, all ſpecific gravities from 0.73 to 0.803; for 0.803 is $\frac{1}{10}$th greater than 0.73. Theſe diviſions muſt be made in harmonic progreſſion, as before directed for an entire ſcale, placing 0.73 at the top of the ſtem and 0.803 at the bottom.

When it floats at the loweſt diviſion, a weight may be put on the top of the ſtem, which will again ſink it to the top. This weight muſt evidently be 0.073, or $\frac{1}{10}$th of the weight of the fluid diſplaced by the unloaded inſtrument. The hydrometer, thus loaded, indicates the ſame ſpecific gravity, by the top of the ſtem, that the unloaded inſtrument indicates by the loweſt diviſion. Therefore, when loaded, it will indicate another ſeries of ſpecific gravities, from 0.803 to 0.8833 (=0.803+0.0803), and will float in a liquor of the ſpecific gravity 0.8833 with the whole ſtem above the ſurface.

In like manner, if we take off this weight, and put on 1=0.080.3, it will ſink the hydrometer to the top of the ſtem; and with this new weight it will indicate another ſeries of ſpecific gravities from 0.8833 to 0.97163 (=0.8833+0.08833). And, in the ſame manner, a third weight =08833 will again ſink it to the top of the ſtem, and fit it for another ſeries of ſpecific gravities up to 1.068793. And thus, with three weights, we have procured a hydrometer fitted for all liquors from ether to a wort for a malt liquor of two barrels per quarter. Another weight, in the ſame progreſſion, will extend the inſtrument to the ſtrongeſt wort that is brewed.

This is a very commodious form of the inſtrument, and is now in very general uſe for examining ſpirituous liquors, worts, ales, brines, and many ſuch articles of commerce. But the diviſions of the ſcale are generally adapted to the queſtions which naturally occur in the buſineſs. Thus, in the commerce of ſtrong liquors, it is uſual to eſtimate the article by the quantity of ſpirit of a certain ſtrength which the liquor contains.—This we have been accuſtomed to call proof ſpirit, and it is ſuch that a wine gallon weighs 7 pounds 12 ounces; and it is by this ſtrength that the exciſe duties are levied. Therefore the diviſions on the ſcale, and the weights which connect the ſucceſſive repetitions of the ſcale, are made to expreſs at once the number of gallons or parts of a gallon of proof ſpirits contained in a gallon of the liquor. Such inſtruments ſave all trouble of calculation to the exciſeman or dealer; but they limit the uſe of a very delicate and expenſive inſtrument to a very narrow employment. It would be much better to adhere to the expreſſion either of ſpecific gravity or of bulk; and then a very ſmall table, which could be compriſed in the ſmalleſt caſe for the inſtrument, might render it applicable to every kind of fluid.

The reader cannot but have obſerved that the ſucceſſive weights, by which the ſhort ſcale of the inſtrument is extended to a great range of ſpecific gravities, do not increaſe by equal quantities. Each difference is the weight of the liquor diſplaced by the graduated ſtem of the inſtrument when it is ſunk to the top of the

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the ſcale. It is a determined aliquot part of the whole weight of the inſtrument ſo loaded, (in our example it is always $\frac{1}{17}$th of it). It increaſes therefore in the ſame proportion with the preceding weight of the loaded inſtrument. In ſhort, both the ſucceſſive additions, and the whole weights of the loaded inſtrument, are quantities in geometrical progreſſion; and in like manner, the diviſions on the ſcale, if they correſpond to equal differences of ſpecific gravity, muſt alſo be unequal.—This is not ſufficiently attended to by the makers; and they commit an error here, which is very conſiderable when the whole range of the inſtrument is great. For the value of one diviſion of the ſcale, when the largeſt weight is on, is as much greater than its value when the inſtrument is not loaded at all, as the full loaded inſtrument is heavier than the inſtrument unloaded. No manner whatever of dividing the ſcale will correſpond to equal differences of ſpecific gravity through the whole range with different weights; but if the diviſions are made to indicate equal *proportions* of gravity when the inſtrument is uſed without a weight, they will indicate equal *proportions* throughout. This is evident from what we have been juſt now ſaying; for the proportion of the ſpecific gravities correſponding to any two immediately ſucceeding weights is always the ſame.

The beſt way, therefore, of conſtructing the inſtrument, ſo that the ſame diviſions of the ſcale may be accurate in all its ſucceſſive repetitions with the different weights, is to make theſe diviſions in geometrical progreſſion. The correſponding ſpecific gravities will alſo be in geometric proportion. Theſe being all inſerted in a table, we obtain them with no more trouble than by inſpecting the ſcale which uſually accompanies the hydrometer. This table is of the moſt eaſy conſtruction; for the ratio of the ſucceſſive bulks and ſpecific gravities being all equal, the differences of the logarithms are equal.

This will be illuſtrated by applying it to the example already given of a hydrometer extending from 0.73 to 1.068793 with three weights. This gives four repetitions of the ſcale on the ſtem. Suppoſe this ſcale divided into 10 parts, we have 40 ſpecific gravities.—Let theſe be indicated by the numbers 0, 1, 2, 3, &c. to 40. The mark 0 is affixed to the top of the ſtem, and the diviſions downwards are marked 1, 2, 3, &c. the loweſt being 10. Theſe diviſions are eaſily determined. The ſtem, which we may ſuppoſe 5 inches long, was ſuppoſed to be $\frac{1}{10}$th of the capacity of the ball. It may therefore be conſidered as the extremity of a rod of 11 times its length, or 55 inches, and we muſt find nine mean proportionals between 50 and 55 inches. Subtract each of theſe from 55 inches, and the remainders are the diſtances of the points of diviſion from 0, the top of the ſcale. The ſmalleſt weight is marked 10, the next 20, and the third 30. If the inſtrument loaded with the weight 20 ſinks in ſome liquor to the mark 7, it indicates the ſpecific gravity 27, that is, the 27th of 40 mean proportionals between 0.73 and 1.068793, or 0.944242. To obtain all theſe intermediate ſpecific gravities, we have only to ſubtract 9.8633229, the logarithm of 0.73 from that of 1.068793, viz. 0.0288937, and take 0.0041393, the 40th part of the difference. Multiply this by 1, 2, 3, &c. and add the logarithm of 0.73 to each of the products. The ſums are the logarithms of the ſpecific gravities required. Theſe will be found to proceed ſo equably, that they may be interpolated ten times by a ſimple table of proportional parts, without the ſmalleſt ſenſible error. Therefore the ſtem may be divided into a hundred parts very ſenſible to the eye (each being nearly the 20th of an inch), and 406 degrees of ſpecific gravity obtained within the range, which is as near as we can examine this matter by any hydrometer. Thus the ſpecific gravities correſponding to N° 26, 27, 28, 29, are as follow:

		1ſt Diff.	2d Diff.
26	0.93529		
		895	
27	0.94424		9
		904	
28	0.95328		9
		913	
29	0.96241		

Nay, the trouble of inſpecting a table may be avoided, by forming on a ſcale the logarithms of the numbers between 7300 and 1068.793, and placing along ſide of it a ſcale of the ſame length divided into 400 equal parts, numbered from 0 to 400. Then, looking for the mark ſhown by the hydrometer on this ſcale of equal parts, we ſee oppoſite to it the ſpecific gravity.

We have been thus particular in the illuſtration of this mode of conſtruction, becauſe it is really a beautiful and commodious inſtrument, which may be of great uſe both to the naturaliſt and to the man of buſineſs.—A table may be compriſed in 20 octavo pages, which will contain the ſpecific gravities of every fluid which can intereſt either, and anſwer every queſtion relative to their admixture with as much preciſion as the obſervations can be made. We therefore recommend it to our readers, and we recommend the very example which we have given as one of the moſt convenient. The inſtrument need not exceed eight inches in length, and may be contained in a pocket caſe of two inches broad and as many deep, which will alſo contain the ſcale, a thermometer, and even the table for applying it to all fluids which have been examined.

It is unfortunate that no graduated hydrometer can be made ſo eaſily for the examination of the corroſive mineral acids (A). Theſe muſt be made of glaſs, and we cannot depend on the accurate cylindric form of any glaſs ſtem. But if any ſuch can be procured, the conſtruction is the ſame. The divided ſcale may either be on thin paper paſted on the inſide of the ſtem, or it may be printed on the ſtem itſelf from a plate, with ink made of a metallic calx, which will attach itſelf to the glaſs with a very moderate heat. We would recommend common white enamel, or arſenical glaſs, as the fitteſt material for the whole inſtrument; and the ink uſed, in taking the impreſſion of the ſcale, may be the ſame that is uſed for the low-priced printing on Delft ware pottery.—Firſt form the ſcale on the ſtem. Then, having meaſured the ſolid contents of the graduated part as exactly as poſſible, and determined on the general ſhape of

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(A) It would be worth while to try copper enamelled. See note at page 599. of this volume.

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of the ball and counterpoiſe below, calculate its ſize, ſo that it may be a little leſs than ten times that of the ſtem. The glaſs-blower can copy this very nearly, and join it to the ſtem. Then make two brines or other liquors, which ſhall have ſpecific gravities in the ratio of 10 to 11. Load the inſtrument ſo that it may ſink to 0 in the lighteſt. When put into the heavieſt, it ſhould riſe to 10. If it does not riſe ſo high, the immerſed part is too ſmall. Let the glaſs-blower enlarge the ball of the counterpoiſe a little. Repeat this trial till it be exact. Nothing now remains but to form the weights: And here we obſerve, that when the inſtrument is to have a very great range, as for examining all ſtates of the vitriolic acid, it has a chance of being very tottering when loaded with the greateſt weight on the top of ſo long a ſcale. To avoid this, Mr Quin and others have added ſome of their weights below.—But this will not ſuit the preſent conſtruction, becauſe it will alter the proportion between the bulks of the ſtem and immerſed part. Therefore let theſe weights conſiſt of cylinders of metal ſmall enough to go into the ſtem, and let them be ſoldered to the end of long wires, which will let them go to the bottom, and leave a ſmall hook or ring at top. Theſe can lie alongſide of the inſtrument in its caſe. This is indeed the beſt conſtruction for every hydrometer, becauſe it makes it incomparably more ſteady. The inſtrument is poiſed by ſmall ſhot or mercury. But it will be much better to do it with Newton's fuſible metal (three parts of tin, five parts of lead, and eight parts of biſmuth) in coarſe filings. When the exact quantity has been put in, the inſtrument may be ſet in a veſſel of oil, and this kept on the fire till all is completely melted. It ſoon freezes again, and remains faſt. If this metal is not to be had, let a few bits of ſealing-wax be added to the mercury or ſhot, to make up the counterpoiſe. When heated, it will float a-top, and when it freezes again it will keep all faſt. Thus we ſhall make a very complete and cheap inſtrument.

There is yet another method of examining the ſpecific gravities of fluids, firſt propoſed by Dr Wilſon, late profeſſor of aſtronomy in the univerſity of Glaſgow. This is by a ſeries of ſmall glaſs bubbles, differing equally, or according to ſome rule, from each other in ſpecific gravity, and each marked with its proper number. When theſe are thrown into a fluid which is to be examined, all thoſe which are heavier than the fluid will fall to the bottom. Then holding the veſſel in the hand, or near a fire or candle, the fluid expands, and one of the floating bubbles begins to ſink. Its ſpecific gravity, therefore, was either equal to, or a little leſs than, that of the fluid; and the degree of the thermometer, when it began to ſink, will inform us how much it was deficient, if we know the law of expanſion of the liquor. Sets of theſe bubbles fitted for the examination of ſpirituous liquors, with a little treatiſe ſhowing the manner of uſing them, and calculating by the thermometer, are made by Mr Brown, an ingenious artiſt of Glaſgow, and are often uſed by the dealers in ſpirits, being found both accurate and expeditious.

Alſo, though a bubble or two ſhould be broken, the ſtrength of ſpirits may eaſily be had by means of the remainder, unleſs two or three in immediate ſucceſſion be wanting: for a liquor which anſwers to N° 4. will ſink N° 2. by heating it a few degrees, and therefore N° 3. may be ſpared. This is a great advantage in ordinary buſineſs. A nice hydrometer is not only an expenſive inſtrument, but exceedingly delicate, being ſo very thin. If broken or even bruiſed, it is uſeleſs, and can hardly be repaired except by the very maker.

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As the only queſtion here is, to determine how many gallons of exciſe proof ſpirits is contained in a quantity of liquor, the artiſt has conſtructed this ſeries of bubbles in the ſimpleſt manner poſſible, by previouſly making 40 or 50 mixtures of ſpirits and water, and then adjuſting the bubbles to theſe mixtures. In ſome ſets the number on each bubble is the number of gallons of proof ſpirits contained in 100 gallons of the liquor. In other ſets the number on each bubble expreſſes the gallons of water which will make a liquor of this ſtrength, if added to 14 gallons of alcohol. Thus, if a liquor anſwers to N° 4, then 4 gallons of water added to 14 gallons of alcohol will make a liquor of this ſtrength. The firſt is the beſt method; for we ſhould be miſtaken in ſuppoſing that 18 gallons, which anſwer to N° 4, contains exactly 14 gallons of alcohol: it contains more than 14, for a reaſon to be given by and by.

By examining the ſpecific gravity of bodies, the philoſopher has made ſome very curious diſcoveries. The moſt remarkable of theſe is the change which the denſity of bodies ſuffers by mixture. It is a moſt reaſonable expectation, that when a cubic foot of one ſubſtance is mixed *any how* with a cubic foot of another, the bulk of the mixture will be two cubic feet; and that 18 gallons of water joined to 18 gallons of oil will fill a veſſel of 36 gallons. Accordingly this was never doubted; and even Archimedes, the moſt ſcrupulous of mathematicians, proceeded on this ſuppoſition in the ſolution of his famous problem, the diſcovery of the proportion of ſilver and gold in a mixture of both. He does not even mention it as a poſtulate that *may* be granted him, ſo much did he conceive it to be an axiom. Yet a little reflection ſeems ſufficient to make it doubtful and to require examination. A box filled with muſket-balls will receive a conſiderable quantity of ſmall ſhot, and after this a conſiderable quantity of fine ſand, and after this a conſiderable quantity of water. Something like this might happen in the admixture of bodies of porous texture. But ſuch ſubſtances as metals, glaſs, and fluids, where no diſcontinuity of parts can be perceived, or was ſuſpected, ſeem free from every chance of this kind of introſuſception. Lord Bacon, however, without being a naturaliſt or mathematician *ex profeſſo*, inferred from the mobility of fluids that they conſiſted of diſcrete particles, which muſt have pores interpoſed, whatever be their figure. And if we aſcribe the different denſities, or other ſenſible qualities, to difference in ſize or figure of thoſe particles, it muſt frequently happen that the ſmaller particles will be lodged in the interſtices between the larger, and thus contribute to the weight of the ſenſible maſs without increaſing its bulk. He therefore ſuſpects that mixtures will be in general leſs bulky than the ſum of their ingredients.

Accordingly, the examination of this queſtion was one of the firſt employments of the Royal Society of London, and long before its inſtitution had occupied the attention of the gentlemen who afterwards compoſed it. The regiſter of the Society's early meetings contains many experiments on this ſubject, with mixtures of gold and ſilver, of other metals, and of various

Specific Gravity.

fluids, examined by the hydroſtatical balance of Mr Boyle. Dr Hooke made a prodigious number, chiefly on articles of commerce, which were unfortunately loſt in the fire of London.

It was ſoon found, however, that Lord Bacon's conjecture had been well founded, and that bodies changed their denſity very ſenſibly in many caſes. In general, it was found that bodies which had a ſtrong chemical affinity increaſed in denſity, and that their admixture was accompanied with heat.

By this diſcovery it is manifeſt that Archimedes had not ſolved the problem of detecting the quantity of ſilver mixed with the gold in King Hiero's crown, and that the phyſical ſolution of it requires experiments made on all the kinds of matter that are mixed together. We do not find that this has been done to this day, although we may affirm that there are few queſtions of more importance. It is a very curious fact in chemiſtry, and it would be moſt deſirable to be able to reduce it to ſome general laws: For inſtance, to aſcertain what is the proportion of two ingredients which produces the greateſt change of denſity. This is important in the ſcience of phyſics, becauſe it give us conſiderable information as to the mode of action of thoſe natural powers or forces by which the particles of tangible matter are united. If this introſuſception, concentration, compenetration, or by whatever name it be called, were a mere reception of the particles of one ſubſtance into the interſtices of thoſe of another, it is evident that the greateſt concentration would be obſerved when a ſmall quantity of the recipiend is mixed with, or diſſeminated through, a great quantity of the other. It is thus that a ſmall quantity of fine ſand will be received into the interſtices of a quantity of ſmall ſhot, and will increaſe the weight of the bagful without increaſing its bulk. The caſe is nowiſe different when a piece of freeſtone has grown heavier by imbibing or abſorbing a quantity of water. If more than a certain quantity of ſand has been added to the ſmall ſhot, it is no longer concealed. In like manner, various quantities of water may combine with a maſs of clay, and increaſe its ſize and weight alike. All this is very conceivable, occaſioning no difficulty.

But this is not the caſe in any of the mixtures we are now conſidering. In all theſe, the firſt additions of either of the two ſubſtances produce but an inconſiderable change of general denſity; and it is in general moſt remarkable, whether it be condenſation or rarefaction, when the two ingredients are nearly of equal bulks. We can illuſtrate even this difference, by reflecting on the imbibition of water by vegetable ſolids, ſuch as timber. Some kinds of wood have their weight much more increaſed than their bulks; other kinds of wood are more enlarged in bulk than in weight. The like happens in grains. This is curious, and ſhows in the moſt unqueſtionable manner that the particles of bodies are not in contact, but are kept together by forces which act at a diſtance. For this diſtance between the centres of the particles is moſt evidently ſuſceptible of variation; and this variation is occaſioned by the introduction of another ſubſtance, which, by acting on the particles by attraction or repulſion, diminiſhes or increaſes their mutual actions, and makes new diſtances neceſſary for bringing all things again into equilibrium. We refer the curious reader to the ingenious theory of the abbé Boſcovich for an excellent illuſtration of this ſubject (*Theor. Phil. Nat.* § de Solutione Chemica.)

This queſtion is no leſs important to the man of buſineſs. Till we know the condenſation of thoſe metals by mixture, we cannot tell the quantity of alloy in gold and ſilver by means of their ſpecific gravity; nor can we tell the quantity of pure alcohol in any ſpirituous liquor, or that of the valuable ſalt in any ſolution of it. For want of this knowledge, the dealers in gold and ſilver are obliged to have recourſe to the tedious and difficult teſt of the aſſay, which cannot be made in all places or by all men. It is therefore much to be wiſhed, that ſome perſons would inſtitute a ſeries of experiments in the moſt intereſting caſes: for it muſt be obſerved, that this change of denſity is not always a ſmall matter; it is ſometimes very conſiderable and paradoxical. A remarkable inſtance may be given of it in the mixture of braſs and tin for bells, great guns, optical ſpeculums, &c. The ſpecific gravity of caſt braſs is nearly 8.006, and that of tin is nearly 7.363. If two parts of braſs be mixed with one of tin, the ſpecific gravity is 8.917; whereas, if each had retained its former bulk, the ſp. grav. would have been only 7.793 $\left(=\frac{2\times 8.006+7.363}{3}\right)$. A mixture of equal parts ſhould have the ſpecific gravity 7.684; but it is 8.441. A mixture of two parts tin with one part braſs, inſtead of being 7.577, is 8.027.

In all theſe caſes there is a great increaſe of ſpecific gravity, and conſequently a great condenſation of parts or contraction of bulk. The firſt mixture of eight cubic inches of braſs, for inſtance, with four cubic inches of tin, does not produce 12 cubic inches of bell-metal, but only $10\frac{1}{2}$ nearly, having ſhrunk $\frac{1}{5}$. It would appear that the diſtances of the braſs particles are moſt affected, or perhaps it is the braſs that receives the tin into its pores; for we find that the condenſations in theſe mixtures are nearly proportional to the quantities of the braſs in the mixtures. It is remarkable that this mixture with the lighteſt of all metals has made a compoſition more heavy and denſe than braſs can be made by any hammering.

The moſt remarkable inſtance occurs in mixing iron with platina. If ten cubic inches of iron are mixed with $1\frac{1}{4}$ of platina, the bulk of the compound is only $9\frac{3}{4}$ inches. The iron therefore has not ſimply received the platina into its pores: its own particles are brought nearer together. There are ſimilar reſults in the ſolution of turbith mineral, and of ſome other ſalts, in water. The water, inſtead of riſing in the neck of the veſſel, when a ſmall quantity of the ſalt has been added to it, ſinks conſiderably, and the two ingredients occupy leſs room than the water did alone.

The ſame thing happens in the mixture of water with other fluids and different fluids with each other: But we are not able to trace any general rule that is obſerved with abſolute preciſion. In moſt caſes of fluids the greateſt condenſation happens when the bulks of the ingredients are nearly equal. Thus, in the mixture of alcohol and water, we have the greateſt condenſation when $16\frac{1}{2}$ ounces of alcohol are mixed with 20 ounces of water, and the condenſation is about $\frac{1}{38}$ of the whole bulk of the ingredients. It is extremely various in different ſubſtances, and no claſſification of them can be made in this reſpect.

A diſſertation has been publiſhed on this ſubject by Dr

Dr Hahn of Vienna, intitled *De Efficacia Mixtionis in mutandis Corporum Voluminibus*, in which all the remarkable inſtances of the variation of denſity have been collected. All that we can do (as we have no directing principle) is to record ſuch inſtances as are of chief importance, being articles of commerce.

The firſt that occurs to us is the mixtures of alcohol and water in the compoſition of ſpirituous liquors. This has been conſidered by many with great care. The moſt ſcrupulous examination of this, or perhaps of any mixture, has been lately made by Dr Blagden (now Sir Charles Blagden) of the Royal Society, on the requiſition of the Board of Exciſe. He has publiſhed an account of the examination in the Philoſophical Tranſactions of London in 1791 and 1792. We ſhall give an account of it under the article *SPIRITUOUS Liquors*; and at preſent only ſelect one column, in order to ſhow the condenſation. The alcohol was almoſt the ſtrongeſt that can be produced, and its ſpecific gravity, when of the temperature 60°, was 0.825. The whole mixtures were of the ſame temperature.

Column 1. contains the pounds, ounces, or other meaſures by weight, of alcohol in the mixture. Column 2. contains the pounds or ounces of water. Column 3. is the ſum of the bulks of the ingredients, the bulk of a pound or ounce of water being accounted 1. Column 4. is the obſerved ſpecific gravity of the mixture, taken from Dr Blagden's diſſertation. Column 5. is the ſpecific gravity which would have been obſerved if the ingredients had each retained its own ſpecific gravity. This we calculated by dividing the ſum of the two numbers of the firſt and ſecond columns by the correſponding number of the third. Column 6. is the difference of column 4. and column 5. and exhibits the condenſation.

TABLE.

A	W.	Volume.	Sp. Grav obſerved.	Sp Grav. calculated.	Condenſation.
20	0	24.2424	0.8250	0.8250	00
20	1	25.2424	0.8360	0 8320	40
20	2	26.2424	0.8457	0.8383	74
20	3	27.2424	0.8543	0.8443	100
20	4	28.2424	0.8621	0.8498	123
20	5	29.2424	0.8692	0.8549	143
20	6	30.2424	0.8757	0.8597	160
20	7	31.2424	0.8817	0.8642	175
20	8	32.2424	0.8872	0.8684	188
20	9	33.2424	0.8923	0.8724	199
20	10	34.2424	0.8971	0.8761	216
20	11	35.2424	0.9014	0.8796	218
20	12	36.2424	0.9055	0.8829	226
20	13	37.2424	0.9093	0.8860	233
20	14	38.2424	0.9129	0.8891	238
20	15	39.2424	0.9162	0.8919	243
20	16	40.2424	0.9193	0.8946	247
20	17	41.2424	0.9223	0.8971	252
20	18	42.2424	0.9250	0.8996	254
20	19	43.2424	0.9276	0.9019	257
20	20	44.2424	0.9300	0.9041	259
19	20	43.0303	0.9325	0.9063	262
18	20	48.1182	0.9349	0.9087	262
17	20	40.6061	0.9375	0.9112	263
16	20	39.3939	0.9402	0.9139	263
15	20	38.1818	0.9430	0.9167	263
14	20	36.9697	0.9458	0.9197	261
13	20	35.7576	0.9488	0.9229	259
12	20	34.5455	0.9518	0.9263	255
11	20	33.3333	0.9549	0.9300	249
10	20	32.1212	0.9580	0.9340	240
9	20	30.9091	0.9612	0.9382	230
8	20	29.6970	0.9644	0.9429	215
7	20	28.4849	0.9675	0.9479	196
6	20	27.2727	0.9707	0.9533	174
5	20	26.0606	0.9741	0.9593	148
4	20	24.8485	0.9777	0.9659	118
3	20	23.6364	0.9818	0.9731	87
2	20	22.4242	0.9865	0.9811	54
1	20	21.2121	0.9924	0.9900	24
0	20	20.0000	1.0000	1.0000	

It is to be remarked, that the condenſation is greateſt when 16½ ounces of alcohol have been added to 20 of water, and the condenſation is $\frac{263}{91833}$, or nearly $\frac{1}{35}$th of the computed denſity. Since the ſpecific gravity of alcohol is 0.825, it is evident that 16½ ounces of alcohol and 20 ounces of water have equal bulks. So that the condenſation is greateſt when the ſubſtances are mixed in equal volumes; and 18 gallons of alcohol mixed with 18 gallons of water will produce not 36 gallons of ſpirits, but 35 only.

We may alſo obſerve, that this is the mixture to which our revenue laws refer, declaring it to be *one to ſix* or *one in ſeven* under proof, and to weigh 7 pounds 13 ounces per gallon. This proportion was probably ſelected as the moſt eaſily compoſed, viz. by mixing equal meaſures of water and of the ſtrongeſt ſpirit which the known proceſſes of diſtillation could produce. Its ſpecific gravity is 0.939 very nearly.

We muſt conſider this elaborate examination of the mixture of water and alcohol as a ſtandard ſeries of experiments, to which appeal may always be made, whether for the purpoſes of ſcience or of trade. The regularity of the progreſſion is ſo great, that in the column which we have examined, viz. that for temperature 60°, the greateſt anomaly does not amount to one part in ſix thouſand. The form of the ſeries is alſo very judiciouſly choſen for the purpoſes of ſcience. It would perhaps have been more directly ſtereometrical had the proportions of the ingredients been ſtated in bulks, which are more immediately connected with denſity. But the author has aſſigned a very cogent reaſon for his choice, viz. that the proportion of bulks varies by a change of temperature, becauſe the water and ſpirits follow different laws in their expanſion by heat.

This is a proper opportunity for taking notice of a miſtake which is very generally made in the concluſions drawn from experiments of this kind. Equal additions of the ſpirit or water produce a ſeries of ſpecific gravities, which decreaſe or increaſe by differences continually diminiſhing. Hence it is inferred that there is a contraction of bulk. Even Dr Lewis, one of our moſt accompliſhed

compliſhed naturaliſts, advances this poſition, in a diſſertation on the potaſh of America; and it conſiderably affects his method for eſtimating the ſtrength of the potaſh leys. But that it is a miſtake, appears plainly from this, that although we add for ever equal quantities of the ſpirits, we ſhall never produce a *mixture* which has as ſmall a ſpecific gravity as alcohol. Therefore the ſeries of ſucceſſive gravities muſt approximate to this without end, like the ordinates of a hyperbolic curve referred to its aſſymptote.

That this may appear in the moſt general terms, let w repreſent the weight of the conſtant quantity of water in the mixture, and let a be the weight of the ſmall addition of ſpirits. Alſo let w repreſent the bulk of this quantity of water, and b the bulk of the ſmall addition of alcohol. The weight of the mixture is $w+a$, and its bulk is $w+b$, and its ſpecific gravity is $\frac{w+a}{w+b}$. If we now add a ſecond equal quantity of ſpirits, the weight will be $w+2a$, and if the ſpirit retains its denſity unchanged, the bulk will be $w+2b$, and the ſpecific gravity is $\frac{w+2a}{w+2b}$: and after any number m of ſuch equal additions of ſpirits, the ſpecific gravity will be $\frac{w+ma}{w+mb}$. Divide the numerator of this fraction by its denominator, and the quotient or ſpecific gravity will be $1+\frac{m\times\overline{a-b}}{w+mb}$. This conſiſts of the conſtant part 1, and the variable part $\frac{m(a-b)}{w+mb}$. We need attend only to this part. If its denominator were conſtant, it is plain that the ſucceſſive ſpecific gravities would have equal differences, each being $=\frac{a-b}{w+mb}$, becauſe m increaſes by the continual addition of an unit, and $a-b$ is a conſtant quantity. But the denominator $w+mb$ continually increaſes, and therefore the value of the fraction $\frac{a-b}{w+mb}$ continually diminiſhes.

Therefore the gradual diminution of the increments or decrements of ſpecific gravity, by equal additions of one ingredient to a conſtant meaſure of the other, is not of itſelf an indication of a change of denſity of either of the ingredients; nor proves that in very diluted mixtures a greater proportion of one ingredient is abſorbed or lodged in the interſtices of the other, as is generally imagined. This muſt be aſcertained by comparing each ſpecific gravity with the gravity expreſſed by $1+\frac{w+m(a-b)}{w+mb}$.

This ſeries of ſpecific gravities reſembles ſuch a numerical ſeries as the following, 1; . . . . ; 1.56; 1.163; 1.+69; &c. the terms of which alſo conſiſt of the conſtant integer 1, and the decimal fractions 0.156; 0.163; 0.169; &c. The fraction $\frac{m(a-b)}{w+mb}$ expreſſes this decimal part. Call this d, or make $d=\frac{m(a-b)}{w+mb}$. This will give us $b=\frac{ma-wd}{m(1+d)}$. Now a is the weight of the added ingredient, and d is the variable part of the ſpecific gravity obſerved; and thus we learn whether b, the bulk of the added ingredient, ſuffers any change. We ſhall have occaſion by and by to reſume the conſideration of this queſtion, which is of the firſt moment in the theory of ſpecific gravities, and has great influence in many tranſactions of commerce.

This ſeries of ſpecific gravities is not ſo well fitted for commercial tranſactions. In theſe the uſual queſtion is, how many gallons of alcohol is there in a caſk, or ſome number of gallons of ſpirit? and it is more directly anſwered by means of a table, formed by mixing the ingredients in aliquant parts of one conſtant bulk. The following table, conſtructed from the experiments of Mr Briſſon of the academy of Paris, and publiſhed in the Memoirs for 1769, is therefore inſerted.

W.	A.	Denſity obſerved.	Denſity Computed.	Condenſation.	Bulk of 10,000 grains.
0	16	0.8371	0.8371		1.0000
1	15	0.8527	0.8473	63	0.9937
2	14	0.8674	0.8575	115	0.9885
3	13	0.8815	0.8677	157	0.9844
4	12	0.8947	0.8778	189	0.9811
5	11	0.9075	0.8880	214	0.9786
6	10	0.9199	0.8982	235	0.9765
7	9	0.9317	0.9084	251	0.9749
8	8	0.9427	0.9186	256	0.9744
9	7	0.9519	0.9287	243	0.9757
10	6	0.9598	0.9389	217	0.9783
11	5	0.9674	0.9491	189	0.9811
12	4	0.9733	0.9593	144	0.9856
13	3	0.9791	0.9695	99	0.9901
14	2	0.9852	0.9796	57	0.9943
15	1	0.9919	0.9898	21	0.9979
16	0	1.0000	1.0000		1.0000

In this table the whole quantity of ſpirituous liquor is always the ſame. The firſt column is the number of meaſures (gallons, pints, inches, &c.) of water in the mixture: and column 2d gives the meaſures of alcohol. Column 3d is the ſpecific gravity which was obſerved by Mr Briſſon. Column 4th is the ſpecific gravity which would have been obſerved if the ſpirits, or water, or both, had retained their ſpecific denſity unchanged. And the 5th column marks the augmentation of ſpecific gravity or denſity in parts of 10,000. A 6th column is added, ſhowing the bulk of the 16 cubic meaſures of the two ingredients. Each meaſure may be conceived as the 16th part of 10,000, or 625; and we may ſuppoſe them cubic inches, pints, gallons, or any ſolid meaſure.

This table ſcarcely differs from Sir Charles Blagden's; and the very ſmall difference that may be obſerved, ariſes from Mr Briſſon's having uſed an alcohol not ſo completely rectified. Its ſpecific gravity is 9.8371, whereas the other was only 0.8250.

Here it appears more diſtinctly that the condenſation is greateſt when the two ingredients are of equal bulk.

Perhaps this ſeries of ſpecific gravities is as declarative as the other, whether or not there is a change of denſity induced in either of the ingredients. The

whole

whole bulk being always the ſame, it is plain that the ſucceſſive equal additions to one of the ingredients is a ſucceſſive equal abſtraction of the other. The change produced, therefore, in the weight of the whole, is the difference between the weight of the ingredient which is taken out and the weight of the equal meaſure of the other which ſupplies its place. Therefore, if neither ingredient changes its denſity by mixture, the weights of the mixtures will be in arithmetical progreſſion. If they are not, there is a variation of denſity in one or both the ingredients.

We ſee this very clearly in the mixtures of water and alcohol. The firſt ſpecific gravity differs from the ſecond by 156, and the laſt differs from the preceding by no more than 81. Had neither of the denſities changed, the common difference would have been 102. We obſerve alſo, that the augmentation of ſpecific gravity, by the ſucceſſive addition of a meaſure of water, grows leſs and leſs till 12 meaſures of water is mixed with 4 of alcohol, when the augmentation is only 58, and then it increaſes again to 81.

It alſo appears, that the addition of one meaſure of water to a quantity of alcohol produces a greater change of denſity than the mixture of one meaſure of alcohol to a quantity of water. Hence ſome conclude, that the water diſappears by being lodged in the interſtices of the ſpirit. But it is more agreeable to the juſteſt notions which we can form of the internal conſtitution of tangible bodies, to ſuppoſe that the particles of water diminiſh the diſtances between the particles of alcohol by their ſtrong attractions, and that this diminution (excedingly minute in itſelf) becomes ſenſible on account of the great number of particles whoſe diſtances are thus diminiſhed. This is merely a probability founded on this, that it would require a much greater diminution of diſtances if it was the particles of water which had their diſtances thus diminiſhed. But the greater probability is, that the condenſation takes place in both.

We have been ſo particular in our conſideration of this mixture, becauſe the law of variation of denſity has, in this inſtance, been aſcertained with ſuch preciſion by the elaborate examination of Sir Charles Blagden, ſo that it may ſerve as an example of what happens in almoſt every mixture of bodies. It merits a ſtill farther diſcuſſion, becauſe it is intimately connected with the action of the corpuſcular forces; and an exact knowledge of the variations of diſtance between the particles will go far to aſcertain the law of action of theſe forces. But the limits of a work like this will not permit us to dwell longer on this ſubject. We proceed therefore to give another uſeful table.

The vitriolic or ſulphuric acid is of extenſive uſe in manufactures under the name of oil of vitriol. Its value depends entirely on the ſaline ingredient, and the water is merely a vehicle for the acid. This, being much denſer than water, affects its ſpecific gravity, and thus gives us a method of aſcertaining its ſtrength.

The ſtrongeſt oil of vitriol that can be eaſily manufactured contains $612\frac{1}{20}$ grains of dry acid, united with $387\frac{1}{20}$ grains of water, which cannot be ſeparated from it by diſtillation, making 1000 grains of OIL OF VITRIOL. Its ſpecific gravity in this ſtate is 1.877.

The following table ſhows its ſpecific gravity at the temperature of 55° when diluted by the ſucceſſive addition of parts of water by weight.

			Specific Gravity.		
Ol. Vit.		Water.	Obſerved.	Calculated.	Cond.
10	×	0	1.877	1.877	.00
		4	1.644	1.501	.143
		8	1.474	1.350	.124
		12	1.381	1.269	.112
		16	1.320	1.219	.101
		20	1.274	1.184	.090
		24	1.243	1.159	.084
		28	1.211	1.140	.071
		32	1.195	1.125	.070
		36	1.183	1.113	.070
		40	1.172	1.103	.070
		50	1.148	1.084	.064
		60	1.128	1.069	.059

Here is obſerved a much greater condenſation than in the mixture of alcohol and water. But we cannot aſſign the proportion of ingredients which produces the greateſt condenſation; becauſe we cannot, in any caſe, ſay what is the proportion of the ſaline and watery ingredients. The ſtrongeſt oil of vitriol is already a watery ſolution; and it is by a conſiderable and uncertain detour that Mr Kirwan has aſſigned the proportion of 612 and 388 nearly. If this be the true ratio, it is unlike every other ſolution that we are acquainted with; for in all ſolutions of ſalts, the ſalt occupies leſs room in its liquid form than it did when ſolid; and here it would be greatly the reverſe.

This ſolution is remarkable alſo for the copious emergence of heat in its dilutions with more water. This has been aſcribed to the great ſuperiority of water in its capacity of heat; but there are facts which render this very doubtful. A veſſel of water, and another of oil of vitriol, being brought from a cold room into a warm one, they both imbibe heat, and riſe in their temperature; and the water employs nearly the ſame time to attain the temperature of the room.

Aquafortis or nitrous acid is another fluid very much employed in commerce; ſo that it is of importance to aſcertain the relation between its ſaline ſtrength and its ſpecific gravity. We owe alſo to Mr Kirwan a table for this purpoſe.

The moſt concentrated ſtate into which it can eaſily be brought is ſuch, that 1000 grains of it conſiſts of 563 grains of water and 437 of dry acid. In this ſtate its ſpecific gravity is 1.557. Let this be called *nitrous acid*.

Nitr. Ac.		Water.			
10	×	0	1.557	1.557	
		1	1.474	1.474	
		6	1.350	1.273	0.077
		11	1.269	1.191	0.078
		16	1.214	1.147	0.067
		21	1.175	1.120	0.055
		26	1.151	1.101	0.050
		31	1.127	1.087	0.040
		36	1.106	1.077	0.029
		41	1.086	1.068	0.018

There is not the ſame uniformity in the denſities of this acid in its different ſtates of dilution. This ſeems

owing

owing to the variable proportion of the deleterious and vital air which compoſe this acid. It is more denſe in proportion as it contains more of the latter ingredient.

The proportions of the aeriform ingredients of the muriatic acid are ſo very variable, and ſo little under our command, that we cannot frame tables of its ſpecific gravity which would enable us to judge of its ſtrength.

It is a general property of theſe acids, that they are more expanſible by heat as they are more concentrated.

There is another claſs of fluids which it would be of great conſequence to reduce to ſome rules with reſpect to ſpecific gravity, namely, the ſolutions of ſalts, gums, and reſins. It is intereſting to the philoſopher to know in what manner ſalts are contained in theſe watery ſolutions, and to diſcover the relation between their ſtrength and denſity; and to the man of buſineſs it would be a moſt deſirable thing to have a criterion of the quantity of ſalt in any brine, or of extractable matter in a decoction. It would be equally deſirable to thoſe who are to purchaſe them as to thoſe who manufacture or employ them. Perhaps we might aſcertain in this way the value of ſugar, depending on the quantity of ſweetening matter which it contains; a thing which at preſent reſts on the vague determination of the eye or palate. It would therefore be doing a great ſervice to the public, if ſome intelligent perſon would undertake a train of experiments with this view. Accuracy alone is required; and it may be left to the philoſophers to compare the facts, and draw the conſequences reſpecting the internal arrangement of the particles.

One circumſtance in the ſolution of ſalts is very general; and we are inclined, for ſerious reaſons, to think it univerſal: this is a diminution of bulk. This indeed in ſome ſalts is inconſiderable. Sedative ſalt, for inſtance, hardly ſhows any diminution, and might be conſidered as an exception, were it not the ſingle inſtance. This circumſtance, and ſome conſiderations connected with our notions of this kind of ſolution, diſpoſe us to think that this ſalt differs in contraction from others only in degree, and that there is ſome, though it was not ſenſible, in the experiments hitherto made.

Theſe experiments, indeed, have not been numerous. Thoſe of Mr Achard of Berlin, and of Dr Richard Watſon of Cambridge, are perhaps the only ones of which we have a deſcriptive narration, by which we can judge of the validity of the inferences drawn from them. The ſubject is not ſuſceptible of much accuracy; for ſalts in their ſolid form are ſeldom free from cavities and ſhivery interſtices, which do not admit the water on their firſt immerſion, and thereby appear of greater bulk when we attempt to meaſure their ſpecific gravity by weighing them in fluids which do not diſſolve them, ſuch as ſpirits of turpentine. They alſo attach to themſelves, with conſiderable tenacity, a quantity of atmoſpheric air, which merely adheres, but makes no part of their compoſition. This eſcapes in the act of ſolution, being ſet at liberty by the ſtronger affinity of the water. Sal gem, however, and a few others, may be very accurately meaſured; and in theſe inſtances the degree of contraction is very conſtant.

The following experiments of Dr Watſon appear to us the moſt inſtructive as to this circumſtance. A glaſs veſſel was uſed, having a ſlender cylindrical neck, and holding 67 ounces of pure water when filled to a certain mark. The neck above this mark had a ſcale of equal parts paſted on it. It was filled to the mark with water. Twenty-four pennyweights of ſalt were thrown into it as ſpeedily as poſſible, and the bulk of the ſalt was meaſured by the elevation of the water. Every thing was attended to which could retard the immediate ſolution, that the error ariſing from the ſolution of the firſt particles, before the reſt could be put in, might be as ſmall as poſſible; and in order that both the abſolute bulk and its variations might be obtained by ſome known ſcale, 24 pennyweights of water were put in. This raiſed the ſurface 58 parts of the ſcale. Now we know exactly the bulk of 24 pennyweights of pure water. It is 2.275 cubic inches; and thus we obtain every thing in abſolute meaſures: And by comparing the bulk of each ſalt, both at its firſt immerſion and after its complete ſolution, we obtain its ſpecific gravity, and the change made on it in paſſing from a ſolid to a fluid form. The following table is an abſtract of theſe experiments. The firſt column of numbers is the elevation of the ſurface immediately after immerſion; the ſecond gives the elevation when the ſalt is completely diſſolved; and the third and fourth columns are the ſpecific gravities of the ſalts in theſe two ſtates.

Twenty-four Pennyweights.	I.	II.	III.	IV.
Water - -	58			
Glauber's ſalt -	42	36	1.380	1.611
Mild volatile alkali -	40	33	1.450	1.787
Sale ammoniac -	40	39	1.450	1.487
Refined white ſugar -	39	36	1.487	1.611
Coarſe brown ſugar -	39	36	1.487	1.611
White ſugarcandy -	37	36	1.567	1.611
Lymington Glauber's ſalt	35	29	1.657	2.000
Terra foliata tartari -	37	30	1.567	1.933
Rochelle ſalt -	33	28	1.757	2.071
Alum not quite diſſolved	33	28	1.757	2.061
Borax not one half diſſolved in two days -	33	31	1.757	
Green vitriol -	32	26	1.812	2.230
White vitriol -	30	24	1.933	2.416
Nitre - - -	30	21	1.933	2.766
Sal gem from Northwich	27	17	2.143	3.411
Blue vitriol - -	26	20	2.230	2.900
Pearl aſhes - -	25	10	2.320	5.800
Tart. vitriolatus -	22	11	2.636	5.272
Green vitriol calcined to white - - -	22	11	2.636	5.272
Dry ſalt of tartar -	21	13	2.761	4.461
Baſket ſea-ſalt - -	19	15	3.052	3.866
Corroſive ſublimate -	14	10	4.142	3.800
Turbith mineral - -	9	0	6.444	

The inſpection of this liſt naturally ſuggeſts two ſtates of the caſe as particularly intereſting to the philoſopher ſtudying the theory of ſolution. The firſt ſtate is when the lixivium approaches to ſaturation. In the very point of ſaturation any addition of ſalt retains its bulk unchanged. In diluted brines, we ſhall ſee that the denſity

ſity of the fluid ſalt is greater, and gradually diminiſhes as we add more ſalt. It is an important queſtion, Whether this diminution goes on continually, till the fluid denſity of the ſalt is the ſame with its ſolid denſity? or, Whether there is an abrupt paſſage from ſome degree of the one to the fixed degree of the other, as we obſerve in the freezing of iron, the ſetting of ſtucco, and ſome other inſtances?

The other intereſting ſtate is that of extreme dilution, when the differences between the ſucceſſive denſities bear a great proportion to the denſities themſelves, and thus enable the mathematician to aſcertain with ſome preciſion the variations of corpuſcular force, in conſequence of a variation of diſtance between the particles. The ſketch of an inveſtigation of this important queſtion given by Boſcovich in his Theory of Natural Philoſophy, is very promiſing, and ſhould incite the philoſophical chemiſt to the ſtudy. The firſt thing to be done is to compare the law of ſpecific gravity; that is, the relation between the ſpecific gravity and quantity of ſalt held in ſolution.

Wiſhing to make this work as uſeful as poſſible, we have ſearched for experiments, and trains of experiments, on the denſity of the many brines which make important articles of commerce; but we were mortified by the ſcantineſs of the information, and diſappointed in our hopes of being able to combine the detached obſervations, ſuited to the immediate views of their authors, in ſuch a manner as to deduce from them ſcales (as they may be called) of their ſtrength. We rarely found theſe detached obſervations attended with circumſtances which would connect them with others; and there was frequently ſuch a diſcrepancy, nay oppoſition, in ſerieſes of experiments made for aſcertaining the relation between the denſity and the ſtrength, that we could not obtain general principles which enable us to conſtruct tables of ſtrength *à priori*.

Mr Lambert, one of the firſt mathematicians and philoſophers of Europe, in a diſſertation in the Berlin Memoirs (1762), gives a narration of experiments on the brines of common ſalt, from which he deduces a very great condenſation, which he attributes to an abſorption in the weak brines of the ſalt, or a lodgement of its particles in the interſtices of the particles of water. Mr Achard of the ſame academy, in 1785, gives a very great liſt of experiments on the bulks of various brines, made in a different way, which ſhow no ſuch introſuſception; and Dr Watſon thinks this confirmed by experiments which he narrates in his Chemical Eſſays. We ſee great reaſon for heſitating our aſſent to either ſide, and do not think the experiments deciſive. We incline to Mr Lambert's opinion; for this reaſon, that in the ſucceſſive dilutions of oil of vitriol and aquafortis there is a moſt evident and remarkable condenſation. Now what are theſe but brines, of which we have not been able to get the ſaline ingredient in a ſeparate form? The experiments of Mr Achard and Dr Watſon were made in ſuch a way that a ſingle grain in the meaſurement bore too great a proportion to the whole change of ſpecific gravity. At the ſame time, ſome of Dr Watſon's are ſo ſimple in their nature that it is very difficult to withhold the aſſent.

In this ſtate of uncertainty, in a ſubject which ſeems to us to be of a public importance, we thought it our duty to undertake a train of experiments to which recourſe may always be had. Works like this are ſeldom conſidered as ſources of original information; and it is thought ſufficient when the knowledge already diffuſed is judiciouſly compiled. But a due reſpect for the public, and gratitude for the very honourable reception hitherto given to our labours, induce us to exert ourſelves with honeſt zeal to merit the continuance of public favour. We aſſure our readers that the experiments were made with care, and on quantities ſufficiently large to make the unavoidable irregularities in ſuch caſes quite inſignificant. The law of denſity was aſcertained in each ſubſtance in two ways. We diſſolved different portions of ſalt in the ſame quantity of water, and examined the ſpecific gravity of the brine by weighing it in a veſſel with a narrow neck. The portions of ſalt were each of them one eighth of what would make a nearly ſaturated ſolution of the temperature 55. We did not make the brine ſtronger, that there might be no riſk of a precipitation in form of cryſtals. We conſidered the ſpecific gravities as the ordinates of a curve, of which the abſciſſæ were the numbers of ounces of dry ſalt contained in a cubic foot of the brine. Having thus obtained eight ordinates correſponding to 1, 2, 3, 4, 5, 6, 7, and 8 portions of ſalt, the ordinates or ſpecific gravities for every other proportion of ſalt were had by the uſual methods of interpoſition.

The other method was, by firſt making a brine nearly ſaturated, in which the proportion of ſalt and water was exactly determined. We then took out one-eighth of the brine, and filled up the veſſel with water, taking care that the mixture ſhould be complete; for which purpoſe, beſides agitation, the diluted brine was allowed to remain 24 hours before weighing. Taking out one-eighth of the brine alſo takes out one-eighth of the ſalt; ſo that the proportion of ſalt and water in the diluted brine was known. It was now weighed, and thus we determined the ſpecific gravity for a new proportion of ſalt and water.

We then took out one-ſeventh of the brine. It is evident that this takes out one-eighth of the original quantity of ſalt; an abſtraction equal to the former. We filled the veſſel with water with the ſame precautions; and in the ſame manner we proceeded till there remained only one-eighth of the original quantity of ſalt.

The ſpecific gravities by theſe two methods agreed extremely well. In the very deliqueſcent ſalts the firſt method exhibited ſome ſmall irregularities, ariſing from the unequal quantities of water which they had imbibed from the atmoſphere. We therefore confided moſt in the experiments made with diluted brines.

That the reader may judge of the authority of the tables which we ſhall inſert, we ſubmit to his inſpection one ſeries of experiments.

Two thouſand one hundred and eighty-eight grains of very pure and dry (but not decrepitated) common ſalt, prepared in large cryſtals, were diſſolved in 6562 grains of diſtilled water of the temperature 55°. A ſmall matraſs with a narrow neck, which held 4200 grains of diſtilled water, was filled with this brine. Its contents weighed 5027 grains. Now $6562+2188 : 2188 = 5027 : 1256.75$. Therefore the bottle of brine contained 1256.75 grains of ſalt diſſolved in 3770.25 grains of water. Its ſpecific gravity is $= \frac{5027}{4200}$, or 1.196905; and a cubic foot of brine weighs

1196.9 ounces avoirdupois. Alſo 5027 : 1256.75 = 1196.9 : 299.28. Therefore a cubic foot of this brine contains 299.28 ounces of perfectly dry ſalt.

The ſubſequent ſteps of the proceſs are repreſented as follows.

Salt.	Brine.	Water.	Wt. of Cub. Ft.	Salt in Cub. Ft.
8)1256.75 157.1	8)5027 628.4	3770.25 $=\frac{1}{8}$ of brine.	1196.9	299.28 37.41$\frac{1}{8}$
	4398.6 527.4	Remains. Water to fill it again.		
7)1099.6 157.1	7)4926.0 703.7	2d Brine. $\frac{1}{7}$ taken out.	1172.7	261.87 37.41
	4222.3 604.7	Water added		
942.5 157.1	6)4827.0 804.5	3d Brine. Taken out.	1149.3	224.46
	4022.5 706.5	Remains. Water added		
785.4 157.1	5)4729.0 946	4th Brine. Taken out.	1125.9	187.05
	3783 847	Remains. Water added		
628.3 157.1	4)4630 1157.5	5th Brine. Taken out.	1102.3	149.64
	3472.5 1054.5	Remains. Water added		
471.2 157.1	3)4527 1509	6th Brine. Taken out.	1077.9	112.23
	3018 1405	Remains. Water added		
314.1 157.1	2)4423 2212	7th Brine. Taken out.	1053.3	74.82
	2211 2102	Remains. Water added		
157.0	4313	8th Brine.	1027.9	37.41

Thus, by repeated abſtraction of brine, ſo as always to take out $\frac{1}{8}$th of the ſalt contained in one conſtant bulk, we have obtained a brine conſiſting of 157 grains of ſalt united with 4313—157, or 4156 grains of water. Its ſpecific gravity is $\frac{4313}{4200}$, =1,0279, and a cubic foot of it weighs 1028 ounces, and contains $37\frac{4}{10}$ ounces of dry ſalt. In like manner may the ſpecific gravity, the weight of a cubic foot, and the ſalt it contains, be eſtimated for the intermediate brines.

When theſe eight quantities of ſalt contained in a cubic foot are made the abſciſſæ, and the weights of the cubic foot of brine are the correſponding ordinates, the curve will be found to be extremely regular, reſembling a hyperbolic arch whoſe aſſymptote makes an angle of 30° with the axis. Ordinates were then interpolated analytically for every 10 ounces of contained ſalt, and thus the table was conſtructed. We did not, however, reſt it on one ſeries alone; but made others, in which one-fourth of the ſalt was repeatedly abſtracted. They agreed, in the caſe of common ſalt, with great exactneſs, and in ſome others there were ſome very inconſiderable irregularities.

To ſhow the authority of the tables of ſtrength was by no means our only motive for giving an example of the proceſs. It may be of uſe as a pattern for ſimilar experiments. But, beſides, it is very inſtructive. We ſee, in the firſt place, that there is a very ſenſible change of denſity in one or both of the ingredients. For the ſeries is of that nature (as we have formerly explained), that if the ingredients retained their denſities in every proportion of commixture, the ſpecific gravities would have been in arithmetical progreſſion; whereas we ſee that their differences continually diminiſh as the brines grow more denſe. We can form ſome notion of this by comparing the different brines. Thus in the firſt brine, weighing 5027 grains, there are 3770 grains of water in a veſſel holding 4200. If the denſity of the water remains the ſame, there is left for the ſalt only as much ſpace as would hold 430 grains of water. In this ſpace are lodged 1257 grains of ſalt, and its ſpecific gravity, in its liquid form, is $\frac{1257}{430}$, = 2.8907 very nearly. But in the 8th brine the quantity of water is 4156, the ſpace left for 157 grains of ſalt is only the bulk of 44 grains of water, and the denſity of the ſalt is $\frac{157}{44}$ = 3.568, conſiderably greater than before. This induced us to continue the dilution of the brine as follows, beginning with the 8th brine.

157	2)4313	8th brine
78.5	2156.5	
	2156.5	
	2105.5	
78.5	2)4262.0	9th brine
39.7	2131	
	2102	
39.7	2)4233	10th brine
	2116.5	
	2116.5	
	2102	
19.8	4218	11th brine.

This laſt brine contains 4198.2 grains of water, leaving only the bulk of 1.8 grains of water to contain 19.8 of ſalt, ſo that the ſalt is ten times denſer than water. This will make the ſtrength 243 inſtead of 210 indicated by the ſpecific gravity. But we do not pretend to meaſure the denſities with accuracy in theſe diluted brines. It is evident from the proceſs that a

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ſingle grain of exceſs or defect in taking out the brine and replacing it with water has a ſenſible proportion to the whole variation. But we ſee with ſufficient evidence, that from the ſtrong to the weak brines the ſpace left for the portion of ſalt is continually diminiſhing. In the firſt dilution 527½ grains of water were added to fill up the veſſel; but one-eighth of its contents of pure water is only 525: ſo that here is a diminution of two grains and a half in the ſpace occupied by the remaining ſalt. The ſubſequent additions are 604.7; 706.5; 847; 1054.5; 1405; 2102; 2105.5; 2102; 2102; inſtead of 600; 700; 840; 1050; 1400; 2100; 2100; 2100; 2100. Nothing can more plainly ſhow the condenſation in general, though we do not learn whether it happens in one or both of the ingredients; nor do the experiments ſhow with ſufficient accuracy the progreſſion of this diminution. The exceſſes of the added water being only ſix or ſeven grains, we cannot expect a nice repartition. When the brine is taken out, the upper part of the veſſel remains lined with a briny film containing a portion of ſalt and water, perhaps equal or ſuperior to the differences. Had our time permitted, we ſhould have examined this matter with ſerupulous attention, uſing a veſſel with a ſtill narrower neck, and in each dilution abſtracting one half of the brine. The curve, whoſe abſciſſæ and ordinates repreſent the weight of the contained ſalt and the weight of a conſtant bulk of the brine, exhibits the beſt and moſt ſynoptical view of the law of condenſation, becauſe the poſition of the tangent in any point, or the value of the ſymbol $\frac{\dot{x}}{\dot{y}}$, always ſhows the rate at which the ſpecific gravity increaſes or diminiſhes. We are inclined to think that the curve in all caſes is of the hyperbolic kind, and complete; that is, having the tangent perpendicular to the axis at the beginning of the curve. The mathematical reader will eaſily gueſs the phyſical notions which incline us to this opinion; and will alſo ſee that it is hardly poſſible to diſcover this experimentally, becauſe the miſtake of a ſingle grain in the very ſmall ordinates will change the poſition of the tangent many degrees. It was for this reaſon that we thought it uſeleſs to proſecute the dilution any farther. But we think that it may be proſecuted much farther in Dr Watſon's or Mr Achard's method, viz. by diſſolving equal weights of ſalt in two veſſels, of very different capacities, having tubular necks, in which the change of bulk may be very accurately obſerved. We can only conclude, that the condenſation is greateſt in the ſtrongeſt brines, and probably attains its maximum when the quantities of true ſaline matter and water are nearly equal, as in the caſe of vitriolic acid, &c.

We conſider theſe experiments as abundantly ſufficient for deciding the queſtion, "Whether the ſalt can be received into the pores of the water, or the water into the pores of the ſalt, ſo as to increaſe its weight without increaſing its bulk? and we muſt grant that it may. We do not mean that it is ſimply lodged in the pores as ſand is lodged in the interſtices of ſmall ſhot; but the two together occupy leſs room than when ſeparate. The experiments of Mr Achard were inſufficient for a deciſion, becauſe made on ſo ſmall a quantity as 600 grains of water. Dr Watſon's experiments have, for the moſt part, the ſame defect. Some of them, however, are of great value in this queſtion, and are very fit for aſcertaining the ſpecific gravity of diſſolved ſalts. In one of them (not particularly narrated) he found that a quantity of diſſolved ſalt occupied the ſame bulk in two very different ſtates of dilution. We cannot pretend to reconcile this with our experiments. We have given theſe as they ſtood; and we think them concluſive, becauſe they were ſo numerous and ſo perfectly conſiſtent with each other; and their reſult is ſo general, that we have not found an exception. Common ſalt is by no means the moſt remarkable inſtance of condenſation. Vegetable alkali, ſal ammoniac, and ſome others, exhibit much condenſation.

We thought this a proper opportunity of conſidering this queſtion, which is intimately connected with the principles of chemical ſolution, and was not perhaps conſidered in ſufficient detail under the article CHEMISTRY. We learn from it in general, that the quantities of ſalt in brines increaſe at ſomewhat a greater rate than their ſpecific gravities. This difference is in many caſes of ſenſible importance in a commercial view. Thus an alkaline lixivium for the purpoſes of bleaching or ſoap-making, whoſe ſpecific gravity is 1.234, or exceeds that of water by 234, contains 361 ounces of ſalt in a cubic foot; a ley which exceeds the weight of water twice as much, or 468 ounces per cubic foot, contains 777 ounces of ſalt, which exceeds the double of 361 by 55 ounces more than ſeven per cent. Hence we learn, that hydrometers for diſcovering the ſtrength of brines, having equal diviſions on a cylindrical ſtem, are very erroneous; for even if the increments of ſpecific gravity were proportional to the quantities of ſalt in a gallon of brine, the diviſions at the bottom of the ſtem ought to be ſmaller than thoſe above.

The conſtruction of the following table of ſtrengths from the above narrated ſeries of brines is ſufficiently obvious. Column 1ſt is the ſpecific gravity as diſcovered by the balance or hydrometer, and alſo is the number of ounces in a cubic foot of the brine. Col. 2d is the ounces of the dry ſalt contained in it.

TABLE of Brines of Common Salt.

Weight Cub. Ft. Brine.	Salt in Cub.Ft.	Weight Cub. Ft. Brine.	Salt in Cub.Ft.
1.000	0	1.115	170
1.008	10	1.122	180
1.015	20	1.128	190
1.022	30	1.134	200
1.029	40	1.140	210
1.036	50	1.147	220
1.043	60	1.153	230
1.050	70	1.159	240
1.057	80	1.165	250
1.064	90	1.172	260
1.070	100	1.178	270
1.077	110	1.184	280
1.083	120	1.190	290
1.090	130	1.197	300
1.096	140	1.203	310
1.103	150	1.206	316
1.109	160	1.208	320

Specific Gravity.

The table differs conſiderably from Mr Lambert's. The quantities of ſalt correſponding to any ſpecific gravity are about $\frac{1}{18}$th leſs than in his table. But the reader will ſee that they correſpond with the ſeries of experiments above narrated; and theſe were but a few of many which all correſponded within an hundredth part. The cauſe of the difference ſeems to be, that moſt kinds of common ſalt contain magneſian ſalts, which contain a very great proportion of water neceſſary for their cryſtallization. The ſalt which we uſed was of the pureſt kind, but ſuch as may be had from every ſalt work, by Lord Dundonald's very eaſy proceſs, viz. by paſſing through it a ſaturated ſolution boiling hot, which carries off with it about four-fifths of all the bitter ſalts. Our aim being to aſcertain the quantities of pure ſea-ſalt, and to learn by the bye its relation to water in reſpect of denſity, we thought it neceſſary to uſe the pureſt ſalt. We alſo dried it for ſeveral days in a ſtove, ſo that it contained no water not abſolutely neceſſary for its cryſtallization. An ounce of ſuch ſalt will communicate a greater ſpecific gravity to water than an ounce of a ſalt that is leſs pure, or that contains extraneous water.

The ſpecific gravity 1.090 is that of ordinary pickles, which are eſtimated as to ſtrength by floating an egg.

We cannot raiſe the ſpecific gravity higher than 1.206 by ſimply diſſolving ſalt in cold water. But it will become much denſer, and will even attain the ſpecific gravity 1.240 by boiling, then holding about 366 ounces in the cubic foot of hot brine. But it will depoſit by cooling, and when of the temperature 55° or 60°, hardly exceeds 1.206. We obtained a brine by boiling till the ſalt grained very rapidly. When it cooled to 60°, its ſpecific gravity was 1.2063; for a veſſel which held 3506 grains of diſtilled water held 4229 of this brine. This was evaporated to dryneſs, and there were obtained 1344 grains of ſalt. By this was computed the number interpoſed between 310 and 320 in the table. We have, however, raiſed the ſpecific gravity to 1.217, by putting in no more ſalt than was neceſſary for this denſity, and uſing heat. It then cooled down to 60° without quitting any ſalt; but if a few grains of ſalt be thrown into this brine, it will quickly depoſit a great deal more, and its denſity will decreaſe to 1.206. We find this to hold in all ſalts; and it is a very inſtructive fact in the theory of cryſtallization; it reſembles the effect which a magnet produces upon iron filings in its neighbourhood. It makes them temporary magnets, and cauſes them to arrange themſelves as if they had been really made permanent magnets. Juſt ſo a cryſtal already formed diſpoſes the reſt to cryſtallize. We imagine that this analogy is complete, and that the forces are ſimilar in both caſes.

The above table is computed for the temperature 55°; but in other temperatures the ſtrength will be different on two accounts, viz. the expanſion of the brine and the diſſolving power of the water. Water expands about 40 parts in 1000 when heated from 60° to 212°. Saturated brine expands about 48 parts, or one-fifth more than water; and this exceſs of expanſion is nearly proportional to the quantity of ſalt in the brine. If therefore any circumſtance ſhould oblige us to examine a brine in a temperature much above 60°, allowance ſhould be made for this. Thus, ſhould the ſpecific gravity of brine of the temperature 130 (which is nearly half way between 60 and 212) be 1.140, we muſt increaſe it by 20 (half of 40); and having found the ſtrength 240 correſponding to this corrected ſpecific gravity, we muſt correct it again by adding 1 to the ſpecific gravity for every 45 ounces of ſalt.

But a much greater and more uncertain correction is neceſſary on account of the variation of the diſſolving power of water by heat. This indeed is very ſmall in the caſe of ſea-ſalt in compariſon with other ſalts. We preſume that our readers are appriſed of this peculiarity of ſea-ſalt, that it diſſolves nearly in equal quantities in hot or in cold water. But although water of the temperature 60 will not diſſolve more than 320 or 325 ounces of the pureſt and dryeſt ſea-ſalt, it will take up above 20 ounces more by boiling on it. When thus ſaturated to the utmoſt, and allowed to cool, it does not quit any of it till it is far cooled, viz. near to 60°. It then depoſits this redundant ſalt, and holds the reſt till it is juſt going to freeze, when it lets it go in the inſtant of freezing. If evaporated in the ſtate in which it continues to hold the ſalt, it will yield above 400 ounces per cubic foot of brine, in good cryſtals, but rather overcharged with water. And ſince in this ſtate the cubic foot of brine weighs about 1220 ounces, it follows, that 820 ounces of water will, by boiling, diſſolve 400 of cryſtallized ſalt.

The table ſhows how much any brine muſt be boiled down in order to grain. Having obſerved its ſpecific gravity, find in the table the quantity of ſalt correſponding. Call this x. Then, ſince a boiling hot graining or ſaturated ſolution contains 340 ounces in the cubic foot of brine, ſay $340 : 1000 = x : \frac{1000}{340} x$. This is the bulk to which every cubic foot (valued at 1000) muſt be boiled down. Thus ſuppoſe the brine has the ſpecific gravity 1109. It holds 160 ounces per foot, and we muſt boil it down to $\frac{1000 \times 160}{340}$ or 471; that is, we muſt boil off $\frac{529}{1000}$ of every cubic foot or gallon.

Theſe remarks are of importance in the manufacture of common ſalt; they enable us to appretiate the value of ſalt ſprings, and to know how far it may be prudent to engage in the manufacture. For the doctrine of latent heat aſſures us, that in order to boil off a certain quantity of water, a certain quantity of heat is indiſpenſably neceſſary. After the moſt judicious application of this heat, the conſumption of fuel may be too expenſive.

The ſpecific gravity of ſea-water in theſe climates does not exceed 1.03, or the cubic foot weighs 1030 ounces, and it contains about 41 ounces of ſalt. The brine-pits in England are vaſtly richer; but in many parts of the world brines are boiled for ſalt which do not contain above 10 or 20 ounces in the cubic foot.

In buying ſalt by weight, it is of importance to know the degree of humidity. A ſalt will appear pretty dry (if free from magneſian ſalts) though moiſtened with one per cent. of water; and it is found that incipient humidity expoſes it much to farther deliqueſcence. A much ſmaller degree of humidity may be diſcovered by the ſpecific gravity of a brine made with a few ounces of the ſalt. And the inſpection of the table informs us, that

that the brine ſhould be weak; for the differences of ſpecific gravity go on diminiſhing in the ſtronger brines: 300 ounces of dry ſalt diſſolved in 897 ounces of water ſhould give the ſpecific gravity 1197. Suppoſe it be but 1190, the quantity of ſalt correſponding is only 290; but when mixed with 897 ounces of water, the weight is 1197, although the weight of the cubic foot is only 1190. There is therefore more than a cubic foot of the brine, and there is as much ſalt as will make more than a cubic foot of the weight 1190. There is $290 \times \frac{1197}{1190}$, or $291\frac{2}{3}$ ounces, and there is $8\frac{1}{3}$ ounces of water attached to the ſalt.

The various informations which we have pointed out as deducible from a knowledge of the ſpecific gravity of the brines of common ſalt, will ſerve to ſuggeſt ſeveral advantages of the knowledge of this circumſtance in other lixivia. We ſhall not therefore reſume them, but ſimply give another table or two of ſuch as are moſt intereſting. Of thoſe, alkaline leys are the chief, being of extenſive uſe in bleaching, ſoap-making, glaſs-making, &c.

We therefore made a very ſtrong ley of the pureſt vegetable alkali that is ever uſed in the manufactories, not thinking it neceſſary, or even proper, to take it in its ſtate of utmoſt purity, as obtained from cubic nitre and the like. We took ſalt of tartar from the apothecary, perfectly dry, of which 3983 grains were diſſolved in 3540 grains of diſtilled water; and after agitation for ſeveral days, and then ſtanding to depoſit ſediment, the clear ley was decanted. It was again agitated; becauſe, when of this ſtrength, it becomes, in a very ſhort time, rarer above and denſer at the bottom. A flaſk containing 4200 grains of water held 6165 of this ley when of the temperature 55°. Its ſpecific gravity was therefore 1.4678, and the 6165 grains of ley contained 3264 grains of ſalt. We examined its ſpecific gravity in different ſtates of dilution, till we came to a brine containing 51 grains of ſalt, and 4189 grains of water, and the contents of the flaſk weighed 4240 grains: its ſpecific gravity was therefore 1.0095. In this train of experiments the progreſſion was moſt regular and ſatisfactory; ſo that when we conſtructed the curve of ſpecific gravities geometrically, none of the points deviated from a moſt regular curve. It was conſiderably more incurvated near its commencement than the curve for ſea-ſalt, indicating a much greater condenſation in the diluted brines. We think that the following table, conſtructed in the ſame manner as that for common ſalt, may be depended on as very exact.

Weight of Cub. Foot oz.	Salt cont. oz.	Weight of Cub. Foot oz.	Salt cont oz.	Weight of Cub Foot oz	Salt cont. oz.	Weight of Cub. Foot oz.	Salt cont. oz.
1000	0	1174	260	1329	520	1471	780
1016	20	1187	280	1340	540	1482	800
1031	40	1200	300	1351	560	1493	820
1045	60	1212	320	1362	580	1504	840
1085	80	1224	340	1372	600	1515	860
1071	100	1236	360	1384	620	1526	880
1084	120	1248	380	1395	640	1537	900
1098	140	1259	400	1406	660	1547	920
1112	160	1270	420	1417	680	1557	940
1125	180	1281	440	1428	700	1567	960
1138	200	1293	460	1438	720	1577	980
1150	220	1305	480	1449	740	1586	1000
1162	240	1317	500	1460	760		

We ſee the ſame augmentation of the denſity of the ſalt in the diluted brines here as in the caſe of common ſalt. Thus a brine, of which the cubic foot weighs 1482 ounces, or which has the ſpecific gravity 1.482, contains 800 ounces of dry alkali and 682 of water. Therefore, if we ſuppoſe the denſity of the water unchanged, there remains the bulk of 318 ounces of water to receive 840 ounces of ſalt: its denſity is therefore $\frac{800}{318}$, $= 2.512$ nearly. But in the brine whoſe weight per foot is only 1016 there are 20 ounces of ſalt, and therefore 996 of water; and there is only four ounce-meaſures of water, that is, the bulk of four ounces of water, to receive 20 ounces of ſalt. Its ſpecific gravity therefore is $\frac{20}{4}$, $= 5$, almoſt twice as great as in the ſtrong brine. Accordingly Mr Achard is diſpoſed to admit the abſorption (as it is careleſsly termed) in the caſe of ſal tart. But it is a general (we think an univerſal) fact in the ſolution of ſalts. It muſt be carefully diſtinguiſhed from the firſt contraction of bulk which ſalts undergo in paſſing from a ſolid to a fluid form. The contraction now under conſideration is analogous to the contraction of oil of vitriol when diluted with water; for oil of vitriol muſt be conſidered as a very ſtrong brine which we cannot dephlegmate by diſtillation, and therefore cannot obtain the dry ſaline ingredient in a ſeparate form, ſo as to obſerve its ſolid denſity, and ſay how much it contracts in firſt becoming fluid. The way of conceiving the firſt contraction in the act of ſolution as a lodging of the particles of the one ingredient on the interſtices of the other, "*qu' ils ſe nichent, en augmentant le poids ſans affecter le volume de la ſaumure*," as Euler and Lambert expreſs themſelves, is impoſſible here, when both are fluids. Indeed it is but a ſlovenly way of thinking

Specific Gravity.

thinking in either caſe, and ſhould be avoided, becauſe inadvertent perſons are apt to uſe as a phyſical principle what is merely a mode of ſpeech.

We learn from the table, that a hydrometer with equidiſtant diviſions on a cylindrical or priſmatical ſtem is ſtill more erroneous than in the brines of common ſalt.

We learn from the experiments of Kirwan, Lavoiſier, and others, that dry ſalt of tartar contains about one-fourth of its weight of fixed air. In many applications of this ſalt to the purpoſes of manufacture, this ingredient is of no uſe. In ſome it is hurtful, and muſt be abſtracted by lime. Soap-maker's ley conſiſts of the pure alkaline ſalt diſſolved in water. It is therefore of importance to aſcertain its quantity by means of the ſpecific gravity of the brine. For this purpoſe we took a ley of ſal tart. whoſe ſpecific gravity was 1.20417, containing 314 ounces of mild alkali in a cubic foot of ley, and we rendered it nearly cauſtic by lime. The ſpecific gravity was then 1.1897. This is a very unexpected reſult. Nothing is employed with more ſucceſs than quicklime for dephlegmating any watery fluid. We ſhould rather have expected an increaſe of ſpecific gravity by the abſtraction of ſome of the water of the menſtruum, and perhaps the water of the cryſtallization, and the aerial part of the ſalt. But we muſt aſcribe this to the great denſity in which the fixed air exiſts in the mild alkali.

It is unneceſſary to give ſimilar tables for all the ſalts, unleſs we were writing a diſſertation on the theory of their ſolution. We ſhall only obſerve, that we examined with particular attention ſal ammoniac, becauſe Mr Achard, who denies what is called the abſorption of ſalts, finds himſelf obliged to allow ſomething like it in this ſalt. It does not, however, differ from thoſe of which we have given an account in detail in any other reſpect than this, that the changes of fluid denſity are much leſs than in others (inſtead of being greater, as Achard's experiments ſeem to indicate) in all brines of moderate ſtrength. But in the very weak brines there is indeed a remarkable difference; and if we have not committed an error in our examination, the addition of one part of ſal ammoniac to 64 of water occupies leſs room than the water alone. We think that we have met with this as an accidental remark by ſome author, whoſe work we do not recollect. But we do not chooſe to reſt ſo much on our form of the experiment in ſuch weak brines. The following mixtures will abundantly ſerve for conſtructing the table of its ſtrength: Sal ammoniac $= 960$ grains was diſſolved in 3506 grains of water, making a brine of 4466 grains. A phial which held 1600 grains water held 1698 of this brine. It contained $\frac{1698 \times 960}{4466}$, or 365 grains of ſalt. The ſpecific gravity was $\frac{1698}{1600}$, $=1.061$, and the cubic foot weighed 1061 ounces. It alſo contained $\frac{1061 \times 365}{1698}$, or 288 ounces of ſalt. By repeated abſtraction of brine, and replacing with water, we had the following ſeries:

Series.	Brine.	Sp. Gr.	Oz. Salt, in Cub. Ft.
Weight of brine, 1ſt,	1698	1.061	228
After taking out $\frac{1}{4}$, 2d,	1676	1.048	171
After taking out $\frac{1}{3}$, 3d,	1653	1.033	114
After taking out $\frac{1}{2}$, 4th,	1630	1.019	57
After taking out $\frac{1}{2}$, 5th,	1616	1.010	$28\frac{1}{2}$
$\frac{1}{2}$, 6th,	1610	1.0063	$14\frac{1}{4}$
$\frac{1}{2}$, 7th,	1605	1.0038	$7\frac{1}{8}$

Speci Gravi Spectac

This ſeries is extremely regular, and the progreſs of denſity may be confidently deduced from it.

From the whole of this diſquiſition on the relation between the ſpecific gravities of brines and the quantities of ſalt contained, we ſee in general that it may be gueſſed at, with a uſeful degree of preciſion, from the denſity or ſpecific gravity of ſaturated ſolutions. We therefore conclude with a liſt of the ſpecific gravities of ſeveral ſaturated ſolutions, made with great care by the biſhop of Landaff.—The temperature was 42°. The firſt numerical column is the denſity of ſaturated brine, and the next is the denſity of a brine conſiſting of 12 parts (by weight) of water and one of ſalt. From this may be inferred the quantity in the ſaturated ſolution, and from this again may be inferred the quantity correſponding to inferior denſities.

Borax,	1.910	
Cor. Sublim.	1.037	
Alum,	1.033	
Glaub. ſalt,	1.054	1.029
Common ſalt,	1.198	1.059
Sal. cath. amar.	1.232	1.039
Sal ammon.	1.072	1.026
Vol. alk. mite,	1.087	
Nitre,	1.095	1.050
Rochelle ſalt,	1.114	
Blue vitriol,	1.150	1.052
Green vitriol,	1.157	1.043
White vitriol,	1.386	1.045
Pearl aſh,	1.534	

SPECTACLES, in *Dioptrics*, a machine conſiſting of two lenſes ſet in ſilver, horn, &c. to aſſiſt the defects of the organ of ſight. Old people, and others who have flat eyes, uſe convex ſpectacles, which cauſe the rays of light to converge ſo as to meet upon the retina: whereas myopes, or ſhort-ſighted people, uſe concave lenſes for ſpectacles, which cauſe the rays to diverge, and prevent their meeting ere they reach the retina. See OPTICS.

Some caſes of a peculiar nature have been met with where the ſight receives no aſſiſtance from the uſe of either convex or concave glaſſes. To remedy this, the following method was contrived and ſucceſsfully adopted. A man about ſixty years of age having almoſt entirely loſt his ſight, could ſee nothing but a kind of thick miſt with little black ſpecks in it which ſeemed to float in the air. He could neither read, walk the ſtreets, nor diſtinguiſh his friends who were moſt familiar to him. In this deplorable ſituation he procured ſome ſpectacles with large rings; and having taken out the glaſſes,

glaſſes, he ſubſtituted for them a conic tube of black Spaniſh copper. Looking through the large end of the cone he could read the ſmalleſt print placed at its other extremity. Theſe tubes were of different lengths, and the openings at the end were alſo of different ſizes; the ſmaller the aperture the better could he diſtinguiſh the ſmalleſt letters; the larger the aperture the more words or lines it commanded; and conſequently the leſs occaſion was there for moving the head and the hand in reading. Sometimes he uſed one eye, ſometimes the other, alternately relieving each, for the rays of the two eyes could not unite upon the ſame object when thus ſeparated by two opaque tubes. The thinner theſe tubes, the leſs troubleſome are they. They muſt be totally blackened within ſo as to prevent all ſhining, and they ſhould be made to lengthen, or contract, and enlarge or reduce the aperture at pleaſure.

When he placed convex glaſſes in theſe tubes, the letters indeed appeared larger, but not ſo clear and diſtinct as through the empty tube: he alſo found the tubes more convenient when not fixed in the ſpectacle rings; for when they hung looſely they could be raiſed or lowered with the hand, and one or both might be uſed as occaſion required. It is almoſt needleſs to add, that the material of the tubes is of no importance, and that they may be made of iron or tin as well as of copper, provided the inſides of them be ſufficiently blackened *.

Ocular SPECTRA, images preſented to the eye after removing them from a bright object, or cloſing them. When any one has long and attentively looked at a bright object, as at the ſetting ſun, on cloſing his eyes, or removing them, an image, which reſembles in form the object he was attending to, continues ſome time to be viſible. This appearance in the eye we ſhall call the ocular ſpectrum of that object.

Ph Tranſ. 17

Theſe ocular ſpectra are of four kinds: 1ſt, Such as are owing to a leſs ſenſibility of a defined part of the retina, or ſpectra from defect of ſenſibility. 2d, Such as are owing to a greater ſenſibility of a defined part of the retina, or ſpectra from exceſs of ſenſibility. 3d, Such as reſemble their object in its colour as well as form; which may be termed direct ocular ſpectra. 4th, Such as are of a colour contrary to that of their object, which may be termed reverſe ocular ſpectra.

SPECTRE, an apparition, or ſomething ſuppoſed to be preternaturally viſible to human ſight, whether the ghoſts of dead men or beings ſuperior to man.

A belief that ſupernatural beings ſometimes make themſelves viſible, and that the dead ſometimes reviſit the living, has prevailed among moſt nations, eſpecially in the rudeſt ſtages of ſociety. It was common among the Jews, among the Greeks, and among the Romans, as we find from the Scriptures, and from the poems of Homer and Virgil. Celeſtial appearances were indeed ſo often exhibited to the Jews, that the origin of their belief is not difficult to be explained.—The Divine Being manifeſted himſelf to each of the patriarchs by ſome ſenſible ſign, generally by a flame of fire, as he did to Moſes. Under this ſemblance alſo did he appear to the Iſraelites during their abode in the deſert, and after they obtained a ſettlement in the land of Canaan. Nor did they believe that heavenly beings alone aſſumed a ſenſible appearance: They believed that deceaſed men alſo ſometimes reviſited this world. When Saul went to conſult the witch at Endor, he aſked her to bring up the perſon whom he ſhould name unto her: a proof that he conſidered his demand as eaſy to be performed, and therefore that he probably acted under the influence of popular opinion. The ſame opinion had been generally entertained at a much earlier period; for necromancy and witchcraft, the arts by which the dead were ſuppoſed to be raiſed, had been prohibited while the Iſraelites were in the wilderneſs, and yet untainted with the vices of the Canaanites. They muſt therefore have derived them from Egypt, the cradle of ſuperſtition, as well as of the arts and ſciences.

Among the Greeks and Romans the apparition of ſpectres was generally believed. On innumerable occaſions the gods are ſaid to have diſcovered themſelves to the eyes of mortals, to have held conferences, and to have interpoſed their aid. The ghoſts of the dead, too, are ſaid to have appeared. When Æneas, amidſt the diſtraction and confuſion of his mind in flying from the deſtruction of Troy, had loſt his wife by the way, he returned in ſearch of her. Her ſhade appeared to him (for ſhe herſelf had been ſlain) with the ſame aſpect as before, but her figure was larger. She endeavoured to aſſuage the grief of her unhappy huſband, by aſcribing her death to the appointment of the gods, and by foretelling the illuſtrious honours which yet awaited him. But when Æneas attempted to claſp her in his arms, the phantom immediately vaniſhed into air. From this ſtory we may obſerve, that the ancients believed that the umbræ or ſhades, retained nearly the ſame appearance after death as before; that they had ſo far the reſemblance of a body as to be viſible; that they could think and ſpeak as formerly, but could not be touched. This deſcription applies equally well to thoſe ſhades which had paſſed the river Styx, and taken up their reſidence in the infernal regions. Such were the ſhades of Dido, of Deiphobus, and all thoſe which Æneas met with in his journey through the ſubterraneous world.

It appears from the writings of modern travellers who have viſited rude and ſavage nations, that the belief of ſpectres is no leſs common among them. Mr Bruce tells us, that the prieſt of the Nile affirmed, that he had more than once ſeen the ſpirit of the river in the form of an old man with a white beard. Among the Mahometans the doctrine of ſpectres ſeems to be reduced to a regular ſyſtem, by the accounts which they give of genii. Whoever has read the Arabian Nights Entertainments muſt have furniſhed his memory with a thouſand inſtances of this kind. Their opinions concerning genii ſeem to be a corrupted mixture of the doctrines of the Jews and ancient Perſians. In Chriſtian countries, too, notwithſtanding the additional light which their religion has ſpread, and the great improvement in the ſciences to which it has been ſubſervient, the belief of ghoſts and apparitions is very general, eſpecially among the lower ranks. They believe that evil ſpirits ſometimes make their appearance in order to terrify wicked men, eſpecially thoſe who have committed murder.—They ſuppoſe that the ſpirits of dead men aſſume a corporeal appearance, hover about church-yards and the houſes of the deceaſed, or haunt the places where murders have been committed. (See Ghost). In ſome places it is believed that beings have been ſeen bearing a perfect reſemblance to men alive. In the Highlands of Scotland, what is called the ſecond ſight is ſtill believed

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* nthly M 1799.

lieved by many (ſee SECOND *Sight*); viz. that future events are foretold by certain individuals by means of ſpectral repreſentation.

So general has the belief of ſpectres been, that this circumſtance alone may be thought by ſome ſufficient to prove that it muſt have its foundation in human nature, or muſt reſt upon rational evidence. When any doctrine has been univerſally received by all nations, by generations living ſeveral thouſand years from one another, and by people in all the different ſtages of ſociety, there is certainly the ſtrongeſt preſumption to conclude that ſuch a doctrine has its foundation in reaſon and in truth. In this way we argue in favour of the exiſtence of a God, concerning moral diſtinction, and the doctrine of a future ſtate: and certainly ſo far we argue well. But if the ſame argument be applied to idolatry, to ſacrifices, or to apparitions, we ſhall find that it is applied improperly. Idolatry was very general among ancient nations; ſo was the offering of ſacrifices, ſo was polytheiſm: but they were by no means univerſal. Should we allow, for the ſake of ſhortening the argument, that all ancient nations were polytheiſts and idolaters, and preſented oblations to their imaginary deities, all that could be concluded from this conceſſion is, that they fell into theſe miſtakes from their ignorance and from the rude ſtate of ſociety, from which their imperfect knowledge of theology and moral philoſophy was never able to reſcue them. Theſe erroneous notions fled before the brightneſs of the Chriſtian ſyſtem; while the doctrines of the exiſtence of God, of moral diſtinction, and of a future ſtate, have been more thoroughly confirmed and aſcertained. The ſame thing may be ſaid of the belief of ſpectres. However generally it has been adopted in the firſt ſtages of ſociety, or by civilized nations who had made but little progreſs in the ſtudy of divine things, it has been rejected, we may ſay invariably, wherever theology and philoſophy have gone hand in hand.

As all popular and long eſtabliſhed opinions are objects of curioſity and reſearch for the philoſopher, we think the belief of ſpectres worthy of ſome attention even in this light. It will therefore, we hope, give ſome ſatisfaction to the philoſophical reader to ſee a ſhort account of the ſources or principles from which the belief is derived. But as the belief of ſpectres is connected with other opinions which appear to us highly injurious to religion; opinions which have been ſupported by many learned men, and which are ſtill believed by ſome men of literary education—it will alſo be proper, in the firſt place, to conſider the evidence on which this belief reſts, in which we muſt conſider both their probability and credibility.

In the preſent inveſtigation we mean to ſet aſide altogether the celeſtial appearances recorded in Scripture, as being founded on unqueſtionable evidence, and perfectly agreeable to thoſe rules by which the Deity acts in the uſual courſe of his Providence. The Iſraelites, during the exiſtence of their ſtate, were immediately under the authority of God, not only as the moral governor of the world, but as the king of Iſrael. In the infancy of the world, while men were rude and unenlightened, and entirely under the influence of idolatry, many revelations were neceſſary to preſerve in their minds pure ideas of the nature of God, and of the worſhip due to Him. They were neceſſary alſo to pave the way for that illuſtrious diſpenſation which the Lord Jeſus came from Heaven to diffuſe over the world. Every celeſtial appearance recorded in Scripture was exhibited for ſome wiſe and important purpoſe, which muſt be apparent to every perſon who conſiders theſe appearances with attention. But when the Scriptures were written and publiſhed, and the Chriſtian religion fully eſtabliſhed, revelation ceaſed, and miracles and heavenly meſſages were no longer requiſite. What credit then ought we to give to thoſe marvellous ſtories related in ancient authors concerning prodigies in the heavens, and the apparition of angels both good and bad.

It is not pretended that any of theſe prodigies and appearances were exhibited for purpoſes equally great and important with thoſe which are deſcribed in Scripture: And can we ſuppoſe that the all-wiſe Governor of the world would permit his angels to render themſelves viſible to the eye of man for no purpoſe at all, or for a purpoſe which might have been equally well accompliſhed without their interpoſition? Would this be conſiſtent with perfect wiſdom, or would it be conſiſtent even with the excellence and ſuperiority of underſtanding which we are taught to aſcribe to theſe elevated beings? The whole will of God is revealed to us in the Scriptures; what further uſe for the viſible interpoſition of angels? It may be objected, Are they not all miniſtering ſpirits, ſent forth to miniſter for them who ſhall be heirs of ſalvation*? We anſwer, That angels may animate and ſupport good men by an inviſible interpoſition. But the Apoſtle is not ſpeaking of celeſtial ſpirits. The word αγγελος ſignifies "a meſſenger;" and in Scripture often refers to men. In the paſſage which we are now reviewing it certainly is applied with much more propriety to men than to angels: for the Apoſtle is ſtating a compariſon between *the Prophets*, by whom God, at ſundry times and in divers manners, ſpake in time paſt to the fathers, and *the Son*, by whom he hath ſpoken in theſe laſt days.

And if God has given no commiſſion to his angels to deliver to men ſince the publication of the Chriſtian religion, is there any probability that he would give any commiſſion or any licence to evil ſpirits? It will be ſaid, that this doctrine is clearly taught in the New Teſtament, in theſe words, "The devil goeth about as a roaring lion ſeeking whom he may devour." We will not avail ourſelves of the interpretation of ſome, who ſay that the word *devil*, which in the Greek language ſignifies an *adverſary*, or *ſlanderer*, refers here to ſome human being, who was a violent enemy of the Chriſtians. All that can be deduced from theſe words, upon the ſuppoſition that they refer to a malignant ſpirit, is merely that he goeth about ſeducing men to vice. But it is not by aſſuming a hideous form, and preſenting himſelf to the midnight traveller, that ſuch a purpoſe is to be accompliſhed. A ſpirit may probably have direct acceſs to our minds without the intervention of any thing corporeal; and by exciting our paſſions may plunge us into vice, which is the only object ſuch a being is ſuppoſed to have in view. None of the marvellous ſtories which we have heard concerning the apparition of evil ſpirits lead us to conclude that they appear to entice men to commit crimes. We never heard of any evil ſpirits that required men to ſteal, to perpetrate robbery or murder. They only appeared to terrify ſome crazy timorous individuals, who have whims and fancies

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* Heb. 14.

enow of their own to agitate their minds, though no preternatural viſion ſhould ever appear to them. It is not conſiſtent, therefore, with the character of God, and what he has revealed to us of his will, to believe that he would commiſſion good angels, or permit evil angels, to appear to men ſince the propagation of the goſpel, or indeed at any former period of the world, unleſs ſome great and mighty purpoſe was to be fulfilled. It is not conſiſtent with what we know of the nature of good or bad angels to ſuppoſe, that though permiſſion were granted them occaſionally to ſhow themſelves to men, that they would appear in that way which ſtory-tellers deſcribe.

It is equally improbable that the ſpirits of the dead who have removed from this world ſhould again be permitted to viſit it. At death men undergo as great, perhaps a greater change, than when they came firſt into the light of the ſun. Is it not therefore as improbable that a man ſhould return in a viſible corporeal form after death, as that, after having arrived at manhood, he ſhould return to the ſtate in which he was before his birth? Such changes as theſe are evidently made permanent by the invariable laws of nature. But ſuppoſe it were poſſible, for what purpoſe ſhould they return? To deſcribe to us what is paſſing in the other world, to animate us to virtue, by informing us of the rewards which there await the good; or to alarm us, by deſcribing the puniſhment of the wicked. Theſe ſeem important reaſons. But Divine Providence has wiſely thrown a veil over futurity. We know every thing of the other world from the ſcripture which it is proper for us at preſent to know. And as to incentives to virtue, we are already bleſſed with a number ſufficiently great and powerful for moral beings, who are to act from rational motives, and not from compulſion. "He that will not hear Moſes and the prophets, will not be perſuaded though one roſe from the dead."

There is one ſtrong objection againſt the probability of ſpectres, which is ſufficient to prove that they are not intelligent creatures; or at leaſt that they poſſeſs ſo ſmall a degree of intelligence, that they are unqualified to act with prudence, to propoſe any end to themſelves, or uſe the proper means to accompliſh that end. Ghoſts often appear in order to diſcover ſome crime that has been committed: but they never appear to a magiſtrate, or perſon in authority, but to ſome illiterate clown, who happens to live near the place where the crime was perpetrated; to ſome perſon who has no connection with the affair at all, and who in general is the moſt improper in the world for making the diſcovery. For inſtance, in Glanville's *Saduciſmus triumphatus* (a book written in the laſt century by a chaplain of Charles II. in ſupport of the common opinions reſpecting witchcraft and apparitions), we have the following ſtory: James Haddock, a farmer, was married to Elenor Welſh, by whom he had a ſon. After the death of Haddock, his wife married one Davis; and both agreed to defraud the ſon by the former marriage of a leaſe bequeathed to him by his father. Upon this the ghoſt of Haddock appeared to one Francis Taverner the ſervant of Lord Chicheſter, and deſired him to go to Elenor Welſh, and to inform her that it was the will of her former huſband that their ſon ſhould enjoy the leaſe. Taverner did not at firſt execute this commiſſion; but he was continually haunted by the apparition in the moſt hideous ſhapes, which even threatened to tear him in pieces, till at laſt he delivered the meſſage. Now, had this ſpectre had the leaſt common ſenſe, it would have appeared firſt to Elenor Welſh and her huſband Davis, and frightened them into compliance at once, and not have kept poor Taverner in ſuch conſtant diſquietude, who had no concern in the matter.

Another very odd circumſtance reſpecting apparitions in general muſt not be omitted, which is, that they have no power to ſpeak till they are addreſſed. In the 27th of Glanville's Relations we read of an old woman that appeared often to David Hunter, a neat-herd, at the houſe of the biſhop of Down and Conners. Whenever ſhe appeared, he found himſelf obliged to follow her; and for three quarters of a year poor David ſpent the whole of almoſt every night in ſcampering up and down through the woods after this old woman. How long this extraordinary employment might have continued, it is impoſſible to gueſs, had not David's violent fatigue made him one night exclaim, "Lord bleſs me! would I were dead!—ſhall I never be delivered from this miſery!" On which the phantom replied, "Lord bleſs me too! It was happy you ſpoke firſt, for till then I had no power to ſpeak, though I have followed you ſo long." Then ſhe gave him a meſſage to her two ſons, though David told her he remembered nothing about her. David, it ſeems, neglected to deliver the meſſage; at which the old beldam was ſo much provoked, that ſhe returned and hit him a hearty blow on the ſhoulder, which made him cry out, and then ſpeak to her. Now if ſhe could not ſpeak till David addreſſed her, why might ſhe not have applied this oratorial medicine the firſt time ſhe appeared to him? It would have ſaved both herſelf and him many a weary journey; and certainly David would much rather have had even half a dozen of blows from her choppy fiſts than have wanted ſo many nights ſleep. To complete the ſtory, we muſt add, that when David's wife found it impoſſible to keep him from following the troubleſome viſitor, ſhe trudged after him, but never was gratified with a ſight of the enchantreſs. David's little dog too was a dutiful attendant on his maſter during his pilgrimage.

It is remarked by Glanville, that ghoſts are generally very eager to be gone. Indeed they are often ſo much ſo, that they do not ſtay to tell their errand. One would be induced from this, as well as the circumſtances already mentioned, to think that they are the ſtupideſt and dulleſt of the dead that aſſume the appearance of ghoſts; unleſs we adopt the ingenious ſolution of Glanville, "that it is a very hard and painful thing for them to force their thin and tenuious bodies into a viſible conſiſtence; that their bodies muſt needs be exceedingly compreſſed; and that therefore they muſt be in haſte to be delivered from the unnatural preſſure."

With reſpect to the *evidence* in favour of ſpectres, if examined ever ſo ſlightly, it will be found very defective. They only appear to one perſon at a time; they are ſeen only in the night; they are viſible only to ignorant, illiterate, and credulous perſons, and never preſent themſelves before men of education and learning.

That ſpectres only appear to one perſon at a time, even though there are more in company, is an objection againſt the credibility of their appearance quite inſurmountable. How is it poſſible that two men of eyeſight equally good, directing their eyes to the ſame ſpot, ſhould not ſee ſo large an object as that of a man or woman at a ſmall diſtance equally well? Some will tell us that a miſt is caſt over the eyes of the one, while the view of the other is free from obſtruction. But how is this to be proved? and beſides, what purpoſe would it ſerve? Ghoſts have ſeldom any ſecrets to diſcloſe; they might be proclaimed to a multitude with as much propriety as confined to one perſon. Shall we be told, that the ſpectre has the power of becoming viſible to ſome, and of remaining inviſible to others? This cannot be allowed without adopting opinions deſtructive to revealed religion; for it would be a miracle: and we cannot be perſuaded, without evidence, that God would empower any inferior being to controul at pleaſure the wiſe laws which he has ordained for governing the world. To him who is of a different opinion, we would recommend Farmer on Miracles; a book in which this queſtion is fully examined.

Spectres appear only in the night. But why ſhould they ſhun the light of the ſun? Thoſe miſchievous ghoſts that Glanville mentions might indeed have ſome reaſon to chooſe midnight for the execution of their pranks, as they would be more eaſily detected in open day. Such was the roguiſh drummer that haunted Mr Mompeſſon's houſe, who beat his drum all night, threw the old gentlewoman's clothes about the room, hid her Bible in the aſhes, plucked the clothes off the bed, and amuſed himſelf with toſſing about Mr Mompeſſon's ſhoes. But why ſhould a grave ſerious ghoſt appear at midnight? Might it not deliver its meſſage with as much eaſe and more ſucceſs in the day-time? In the day-time it would not excite much fear; it would be liſtened to therefore with more attention; and did it chooſe to exhibit itſelf before a number of witneſſes, its grievances would be more ſpeedily redreſſed, becauſe more perſons would intereſt themſelves in ſeeing juſtice done to the injured ghoſt.

Spectres not only chooſe the moſt improper time, but the moſt improper perſons. To render the teſtimony of any perſon credible, he muſt not only be a man of veracity, but he muſt have ſufficient ability to judge of the ſubject to which he is to bear witneſs. It is not on the evidence of an ignorant illiterate perſon, who has more fancy and fear than judgment, that we are to reſt our belief of what is ſupernatural. It is alſo worthy of remark, that we have never heard of a ghoſt appearing to any perſon who did not previouſly believe their exiſtence. A man muſt be prejudiced in favour of this opinion, or he will never ſee a ghoſt. But ſenſible men know, that he who has been accuſtomed to hear frightful ſtories of ghoſts and apparitions gliding through a churchyard, or haunting ſome particular place, can ſcarcely paſs through a churchyard, or haunted ſpot without conjuring up in his imagination the hideous phantoms which he has been accuſtomed to aſſociate with ſuch places. Is it ſtrange, then, that an ignorant man, with a mind uncultivated and uninformed, with all the prejudices of the nurſery about him, ſhould imagine he ſees ghoſts in thoſe places where he believes they hover, eſpecially in the dead hour of midnight, when, with the ſlighteſt aid of the imagination, a cow may be turned into a monſtrous phantom, and the reflection of the beams of the moon from a little water be converted into a ghoſt with a winding-ſheet? But why ſhould apparitions ſhun men of underſtanding and learning? Why ſhould learning be formidable to them (A)? It was not ſo with the celeſtial meſſengers mentioned in the Scriptures: they appeared to the patriarchs and prophets; and the miracles there recorded were performed in the moſt public places, before the eyes of Rabbies, of Scribes, and Phariſees. Indeed this circumſtance is ſufficient to deſtroy the evidence of ſpectres. They have never been ſeen by any but men of weak or diſtempered minds, or by men who have previouſly believed in them.

Having now conſidered the evidence on which the belief of ſpectres reſts, we will endeavour to give ſome account of the foundation of it. To trace an opinion that has prevailed ſo generally in the world to its ſource, is a labour not unworthy of the philoſopher, even though the opinion be falſe. It is always gratifying to detect the cauſes of error: it is no leſs uſeful; for in order to refute error, it is often ſufficient to point out the ſources from which it has ſprung. To reach the origin of the belief of ſpectres is not more difficult than to account for idolatry or polytheiſm. In the infant ſtate of the intellectual powers every thing is conſidered as poſſeſſing life and intelligence. The child beats the ſtool

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(A) The celebrated hiſtorian De Thou had a very ſingular adventure at Saumur, in the year 1598. One night, having retired to reſt very much fatigued, while he was enjoying a ſound ſleep, he felt a very extraordinary weight upon his feet, which having made him turn ſuddenly, fell down and awakened him. At firſt he imagined that it had been only a dream, but hearing ſoon after ſome noiſe in his chamber, he drew aſide the curtains, and ſaw, by help of the moon, which at that time ſhone very bright, a large white figure walking up and down, and at the ſame time obſerved upon a chair ſome rags, which he thought belonged to thieves who had come to rob him. The figure then approaching his bed, he had the courage to aſk it what it was. "I am (ſaid it) the Queen of Heaven." Had ſuch a figure appeared to any credulous ignorant man in the dead of night, and made ſuch a ſpeech, would he not have trembled with fear, and have frightened the whole neighbourhood with a marvellous deſcription of it? But De Thou had too much underſtanding to be ſo impoſed upon. Upon hearing the words which dropped from the figure, he immediately concluded that it was ſome mad woman, got up, called his ſervants, and ordered them to turn her out of doors; after which he returned to bed and fell aſleep. Next morning he found that he had not been deceived in his conjecture, and that having forgot to ſhut his door, this female figure had eſcaped from her keepers, and entered his apartment. The brave Schomberg, to whom De Thou related his adventure ſome days after, confeſſed that in ſuch a caſe he would not have ſhown ſo much courage. The king alſo, who was informed of it by Schomberg, made the ſame acknowledgement.

ſtool over which he has fallen with the ſame paſſion that he would treat his companion: The young girl talks to her doll as if it underſtood her: The ſavages aſcribe every change which they obſerve on the face of nature to the action of ſome animated being. As knowledge advances, they ſingle out thoſe beings which ſeem to produce the moſt ſtriking effects, arrange them into ſome kind of order, and divide the government of the world among them. Unable, at the ſame time, to conceive any notion of a pure ſpirit, they imagine thoſe divinities are corporeal beings. This is the foundation of idolatry. The belief of ſpectres is but another ſtep. That theſe animated corporeal beings, to whom they addreſs their prayers, and who preſide over the world, ſhould on particular occaſions diſplay themſelves to the human eye, is what they muſt be previouſly diſpoſed to expect. Hence the numberleſs appearances of the heathen gods, of the Perſian and Mahometan genii. The belief of ghoſts may be eaſily deduced from the opinions entertained reſpecting a future ſtate. Theſe opinions are founded on that eſſential doctrine of natural religion, that there is another world in which men ſhall exiſt when death has removed them hence. This doctrine has been univerſally received both by ſavage and civilized nations; but, as might be expected, men have formed very different ſentiments concerning the nature of a future ſtate, of the ſituation and employments of departed ſpirits, according to the degree of knowledge which they poſſeſſed. But the general opinion in ancient and rude nations was, that departed ſpirits retained the ſame external appearance, the ſame paſſions and principles as before. Nothing therefore was more natural than the opinion, that they might occaſionally reviſit this world, from an anxious deſire to alleviate the ſufferings of thoſe beloved friends and relations whom they had left behind them, or to communicate from the unſeen world what might be important to their welfare. Upon ſuch an errand did Creüſa appear to Æneas. The apparition of the ghoſts of murderers is eaſily explained upon the ſame general principles. The remorſe and horror of mind which the murderer feels are ſuppoſed to haunt him in the other world, and to render his ſituation there intolerable (eſpecially if the murder was never detected and puniſhed), till he return and give information againſt himſelf. In this way, then, we think it highly probable the belief of ſpectres has originated. But many other cauſes concur to confirm and propagate this belief. Theſe are, imperfect viſion united with fear, dreams, opium, diſeaſes, drunkenneſs, and opium.

1. Indiſtinct viſion is one ſource of apparitions, eſpecially when the mind is under the influence of fear. It is well known, that the ſenſe of ſeeing conveys no idea of diſtance till improved by experience and obſervation; and how we come at length to diſtinguiſh objects at a diſtance from thoſe that are near, has been explained in another place (ſee METAPHYSICS, N° 50.).

In the daytime we ſeldom commit miſtakes, becauſe we know the object at which we look; but at night, when we ſee objects obſcurely, and know not what they are, we have no diſtinct idea either of their diſtances or of their magnitude. We may miſtake a buſh that is near us for a tree at a diſtance; or if the imagination be under the influence of fear, it will eaſily convert it into a gigantic figure. "It is generally aſſerted (ſays Buffon) that theſe figures exiſt only in the imagination; yet they may have a real exiſtence in the eye; for whenever we have no other mode of judging of an unknown object but by the angle it forms in the eye, its magnitude will uniformly increaſe in proportion to its propinquity. If it appears, when at the diſtance of 20 or 30 paces, to be only a few feet high, its height, when within two or three feet of the eye, will be many fathoms. An object of this kind muſt naturally excite terror and aſtoniſhment in the ſpectator, till he approaches and recogniſes it by actual feeling; for the moment a man knows an object, the gigantic appearance it aſſumed in the eye inſtantly diminiſhes, and its apparent magnitude is reduced to its real dimenſions. But if, inſtead of approaching ſuch an object, the ſpectator flies from it, he can have no other idea of it but from the image which it formed in his eye; and, in this caſe, he may affirm with truth that he ſaw an object terrible in its aſpect, and enormous in its ſize. Thus the notions concerning ſpectres is founded in nature, and depend not, as ſome philoſophers aſſirm, upon the imagination alone."

In addition to theſe obſervations of Buffon, we may take notice, that objects are always magnified in a fog; ſo that when a fog happens in the night-time, objects may be magnified to an enormous ſize. But, at any rate, whether there be fog in the night or not, there is ſuch a great analogy between darkneſs and a fog, that if the latter deceive us with reſpect to the ſize of objects, the former will alſo deceive us. The writer of this article was paſſing the Frith of Forth at Queensferry, near Edinburgh, one morning which was extremely foggy. Though the water be only two miles broad, the boat did not get within ſight of the ſouthern ſhore till it approached very near it. He then ſaw to his great ſurpriſe a large perpendicular rock, where he knew the ſhore was low and almoſt flat. As the boat advanced a little nearer, the rock ſeemed to ſplit perpendicularly into portions, which ſeparated at a little diſtance from one another. He next ſaw theſe perpendicular diviſions move; and upon approaching a little nearer, found it was a number of people ſtanding on the beach, waiting the arrival of the ferry-boat.

2. Dreams are another fertile ſource of apparitions. It is well known to every perſon, that while the mind is under the influence of a dream it conſiders it as much a reality as it does any particular action while awake. Now if a perſon of a weak ſuperſtitious mind ſhould have a very lively dream, which intereſts his paſſions, particularly the paſſion of fear, it may make ſo deep an impreſſion, that he may be firmly convinced that he has actually ſeen with his eyes what has only paſſed before his imagination (ſee APPARITION) (B). We ſhall here tell a ſtory, by way of illuſtration, which we

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(B) When the thoughts are much troubled, and when a perſon ſleeps without the circumſtances of going to bed, or putting off his clothes, as when he nods in his chair, it is very difficult, as Hobbes remarks, to diſtinguiſh a dream from a reality. On the contrary, he that compoſes himſelf to ſleep, in caſe of any uncouth or abſurd fancy, eaſily ſuſpects it to have been a dream.—*Leviathan*, par. i. c. i.

Spectre.

have received on unqueſtionable authority. An Eaſt India captain had an honeſt faithful ſervant named *John*, for whom he had a great regard. John died, if we recollect right, on a voyage from England to the Eaſt Indies during a French war. As the ſhip approached the place of its deſtination the captain had a dream, in which John appeared to him, and earneſtly beſought him not to fail to the port for which he was bound, as it was in the hands of the French. The captain, though not addicted to ſuperſtition, thought it prudent to follow this admonition; and after landing at a different port, he was informed that the place to which he had intended to ſteer was, according to the information of the dream, captured by the French. On the voyage home, the captain had a ſecond dream, in which John again appeared to him, and gave him notice that he ſhould ſoon die, and that the ſhip ſhould be taken in the mouth of the Channel by the French. Next morning the captain called his firſt mate, told him his dream, which he believed was prophetic, and delivered his papers, that he might take proper care of them after his deceaſe. Every thing happened exactly as the dream had foretold; the captain died, and the veſſel was taken by a French man of war in the mouth of the Channel. This dream, wonderful as it appears, is eaſily explained. In the voyage out to India, nothing was more natural than that the captain ſhould ſometimes be thinking, that amidſt the various chances of war, the port to which he was bound might be taken; perhaps it was a place of conſequence, which the French might be eager to poſſeſs. The captain being accuſtomed to revolve theſe thoughts in the day-time, they would naturally return at night; the regret which he felt for the loſs of a faithful fervant might mingle with his apprehenſions, and thus produce the dream. Perhaps the advice was ſuch as John would have given had he been alive. It is equally eaſy to explain the cauſe of the dream in the paſſage home. The captain, we are told, was very ill, and thought himſelf dying, at the very time he had the ſecond dream, and therefore did not expect to reach England. This part of the dream, then, was only his own thoughts, delivered by his ſervant. As to the other part, that his ſhip ſhould be taken in the mouth of the Channel, it may be thought unaccountable how the very place ſhould be foreſeen. But we muſt recollect, that the mouth of the Channel, being over againſt the coaſt of France, was by far the moſt dangerous place in the whole paſſage; and that, therefore, the captain had more reaſon to be afraid of loſing his ſhip there than in any other place. The uſe which we mean to make of this ſtory is this: Had the captain been a man of a weak mind, he would certainly have conſidered the dream as a reality, and believed that, inſtead of having dreamed of the things on which his imagination had dwelt, he had actually ſeen his ſervant return from the dead, and heard him deliver the meſſage. But, on the other hand, the captain, though he believed the dream was prophetic, mentioned it without any ſigns of fear; and no man of courage and reflection ever ſees an apparition. This ſight is reſerved for the weak, the timid, and the ſuperſtitious. Of this many inſtances might be mentioned.

3. Spectres are alſo ſometimes occaſioned by opium. Gaſſendi the philoſopher found a number of people going to put a man to death for having intercourſe with the devil; a crime which the poor wretch readily acknowledged. Gaſſendi begged of the people that they would permit him firſt to examine the wizard before putting him to death. They did ſo; and Gaſſendi, upon examination, found that the man firmly believed himſelf guilty of this impoſſible crime. He even offered to Gaſſendi to introduce him to the devil. The philoſopher agreed; and when midnight came, the man gave him a pill, which he ſaid it was neceſſary to ſwallow before ſetting off. Gaſſendi took the pill, but gave it to his dog. The man having ſwallowed his, fell into a profound ſleep; during which he ſeemed much agitated by dreams. The dog was affected in a ſimilar manner. When the man awoke, he congratulated Gaſſendi on the favourable reception he had met with from his ſable highneſs. It was with difficulty Gaſſendi convinced him that the whole was a dream, the effect of ſoporific medicines, and that he had never ſtirred from one ſpot during the whole night.

4. That diſeaſes, eſpecially the night-mare, the hypochondria, hyſteric paſſion, and madneſs, are another ſource of ſpectres, we have the ſtrongeſt reaſon to affirm. Perſons ſubject to the night-mare often imagine that they ſee ſpectres. This is ſtill more the caſe with hypochondriac and hyſteric perſons, and thoſe who are in any degree deranged in their intellects. A fact which fell within the obſervation of the writer of this article will both prove and illuſtrate this aſſertion. In a village in one of the midland counties of Scotland, lived a widow diſtinguiſhed among her neighbours for decency of manners, integrity, and reſpect for religion. She affirmed, that for ſeveral nights together ſhe had heard a ſupernatural voice exclaiming aloud, *Murder! murder!* This was immediately reported through the neighbourhood; all were alarmed, and looked around them with ſolicitude for the detection of the murder which they ſuppoſed to have been committed; and it was not long till a diſcovery ſeemed actually to be made. It was reported, that a gentleman, who had relations at no great diſtance, and had been reſiding in the Weſt Indies, had lately arrived with a conſiderable fortune; that he had lodged in an inn about three miles off; and that he had afterwards been ſeen entering a houſe in the village where the widow lived, from which he had never returned. It was next affirmed, that a tradeſman paſſing the churchyard about twelve at midnight had ſeen four men carry a dead corpſe into that cemetery. Theſe three facts being joined together ſeemed perfectly to agree and to confirm one another, and all believed ſome horrible murder had been committed. The relations of the gentleman thought they were called upon to make inquiry into the truth of theſe allegations: they accordingly came firſt to the churchyard, where, in company with the ſexton, they examined all the graves with great care, in order to diſcover whether any of them had been lately dug, or had the appearance of containing more than one coffin. But this ſearch was to no purpoſe, for no alteration had been made upon the graves. It was next reported that the murdered man had been buried in a plantation about a mile diſtant from the village. As the alarm was now very general, a number of the inhabitants propoſed of their own accord to explore it. They accordingly ſpread themſelves over the wood, and ſearched it with care, but no grave nor new dug earth was found. The writer of this article, who was then a boy at ſchool, was along with them. The mat-

ter did not reſt here: The perſon who was ſaid to have ſeen four men carry a dead corpſe into the churchyard at midnight was ſummoned to appear before a meeting of the juſtices of the peace. Upon examination he denied any knowledge of the affair, but referred the court to another perſon from whom he had received his information. This perſon was examined, and the reſult was the ſame as the former. In ſhort, one perſon had heard it from another, who had received it from a third, who had heard it from a fourth; but it had received a little embelliſhment from every perſon who repeated it. It turned out to be the ſame with Smollet's ſtory of the three black crows, which ſome body was ſaid to have vomited.

Upon inquiry at the inn where the Weſt Indian gentleman had lodged, no ſuch gentleman had been ſeen there. It was found afterwards he had never left the Weſt Indies. Still, however, the veracity of the widow was not diſputed; and ſome dark and ſecret tranſaction was ſuſpected. But the whole affair was at length explained by diſcovering that ſhe was ſomewhat deranged by melancholy. And the cries which ſhe had at firſt imagined ſhe had heard were afterwards imitated by ſome roguiſh perſon, who was highly amuſed with ſpreading terror among the credulous.

5. Drunkenneſs alſo has the power of creating ſpectres. Its natural effect in moſt caſes is to derange the underſtanding, to throw it off its guard, and to give full ſcope to that paſſion which has a natural diſpoſition to gain an aſcendancy; and ſometimes it excites paſſions which ſcarcely ſeem to exiſt at any other time. It makes ſome men licentious, ſome furious, ſome all benevolence and kindneſs, ſome from being cowards it renders undaunted heroes. It ſeldom, if ever, excites fear; and therefore it may be thought ſtrange that men ſhould imagine they ſee ghoſts when intoxicated. But it muſt be remarked, that the ghoſts which the drunkard ſees, he ſees not with the ſame alarm and terror as men who are ſober. He is not afraid of them. He has the courage to converſe with them, and even to fight with them, if they give him provocation. A man returning home intoxicated, affirmed that he had met with the devil; and that after a ſevere encounter he had vanquiſhed him and brought him to the ground, to which he had nailed him faſt by driving his ſtaff through his body. Next morning the ſtaff was found ſtuck with great violence into a heap of turfs!

6. Many apparations of ſpectres have no other origin than the artifices of the waggiſh or ſelf-intereſted. Dr Plot, in his Natural Hiſtory of Oxfordſhire, relates a marvellous ſtory, which will illuſtrate this aſſertion. Soon after the murder of King Charles I. a commiſſion was appointed to ſurvey the king's houſe at Woodſtock, with the manor, park, woods, and other demeſnes to that manor belonging; and one Collins, under a feigned name, hired himſelf as ſecretary to the commiſſioners, who, upon the 13th of October 1649, met, and took up their reſidence in the king's own rooms. His majeſty's bed-chamber they made their kitchen, the council hall their pantry, and the preſence-chamber was the place where they ſat for the diſpatch of buſineſs. His majeſty's dining-room they made their wood yard, and ſtored it with the wood of the famous royal-oak from the High Park, which, that nothing might be left with the name of king about it, they had dug up by the roots, and ſplit and bundled up into faggots for their firing. Things being thus prepared, they ſat on the 16th of the ſame month for the diſpatch of buſineſs; and in the midſt of their firſt debate there entered a large black dog (as they thought,) which made a dreadful howling, overturned two or three of their chairs, and then crept under a bed and vaniſhed. Thus gave them the greater ſurpriſe, as the doors were kept conſtantly locked, ſo that no real dog could get in or out. The next day their ſurpriſe was increaſed, when ſitting at dinner in a lower room, they heard plainly the noiſe of perſons walking over their heads, though they well knew the doors were all locked, and there could be no body there. Preſently after they heard alſo all the wood of the king's oak brought by parcels from the dining-room, and thrown with great violence into the preſence chamber; as alſo all the chairs, ſtools, tables, and other furniture, forcibly hurried about the room; their papers, containing the minutes of their tranſactions were torn, and the ink-glaſs broken. When all this noiſe had ceaſed, Giles Sharp, their ſecretary, propoſed to enter firſt into theſe rooms; and in preſence of the commiſſioners, from whom he received the key, he opened the doors, and found the wood ſpread about the room, the chairs toſſed about and broken, the papers torn, the ink-glaſs broken (as has been ſaid), but not the leaſt track of any human creature, nor the leaſt reaſon to ſuſpect one, as the doors were all faſt, and the keys in the cuſtody of the commiſſioners. It was therefore unanimouſly agreed, that the power who did this miſchief muſt have entered the room at the key-hole. The night following, Sharp the ſecretary, with two of the commiſſioners ſervants, as they were in bed in the ſame room, which room was contiguous to that where the commiſſioners lay, had their bed's feet lifted up ſo much higher than their heads, that they expected to have their necks broken, and then they were let fall at once with ſo much violence as ſhook the whole houſe, and more than ever terrified the commiſſioners. On the night of the 19th, as all were in bed in the ſame room for greater ſafety, and lights burning by them, the candles in an inſtant went out with a ſulphureous ſmell, and that moment many trenchers of wood were hurled about the room, which next morning were found to be the ſame their honours had eaten on the day before, which were all removed from the pantry, though not a lock was found opened in the whole houſe. The next night they fared ſtill worſe; the candles went out as before, the curtains of their honours beds were rattled to and fro with great violence; their honours received many cruel blows and bruiſes, by eight great pewter-diſhes and a number of wooden trenchers being thrown on their beds, which being heaved off, were heard rolling about the room, though in the morning none of theſe were to be ſeen. This night likewiſe they were alarmed with the tumbling down of oaken billets about their beds, and other frightful noiſes; but all was clear in the morning, as if no ſuch thing happened. The next night the keeper of the king's houſe and his dog lay in the commiſſioners room, and then they had no diſturbance. But on the night of the 22d, though the dog lay in the room as before, yet the candles went out, a number of brick-bats fell from the chimney into the room, the dog howled piteouſly, their bed clothes were all ſtripped off, and their terror increaſed. On the

24th they thought all the wood of the king's oak was violently thrown down by their bed ſides ; they counted 64 billets that fell, and ſome hit and ſhook the beds in which they lay ; but in the morning none were found there, nor had the door been opened where the billet wood was kept. The next night the candles were put out, the curtains rattled, and a dreadful crack like thunder was heard ; and one of the ſervants running in haſte, thinking his maſter was killed, found three dozen of trenchers laid ſmoothly under the quilt by him. But all this was nothing to what ſucceeded afterwards : The 29th, about midnight, the candles went out, ſomething walked majeſtically through the room, and opened and ſhut the windows ; great ſtones were thrown violently into the room, ſome of which fell on the beds, others on the floor ; and at about a quarter after one a noiſe was heard as of forty cannon diſcharged together, and again repeated at about eight minutes diſtance. This alarmed and raiſed all the neighbourhood, who coming into their honours room, gathered up the great ſtones, fourſcore in number, and laid them by in the corner of a field, where, in Dr Plot's time, who reports this ſtory, they were to be ſeen. This noiſe, like the diſcharge of cannon, was heard through all the country for 16 miles round. During theſe noiſes, which were heard in both rooms together, the commiſſioners and their ſervants gave one another over for loſt, and cried out for help ; and Giles Sharp, ſnatching up a ſword, had well nigh killed one of their honours, miſtaking him for the ſpirit, as he came in his ſhirt from his own room to theirs. While they were together, the noiſe was continued, and part of the tiling of the houſe was ſtript off, and all the windows of an upper room were taken away with it. On the 30th at midnight ſomething walked into the chamber treading like a bear ; it walked many times about, then threw the warming-pan violently on the floor ; at the ſame time a large quantity of broken glaſs, accompanied with great ſtones and horſes bones, came pouring into the room with uncommon force. Theſe were all found in the morning to the aſtoniſhment and terror of the commiſſioners, who were yet determined to go on with their buſineſs. But on the firſt of November the moſt dreadful ſcene of all enſued : Candles in every part of the room were lighted up, and a great fire made ; at midnight, the candles all yet burning, a noiſe like the burſting of a cannon was heard in the room, and the burning billets were toſſed about by it even into their honours beds ; who called Giles and his companions to their relief, otherwiſe the houſe had been burnt to the ground ; about an hour after the candles went out as uſual, the crack as if many cannon was heard, and many pailfuls of green ſtinking water were thrown upon their honours beds ; great ſtones were alſo thrown in as before, the bed curtains and bedſteads torn and broken, the windows ſhattered, and the whole neighbourhood alarmed with the moſt dreadful noiſes ; nay, the very rabbit-ſtealers that were abroad that night in the warren were ſo terrified, that they fled for fear and left their ferrets behind them. One of their honours this night ſpoke, and, *in the name of God, aſked what it was, and why it diſturbed them ſo ?* No anſwer was given to this ; but the noiſe ceaſed for a while, when the ſpirit came again ; and, as they all agreed, *brought with it ſeven devils worſe than itſelf.* One of the ſervants now lighted a large candle, and ſet it in the door-way between the two chambers, to ſee what paſſed ; and as he watched it, he plainly ſaw a hoof ſtriking the candle and candleſtick into the middle of the room, and afterwards making three ſcrapes over the ſtuff, ſcraped it out. Upon this the ſame perſon was ſo bold as to draw a ſword ; but he had ſcarce got it out when he felt another inviſible hand holding it too, and pulling it from him ; and at length prevailing, ſtruck him ſo violently on the head with the pummel, that he fell down for dead with the blow. At this inſtant was heard another burſt like the diſcharge of the broadſide of a ſhip of war, and at about a minute or two's diſtance each no leſs than 19 more ſuch : theſe ſhook the houſe ſo violently, that they expected every moment it would fall upon their heads. The neighbours, on this, as has been ſaid, being all alarmed, flocked to the houſe in great numbers, and all joined in prayer and pſalm ſinging ; during which the noiſe ſtill continued in the other rooms, and the diſcharge of cannons was heard as from without, though no viſible agent was ſeen to diſcharge them. But what was the moſt alarming of all, and put an end to their proceedings effectually, happened the next day as they were all at dinner, when a paper, in which they had ſigned a mutual agreement to reſerve a part of the premiſes out of the general ſurvey, and afterwards to ſhare it equally amongſt themſelves, (which paper they had hid for the preſent under the earth in a pot in one corner of the room, and in which an orange-tree grew), was conſumed in a wonderful manner, by the earth's taking fire with which the pot was filled, and burning violently with a blue fume, and an intolerable ſtench ; ſo that they were all driven out of the houſe, to which they could never again be prevailed upon to return.

This wonderful contrivance was all the invention of the memorable Joſeph Collins of Oxford, otherwiſe called *Funny Joe*, who having hired himſelf as ſecretary, under the name of *Giles Sharp*, by knowing the private traps belonging to the houſe, and the help of *pulvis fulminans* and other chemical preparations, and letting his fellow-ſervants into the ſcheme, carried on the deceit without diſcovery to the very laſt ; inſomuch that the Dr Plot, in his Natural Hiſtory, relates the whole for fact, and concludes in this grave manner, " That though tricks have been often played in affairs of this kind, many of the things above related are not reconcileable with juggling ; ſuch as the loud noiſes, beyond the power of man to make without ſuch inſtruments as were not there ; the tearing and breaking the beds ; the throwing about the fire ; the hoof treading out the candle ; and the ſtriving for the ſword, and the blow the man received from the pummel of it."

SPECTRE of the Broken, a ſingular phenomenon obſerved on the top of the *Broken*, one of the Hartz mountains in Hanover, of which M. Haue has given the following account. " After having been here (ſays he) for the thirtieth time, and having procured information reſpecting the above-mentioned atmoſpheric phenomenon, I was at length, on the 23d of May 1797, ſo fortunate as to have the pleaſure of ſeeing it ; and perhaps my deſcription may afford ſatisfaction to others who viſit the Broken through curioſity. The ſun roſe about four o'clock, and, the atmoſphere being quite ſerene towards the eaſt, his rays could paſs without any obſtruction over the Heinrichſhöhe. In the ſouth-weſt, however,

ever, towards Achtermannſhöhe, a briſk weſt wind carried before it thin tranſparent vapours, which were not yet condenſed into thick heavy clouds.

"About a quarter paſt four I went towards the inn, and looked round to ſee whether the atmoſphere would permit me to have a free proſpect to the ſouth-weſt; when I obſerved, at a very great diſtance towards Achtermannſhöhe, a human figure of a monſtrous ſize. A violent guſt of wind having almoſt carried away my hat, I clapped my hand to it by moving my arm towards my head, and the coloſſal figure did the ſame.

"The pleaſure which I felt on this diſcovery can hardly be deſcribed; for I had already walked many a weary ſtep in the hopes of ſeeing this ſhadowy image, without being able to gratify my curioſity. I immediately made another movement by bending my body, and the coloſſal figure before me repeated it. I was deſirous of doing the ſame thing once more—but my coloſſus had vaniſhed. I remained in the ſame poſition, waiting to ſee whether it would return; and in a few minutes it again made its appearance on the Achtermannſhöhe. I paid my reſpects to it a ſecond time, and it did the ſame to me. I then called the landlord of the Broken; and having both taken the ſame poſition which I had taken alone, we looked towards the Achtermannſhöhe, but ſaw nothing. We had not, however, ſtood long, when two ſuch coloſſal figures were formed over the above eminence, which repeated our compliments by bending their bodies as we did; after which they vaniſhed. We retained our poſition; kept our eyes fixed on the ſame ſpot, and in a little the two figures again ſtood before us, and were joined by a third. Every movement that we made by bending our bodies theſe figures imitated—but with this difference, that the phenomenon was ſometimes weak and faint, ſometimes ſtrong and well defined. Having thus had an opportunity of diſcovering the whole ſecret of this phenomenon, I can give the following information to ſuch of my readers as may be deſirous of ſeeing it themſelves. When the riſing ſun, and according to analogy the caſe will be the ſame at the ſetting ſun, throws his rays over the Broken upon the body of a man ſtanding oppoſite to fine light clouds floating around or hovering paſt him, he needs only fix his eyes ſtedfaſtly upon them, and, in all probability, he will ſee the ſingular ſpectacle of his own ſhadow extending to the length of five or ſix hundred feet, at the diſtance of about two miles before him."

SPECULARIS Lapis, compoſed of large plates of extreme thinneſs. (See Talc, Mineralogy *Index*). The white variety with large and broad leaves, commonly called *iſinglaſs* and *Muſcovy glaſs*, is imported in great quantities; the miniature-painters cover their pictures with it; the lantern-makers ſometimes uſe it inſtead of horn; and minute objects are uſually preſerved between two plates of it, for examination by the microſcope.

SPECULATIVE, ſomething relating to the theory of ſome art or ſcience, in contradiſtinction to practical.

SPECULUM for reflecting teleſcopes, is made of a kind of white copper conſiſting of 32 parts fine red copper, one of braſs, 15 of grain-tin, and three of white arſenic. The proceſs given by the late J. Edwards, who was rewarded by the Board of Longitude for diſcloſing it to the public, was publiſhed in the Nautical Almanack for 1787, and is as follows: Melt the copper in a large crucible, employing ſome black flux, compoſed of two parts of tartar and one of nitre: when melted, add to it the braſs and the ſilver. Let the pure tin be melted in another crucible, alſo with ſome black flux. Take them both from the fire, and pour the melted tin into the fuſed maſs in the large crucible. Stir the whole well with a dry ſpatula of birch, and pour off the fuſed metal immediately into a large quantity of cold water. The ſudden chill of the water will cauſe the fluid metal to divide into an infinite number of ſmall particles, which will cool inſtantly.

Cronſtedt's Mineralogy, vol. ii. p. 712.

If the copper be completely ſaturated, the fracture of one piece of this mixed metal will appear bright, and of a gloſſy look, reſembling the face of pure quickſilver. But if it is of a brown reddiſh colour, it wants a little more tin. To aſcertain the required proportion, melt a ſmall quantity, known by weight, of the mixed metal, with a known very ſmall part of tin; and, if neceſſary, repeat the trial with different doſes, till the fracture of the new mixture looks as already deſcribed. Having now aſcertained the neceſſary addition of tin that is required, proceed to the laſt melting of the whole metal, together with the additional proportional doſe of tin; fuſe the whole, obſerving the ſame cautions as before; and you will find that the mixture will melt with a much leſs heat than that for the firſt fuſion. Have ready as many ounces of white arſenic in coarſe powder as there are pounds in the weight of the metal; wrap up the arſenic in a ſmall paper, and put it, with a pair of tongs, into the crucible; ſtir it well with the ſpatula, retaining the breath to avoid the arſenical fumes or vapours (which however are not found to be hurtful to the lungs) till they diſappear; take the crucible off the fire, clear away the droſs from the top of the metal, pour in about one ounce of powdered roſin, with as much metal, in order to give the metal a clean ſurface, and pour out the metal into the moulded flaſks.

The ſpeculum ſhould be moulded with the concave ſurface downwards, and many ſmall holes ſhould be made through the ſand upwards, to diſcharge the air. The moulding ſand from Highgate near London, uſed by the founders, is as good as any for caſting theſe metallic mirrors. The caſt metal ſhould be taken out from the ſand of the flaſks whilſt it is hot, or elſe it may happen to crack if left to cool within. See Telescope.

But in addition to what has now been ſaid, we muſt notice ſome other information relative to the grinding, poliſhing, and other important circumſtances connected with the method of preparing the moſt perfect ſpeculum for teleſcopes. The metal being taken out of the flaſk, as already noticed, and this ſhould be done as ſoon as it has become ſolid, and while it is yet red hot, care muſt be taken to keep the face downwards to prevent it from ſinking. Holding it in that poſition by the git, force out the ſand from the hole in the middle of the mirror with a piece of wood or iron, and place the ſpeculum in an iron pot, with a large quantity of hot aſhes or ſmall coals, ſo as to bury the ſpeculum in them a ſufficient depth. If the ſand is not forced out of the hole in the manner above directed, the metal, by ſinking as it cools, will

will embrace the ſand in the middle of the ſpeculum ſo tight, as to cauſe it to crack before it becomes entirely cold. And if the metal be not taken out of the ſand, and put in a pot with hot aſhes or coals to anneal it, the moiſture from the ſand will always break the metal. Let the ſpeculum remain in the aſhes till the whole is become quite cold. The git may be eaſily taken off by marking it round with a common fine half round file, and giving it then a gentle blow. The metal is then to be rough ground and figured.

But before we proceed to deſcribe that proceſs, it may be proper to give an account of another compoſition for the ſpeculum of a reflecting teleſcope, which has been employed with great ſucceſs, by Rochon director of the marine obſervatory at Breſt. Of this compoſition the principal ingredient is platina; which, in grains, muſt be purified in a ſtrong fire by means of nitre and the ſalt of glaſs, or that flux which in the Engliſh glaſs-houſes is called by the workmen *ſandifer*. To the platina, when purified, add the eighth part of the metal employed in the compoſition of common ſpecula; for tin without red copper would not produce a good effect. This mixture is then to be expoſed to the moſt violent heat, which muſt be ſtill excited by the oxygen gas that diſengages itſelf from nitre when thrown into the fire. One melting would be inſufficient: five or ſix are requiſite to bring the mixture to perfection. It is neceſſary that the metal ſhould be in a ſtate of complete fuſion at the moment when it is poured into the mould. By this proceſs I have been enabled (ſays the author) to conſtruct a teleſcope with platina, which magnifies the diameters of objects five hundred times, with a degree of clearneſs and diſtinctneſs requiſite for the niceſt obſervations. The large ſpeculum of platina weighs fourteen pounds: it is eight inches in diameter, and its focus is ſix feet. Though the high price of platina will, in all probability, for ever prevent it from coming into general uſe for the ſpeculums of teleſcopes, we thought it proper to notice this diſcovery, and ſhall now proceed to the grinding of the ſpeculum.

For accompliſhing this object, a very complicated proceſs is recommended in Smith's Optics, and one not much more ſimple, by Mr Mudge in the 67th volume of the *Philoſophical Tranſactions*; but according to Mr Edwards, whoſe ſpeculums are confeſſedly the beſt, neither of theſe is neceſſary. Beſides a common grindſtone, all the tools that he made uſe of are a rough grinder, which ſerves alſo as a poliſher, and a bed of hones. When the ſpeculum was cold, he ground its ſurface bright on a common grindſtone, previouſly brought to the form of the gage; and then took it to the rough grinder.

The tool is compoſed of a mixture of lead and tin, or of pewter, and is made of an elliptical form, of ſuch dimenſions, that the ſhorteſt diameter of the ellipſe is equal to the diameter of the mirror or ſpeculum, and the longeſt diameter is to the ſhorteſt in the proportion of ten to nine. This rough grinder may be fixed upon a block of wood, in order to raiſe it higher from the bench; and as the metal is ground upon it with fine emery, Mr Mudge, with whom, in this particular, Mr Edwards agrees, directs a hole or pit to be made in the middle of it as a lodgement for the emery, and deep grooves to be cut out acroſs its ſurface with a graver for the ſame purpoſe. By means of a handle fixed on the back of the metal with ſoft cement, the ſpeculum can be whirled round upon this grinder ſo rapidly, that a common labourer has been known to give a piece of metal, four inches in diameter, ſo good a face and figure as to fit it for the hones in the ſpace of two hours. The emery, however fine, will break up the metal very much; but that is remedied by the ſubſequent proceſſes of honing and poliſhing.

When the metal is brought to a true figure, it muſt be taken to a convex tool, formed of ſome ſtones from a place called Edgedon in Shropſhire, ſituated between Ludlow and Biſhop's Caſtle. The common blue hones, uſed by many opticians for this purpoſe, will ſcarcely touch the metal of Mr Edward's ſpeculums; but where they muſt be employed for want of the others, as little water ſhould be uſed as poſſible when the metal is put upon them; becauſe it is found by experience that they cut better when but barely wet, than when drenched with water. The ſtones, however, from Edgedon are greatly preferable; for they cut the metal more eaſily, and having a very fine grain, they bring it to a ſmooth face. Theſe ſtones are directed by Mr Mudge to be cemented in ſmall pieces upon a thick round piece of marble, or of metal made of tin and lead like the former compoſition, in ſuch a manner, that the lines between the ſtones may run ſtraight from one ſide to the other; ſo that placing the teeth of a very fine ſaw in each of theſe diviſions, they may be cleared from one end to the other of the cement which riſes between the ſtones. As ſoon as the hones are cemented down, this tool muſt be fixed in the lathe, and turned as exactly true to the gage as poſſible. It ſhould be of a circular figure, and but very little larger than the metal intended to be figured upon it. If it be made conſiderably larger, it will grind the metal into a larger ſphere and a bad figure; and if it be made exactly of the ſame ſize, it will work the metal indeed into a figure truly ſpherical, but will be apt to ſhorten its focus, unleſs the metal and tool be worked alternately upwards. On theſe accounts Mr Edwards recommends it to be made about one twentieth part longer in diameter than the ſpeculum, becauſe he has found that it does not then alter its focus; and he earneſtly diſſuades the uſe of much water on the hone pavement at the time of uſing it, otherwiſe, he ſays, that the metal in different parts of it will be of different degrees of brightneſs.

The metal being brought to a very fine face and figure by the bed of ſtones, is ready to receive a poliſh, which is given to it by the elliptical rough grinder covered with pitch. With reſpect to the conſiſtency of this pitch, Mr Mudge and Mr Edwards give very different directions. Whilſt the former ſays that it ſhould be neither too hard nor too ſoft, the latter affirms that the harder the pitch is, the better figure it will give to the metal. Pitch may be eaſily made of a ſufficient hardneſs by adding a proper quantity of roſin; and when it is hardened in this way, it is not ſo brittle as pitch alone, which is hardened by boiling. Mr Edwards adviſes to make the mixture juſt ſo hard as to receive, when cold, an impreſſion from a moderate preſſure of the nail of one's finger. When the elliptical tool is to be covered with this mixture, it muſt be made pretty warm, and in that ſtate have the mixture poured upon it when beginning to cool in the crucible. Our author recommends this coating to be made everywhere of about the thickneſs of half a crown; and to give it the proper form, it muſt, when ſomewhat cool, be preſſed upon the face of the mirror, which has firſt been dipped in cold water, or covered over with very fine writing paper. If it be not found to have taken the exact figure from the firſt preſſure, the ſurface of the pitch muſt be gently warmed, and the operation repeated as before. All the ſuperfluous pitch is now to be taken away from the edge of the poliſher with a pen knife, and a hole to be made in the middle, accurately round, with a conical piece of wood. This hole ſhould go quite through the tool, and ſhould be made of the ſame ſize, or ſomewhat leſs than the hole in the middle of the ſpeculum. Mr Edwards ſays, that he has always found that ſmall mirrors, though without any hole in the middle, poliſh much better, and take a more correct figure, for the poliſher's having a hole in the middle of it.

The poliſher being thus formed, it muſt be very gently warmed at the fire, and divided into ſeveral ſquares by the edge of a knife. Theſe, by receiving the ſmall portion of metal that works off in poliſhing, will cauſe the figure of the ſpeculum to be more correct than if no ſuch ſquares had been made. Mr Mudge directs the poliſher to be ſtrewed over with very fine *putty*; but Mr Edwards prefers Colcothar of vitriol. Putty (ſays he) gives to metals a white luſtre, or, as workmen call it, a ſilver hue; but good colcothar of vitriol will poliſh with a very fine and high black luſtre, ſo as to give the metal finiſhed with it the complexion of poliſhed ſteel. To know if the colcothar of vitriol is good, put ſome of it into your mouth, and if you find it diſſolves away it is good; but if you find it hard, and crunch between your teeth, then it is bad, and not well burned. Good colcothar of vitriol is of a deep red, or of a deep purple colour, and is ſoft and oily when rubbed between the fingers; bad colcothar of vitriol is of a light red colour, and feels harſh and gritty. The colcothar of vitriol ſhould be levigated between two ſurfaces of poliſhed ſteel, and wrought with a little water; when it is worked dry, you may add a little more water, to carry it lower down to what degree you pleaſe. When the colcothar of vitriol has been wrought dry three or four times, it will acquire a black colour, and will be low enough, or ſufficiently fine, to give an exquiſite luſtre. This levigated colcothar of vitriol muſt be put into a ſmall phial, and kept with ſome water upon it. When it is to be uſed, every part of the pitch-poliſher muſt be firſt bruſhed over with a fine camel's hair bruſh, which has been dipped in pure water, and rubbed gently over a piece of dry clean ſoap. The waſhed colcothar of vitriol is then to be put upon the poliſher; and Mr Edwards directs a large quantity of it to be put on at once, ſo as to ſaturate the pitch, and form a fine coating. If a ſecond or third application of this powder be found neceſſary, it muſt be uſed very ſparingly, or the poliſh will be deſtroyed which has been already attained. When the metal is nearly poliſhed, there will always appear ſome black mud upon its ſurface, as well as upon the tool. Part of this muſt be wiped away with ſome very ſoft waſh leather; but if the whole of it be taken away, the poliſhing will not be ſo well completed.

With reſpect to the *parabolic figure* to be given to the mirror, Mr Edwards aſſures us, that a very little experience in theſe matters will enable any one to give it with certainty, by poliſhing the ſpeculum in the common manner, only with croſs ſtrokes in every direction, upon an elliptical tool of the proper dimenſions.

Speculum, a looking-glaſs or mirror, capable of reflecting the rays of the ſun.

Speculum, in *Surgery*, an inſtrument for dilating a wound, or the like, in order to examine it attentively. See Surgery.

SPEECH, in general, the art or act of expreſſing a perſon's thoughts by means of articulate ſounds, which we call words. See Language, Grammar, Reading, and Oratory, Part IV.

SPEED, John, an Engliſh hiſtorian, was born at Farington, in Cheſhire, in the year 1542. He was by profeſſion a taylor, and freeman of the company of merchant taylors in the city of London. In 1606, he publiſhed his Theatre of Great Britain, which was afterwards reprinted in folio, under the title of the *Theatre of the Empire of Great Britain*. His genealogies of Scripture were firſt bound up with the Bible in 1611, when the firſt edition of the preſent tranſlation was printed. In 1614 appeared his *Hiſtory of Great Britain*, which has been tranſlated into Latin; and in 1616 he publiſhed his *Cloud of Witneſſes*, in octavo. He lived in marriage 57 years with his wife, by whom he had twelve ſons and ſix daughters; and died in 1629. He was interred in the church of St Giles's, Cripplegate, London, where a monument was erected to his memory.

SPEEDWELL. See Veronica, Botany *Index*.

SPELL, a charm conſiſting of ſome words of occult power, generally attended with ſome ceremony.—In order to explain it, we will produce a few examples. On St Agnes's night, 21ſt of January, take a row of pins, and pull out every one, one after another, ſaying a Pater-noſter on ſticking a pin in your ſleeve, and you will dream of him or her you ſhall marry.

Groſe's Provincial Gloſſary.

Another method to ſee a future ſpouſe in a dream. The party inquiring muſt lie in a different county from that in which he commonly reſides, and on going to bed muſt knit the left garter about the right-legged ſtocking, letting the other garter and ſtocking alone; and as he rehearſes the following verſes, at every comma knit a knot:

This knot I knit,
To know the thing I know not yet;
That I may ſee
The man (woman) that ſhall my huſband (wife) be;
How he goes, and what he wears,
And what he does all days and years.

Accordingly, in a dream, he will appear with the inſignia of his trade or profeſſion.

Another, performed by charming the moon, thus: At the firſt appearance of the new moon, immediately after the new year's day, (though ſome ſay any other new moon is as good), go out in the evening, and ſtand over the ſpars of a gate or ſtile, and, looking on the moon, repeat the following lines:

All hail to the moon! all hail to thee!
I prithee, good moon, reveal to me
This night who my huſband (wife) muſt be.

Immediately after you muſt go to bed, when you will dream of the perſon deſtined for your future huſband or wife.

SPELLING, in *Grammar*, that part of orthography which teaches the true manner of reſolving words into their ſyllables.

All words are either ſimple or compound, as *uſe, diſuſe; done, undone;* and the rules for dividing each muſt be ſuch as are derived from the analogy of language in general, or from the eſtabliſhed cuſtom of ſpeaking; which, for the Engliſh language, are reduced to the following rules: 1. A conſonant between two vowels muſt be joined with the latter in ſpelling, as *na-ture, ve-ri-ly, ge-ne-rous;* except, however, the letter *x*, which is joined to the firſt, as in *flax-en, ox-en*, &c. and compound words, as in *up-on, un-uſed*, &c. 2. A double conſonant muſt be divided, as in *let-ter, man-ner*, &c. 3. Thoſe conſonants which can begin a word, muſt not be parted in ſpelling, as in *de-fraud, re-prove, di-ſtinct;* however, this rule is found ſometimes to fail; for though *gn* begins a word, as *gnaw, gnat*, &c. yet it muſt be divided in ſpelling, as in *cog-ni-zance, ma-lig-ni-ty*, &c. 4. Thoſe conſonants which cannot begin a word muſt be divided, as *ld* in *ſeldom, lt* in *mul-ti-tude, mp* in *temper, rd* in *ar-dent;* but in final ſyllables there are exceptions, as *tl* in *ti-tle, dl* in *han-dle*, &c. 5. When two vowels come together, and are both of them diſtinctly ſounded, they muſt be ſeparated in ſpelling, as in *co-e-val, mu-tu-al*, &c. 6. The grammatical terminations or endings muſt be ſeparated in ſpelling, as *ed* in *wing-ed, edſt* in *de-li-ver-edſt, ing* in *hear-ing, ance* in *de-li-ver-ance*, &c. 7. Compound words muſt be reſolved into their ſimple or component words, as *up-on, in-to, ne-ver-the-leſs, not-with-ſtand-ing*, &c.

SPELMAN, Sir Henry, an eminent Engliſh antiquarian, was deſcended from an ancient family, and born at Cengham, near Lynn in Norfolk, about the year 1561. He was knighted by King James I. who had a particular eſteem for him on account of his known capacity for buſineſs; and he employed him ſeveral times in Ireland on public affairs. When he was about 50 years of age, he went to reſide in London; where falling into a ſtudy to which his own genius had always inclined him, he collected all ſuch books and MSS. as concerned the ſubject of antiquities, either foreign or domeſtic. In 1626, he publiſhed the firſt part of his well-known Gloſſary, which he never carried beyond the letter L; becauſe, as ſome have ſuggeſted, he had ſaid things under "Magna charta," and "Maximum conſilium," that could not then have appeared without giving offence. Upon his death all his papers came into the hands of his ſon Sir John Spelman, a gentleman who had abilities to have completed his father's deſign, if death had not prevented him. The ſecond part was afterwards publiſhed by Sir William Dugdale; but with all the marks of a ſcanty unfiniſhed performance. The next work he entered upon was an edition of the Engliſh Councils, of which he publiſhed the firſt volume about two years before his death, leaving the ſecond volume, as well of this as of his Gloſſary, to be publiſhed by Sir William Dugdale. Sir Henry wrote ſeveral other things, all relating to ancient laws and cuſtoms, and died in 1641. His Poſthumous Works were publiſhed in folio, 1698, under the inſpection of Mr Gibſon, afterwards biſhop of London.

SPELTER, in *Metallurgy*, the ſame with Zinc.

SPENCE, Joseph, an eminent writer, was fellow of New College, Oxford, where he took the degree of A.M. in 1727. About that time he became firſt known as an author, by an *Eſſay on Pope's Odyſſey, in which ſome particular beauties and blemiſhes of that work are conſidered;* a work of great merit, and which for ſound criticiſm and candid diſquiſition is almoſt without a parallel. He was elected profeſſor of poetry by the univerſity in 1728, and held that office ten years, which is as long as the ſtatutes will allow. His Hiſtory of Stephen Duck was firſt publiſhed in 1731; but it was afterwards much altered, and prefixed to an edition of Duck's poems.

About this time he travelled into Italy as tutor to the earl of Lincoln, afterwards duke of Newcaſtle.—In 1736 he republiſhed Gorboduc, at Mr Pope's deſire, with a preface giving an account of the author, the earl of Dorſet. He quitted his fellowſhip in 1742, upon being preſented by the Society of New College to the rectory of Great Harwood in Buckinghamſhire.—He never reſided in his living; but paid it an annual viſit, diſtributing large ſums of money among the poor, and providing for many of their children. The ſame year he was made profeſſor of modern hiſtory at Oxford. In 1747 he publiſhed *Polymetis;* or an inquiry concerning the agreement between the works of the Roman poets and the remains of ancient artiſts, being an attempt to illuſtrate them mutually from each other. This work was treated by Gray with a contempt which it did not deſerve. He raiſes objections becauſe the author did not illuſtrate his ſubject from Greek writers; that is, becauſe he failed to execute what he never undertook. He was inſtalled prebendary of the ſeventh ſtall at Durham the 24th May 1754. He publiſhed the ſame year, "An Account of the Life, Character, and Poems, of Mr Blacklock, ſtudent of philoſophy at Edinburgh;" which was afterwards prefixed to his Poems. The proſe pieces which he printed in the Muſeum he collected and publiſhed, together with ſome others, in a pamphlet called *Moralities*, by Sir Harry Beaumont. Under the ſame name he publiſhed "Crito, or a Dialogue on Beauty," and "A particular Account of the emperor of China's Gardens near Pekin, in a letter from F. Attiret, a French miſſionary now employed by that emperor to paint the apartments in thoſe gardens, to his friend at Paris." Both theſe treatiſes are printed in Dodſley's fugitive pieces, as is alſo "A Letter from a Swiſs Officer to his friend at Rome;" which Mr Spence firſt publiſhed in the Muſeum. In 1758 he publiſhed "A Parallel, in the Manner of Plutarch, between a moſt celebrated man of Florence and one ſcarce ever heard of in England." This was alſo inſerted in the fugitive pieces. The ſame year he made a journey into Scotland, which he deſcribed in an affectionate letter to Mr Shenſtone, publiſhed in Hall's Collection of Letters, 1778. In 1764 he was very well deſcribed by Mr James Ridley, in his admirable Tales of the Genii, under the name of *Pheſoi Ecneps* (his name read backwards), derviſe of the groves. A letter from Mr Spence to that ingenious moraliſt, under the ſame ſignature, is preſerved in the 3d volume of "Letters of Eminent Perſons." In 1768 he publiſhed "Remarks and Diſſertations on Virgil, with ſome other claſſical obſervations, by the late Mr Holdſworth." On the 20th of Auguſt the ſame year he was unfortunately drowned in a canal in his garden at Byfleet in Surrey. He was found flat upon his face at the edge of the canal, where the water was ſo ſhallow as not even to cover his head. The accident, it was ſuppoſed, for he was quite alone, was owing to a fit.

The duke of Newcaſtle poſſeſſes ſome manuſcript volumes of anecdotes collected by Mr Spence, from which Dr Johnſon was permitted to inſert many extracts in his Lives of the Poets.

SPENCER, Dr John, an eminent divine, was born in Kent in 1630, and educated at Cambridge. He was choſen fellow of his college, and took a doctor's degree in 1663. In 1667 he was choſen maſter of Corpus Chriſti College, and preferred to the deanery of Ely in 1677. He died on the 20th of May 1695. His works are, 1. The Righteous Ruler; a ſermon on Proverbs xxix. 2. preached June 28. 1660. 2. A Diſcourſe concerning Prodigies, wherein the vanity of preſages by them is reprehended, and their true and proper ends aſſerted and vindicated. To this excellent work was afterwards added, A Diſcourſe concerning vulgar prophecies, wherein the vanity of receiving them as the certain indications of any future event is expoſed; and ſome marks of diſtinction between true and pretended prophets are laid down. 3. A Latin diſſertation concerning Urim and Thummim. 4. His famous treatiſe *De legibus Hebræorum ritualibus et earum rationibus.* The intention of this book, as he informs us himſelf, was to vindicate the Deity from the imputation of acting from arbitrary and fantaſtical motives. It has been highly and juſtly eſteemed both for the elegance of ſtyle and the uncommon erudition and ſound ſenſe which it diſplays. It has, however, (that part of it particularly which endeavours to deduce ſome of the Jewiſh ceremonies from the practices of their heathen neighbours), alarmed many perſons, as if ſuch a doctrine, if it could be proved, would derogate from the Divine wiſdom, and undermine revelation. But this is ſo far from being the caſe, that Dr Spencer's attempt, whether ſucceſsful or not, deſerves the gratitude of Chriſtians, becauſe it has a tendency to throw light on an important and difficult ſubject.

SPENSER, Edmund, the poet, was born in London in the year 1553, and deſcended from an ancient family of the Spenſers in Northamptonſhire. All we know concerning his education is, that he was admitted a ſizer of Pembroke-hall in Cambridge, and matriculated in 1569. At this time began his intimacy with Mr Gabriel Harvey, a man of genius and a poet. In 1576, having completed his degrees in arts, he left the univerſity, as it is conjectured, for want of ſubſiſtence, and retired to the north of England. Here he had the misfortune to become enamoured of his Roſalind, who, after flattering his paſſion for a time, at length preferred his happier rival. Spenſer continued in the country till the year 1578, when at the perſuaſion of his friend Mr Harvey he removed to London, where that gentleman introduced him to Mr Sidney (afterwards Sir Philip Sidney). Concerning his firſt introduction to Sir Philip, there is indeed a different ſtory, which was firſt told by the writer of his life, prefixed to his works in 1679, and tranſcribed by Hughes, Cibber, and ſeveral others; which, nevertheleſs, is certainly not true. The purport of it is, that Spenſer, being unknown to this Mecænas of the age, went to Leiceſter-houſe, and ſent in the 9th canto of the firſt book of the Fairy Queen; that, on reading part of it, Sir Philip ordered his ſteward to give the bearer 50l.; on reading a little farther 50l. more; then 200l.; bidding him to make haſte and pay the money, leſt he ſhould give the poet his whole eſtate. The ſtory tells prettily enough; but it is very certain, that the Fairy Queen was begun long after his acquaintance with Sir Philip. By this univerſal patron of genius, however, he was preſented to Queen Elizabeth, who honoured him with the place of poet-laureat. About this time he finiſhed his Shepherd's Calendar, which was firſt printed in 1579; and in the following year, being recommended by his patron to the earl of Leiceſter, he went to Ireland as ſecretary to the lord Grey of Wilton, then appointed lord-lieutenant of that kingdom. Lord Grey was recalled in 1582, and with him Spenſer returned to London, where he continued till after the death of Sir Philip Sidney in 1586; a loſs which he bewailed to the end of his life. The following year, our poet, having obtained a royal grant of 3000 acres of forfeited lands in the county of Cork in Ireland, ſet out for that kingdom, took poſſeſſion of his eſtate, and fixed his reſidence in the caſtle of Kilcolman, which had belonged to the earl of Deſmond. In this retirement he reſumed his great work of the Fairy Queen; and continued in Ireland till, being viſited by his old friend Sir Walter Raleigh in 1589, he came over with him to England, but returned to Ireland the year following, where he fell in love with a country girl, and married her. Soon after his marriage, he paid another viſit to his native country, where we alſo find him in 1596. In the following year he returned once more to Kilcolman; but on the rebellion of Lord Tyrone, who ravaged the whole county of Cork, he was obliged to fly for ſafety with his family to England, where, in the year 1599, he died in extreme poverty (a). He was buried in Weſtminſter Abbey, according to his requeſt, near Chaucer. A monument was erected to his memory by Ann counteſs of Dorſet. We know but little of his character as a man; as a poet, conſidering the age in which he lived, he deſerves our utmoſt veneration. He wrote various pieces beſides thoſe above mentioned. His whole works, with his life by Hughes, were publiſhed in ſix volumes 12mo, in 1715 and 1750.

SPERGULA, Spurrey, a genus of plants belonging to the claſs of decandria; and in the natural ſyſtem arranged

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(a) This is Camden's account, and it has been generally believed; but Mr Malone, the laſt editor of Shakeſpeare's works, by examining the patent roll, 33 Eliz. p. 3. has diſcovered, that in February 1690-1 Spenſer obtained from Queen Elizabeth an annuity or penſion of 50l. during his life; a ſum equivalent to 200l. at preſent.

arranged under the 22d order, *caryophylleæ*. See Botany *Index*.

SPERM, the ſeed whereof an animal is formed. See Physiology.

SPERMACETI, a whitiſh, unctuous, flaky ſubſtance, prepared from oil, but chiefly from the brains of a ſpecies of whale called *phyſeter macrocephalus*.

The method of preparing ſpermaceti is kept a ſecret; but the proceſs is ſaid to be this: The brains being taken out of the animal, are then, as ſome ſay, melted over a gentle fire, poured into moulds, and when cold melted again; and this proceſs is continued till they are purified. Others ſay, that after being preſſed and drained they are more thoroughly purified by ſteeping them in a ley of alkaline ſalt and quicklime. The brains are then waſhed, and cut into thin flakes or ſlices with wooden knives. One fiſh is ſaid to afford ſome tons of brains. Good ſpermaceti is gloſſy and ſemitranſparent, in fine white flakes; ſoft and unctuous to the touch, yet dry and friable; in taſte, ſomewhat like butter, and of a faint ſmell like that of tallow. Some adulterate it with wax; but the deceit is diſcovered, either by the ſmell of the wax or by the dulneſs of the colour. Some alſo ſell a preparation of oil taken from the tail of the whale inſtead of that from the brain; but this kind turns yellow as ſoon as expoſed to the air. Indeed it is apt in general to grow yellowiſh, and to contract a rancid fiſhy ſmell if not carefully ſecured from the air. The more perfectly it has been purified at firſt, the leſs ſuſceptible it is of theſe alterations; and after it has been changed, it may be rendered white and ſweet again by ſteeping it afreſh in a ley of alkaline ſalt and quicklime. It melts in a ſmall degree of heat, and congeals again as it cools.

Spermaceti is of uſe in medicine. Quincy ſays it is a noble remedy in the aſthma, &c. though chiefly uſed in bruiſes, inward hurts, and after delivery. For internal uſe, it may be diſſolved in aqueous liquors into the form of an emulſion, by trituration with almonds, the yoke or white of an egg, and more elegantly by mucilages; or made into a lohoch, by mixing two drams of it with a ſuitable quantity of yolk of egg, then adding half an ounce of freſh drawn oil of almonds, and an ounce of balſamic ſyrup. Spermaceti is not capable of being diſſolved by cauſtic alkalies, and of forming ſoaps, like other oily matters: but it is altogether ſoluble in oils, and unites by liquefaction with wax and reſins; and in theſe forms is applied externally. But it is certain, its greateſt property, and that which makes it ſo much in vogue in many places, is its ſoftening the ſkin. Whence it comes to be uſed by the ladies in paſtes, waſhes, &c.

Spermaceti candles are of modern manufacture: they are made ſmooth, with a fine gloſs, free from rings and ſcars, ſuperior to the fineſt wax candles in colour and luſtre; and, when genuine, leave no ſpot or ſtain on the fineſt ſilk, cloth, or linen.

A method has been lately propoſed by Dr Smith Gibbes of Briſtol, to convert animal muſcle into a ſubſtance much reſembling ſpermaceti. The proceſs is remarkably ſimple: Nothing more is neceſſary than to take a dead carcaſe and expoſe it to a ſtream of running water: it will in a ſhort time be changed to a maſs of fatty matter. To remove the offenſive ſmell, a quantity of nitrous acid may then be poured upon it, which uniting with the fetid matter, the fat is ſeparated in a pure ſtate. This acid indeed turns it yellow, but it may be rendered white and pure by the action of the oxygenated muriatic acid. Mr Gibbes brought about the ſame change in a much ſhorter time. He took three lean pieces of mutton and poured on them the three mineral acids, and he perceived that at the end of three days each was much altered; that in the nitrous acid was much ſoftened, and on ſeparating the acid from it, he found it to be exactly the ſame with that which he had before got from the water; that in the muriatic acid was not in that time ſo much altered; the vitriolic acid had turned the other black.

Phil. Tranſ. 1794.

SPERMACOCE, Button-wood, a genus of plants belonging to the claſs of tetrandria; and in the natural ſyſtem arranged under the 47th order, *Stellatæ*. See Botany *Index*.

SPERMATIC, in *Anatomy*, ſomething belonging to the ſperm or ſeed.

SPEUSIPPUS, an Athenian philoſopher, the nephew and ſucceſſor of Plato. Contrary to the practice of Plato, Speuſippus required from his pupils a ſtated gratuity. He placed ſtatues of the Graces in the ſchool which Plato had built. On account of his infirm ſtate of health, he was commonly carried to and from the academy in a vehicle. On his way thither he one day met Diogenes, and ſaluted him; the ſurly philoſopher refuſed to return the ſalute, and told him, that ſuch a feeble wretch ought to be aſhamed to live; to which Speuſippus replied, that he lived not in his limbs, but in his mind. At length, being wholly incapacitated, by a paralytic ſtroke, for the duties of the chair, he reſigned it to Xenocrates. He is ſaid to have been of a violent temper, fond of pleaſure, and exceedingly avaricious. Speuſippus wrote many philoſophical works, which are now loſt, but which Ariſtotle thought ſufficiently valuable to purchaſe at the expence of three talents. From the few fragments which remain of his philoſophy, it appears that he adhered very ſtrictly to the doctrine of his maſter.

SPEY, a river of Scotland, riſing from a lake of the ſame name in Badenoch, and, after a ſerpentine courſe of 76 miles, paſſes by Rothes caſtle, and falls into the German ſea at Garnoch near Elgin. Mr Pennant tells us, that the Spey is a dangerous neighbour to Caſtle Gordon, overflowing frequently in a dreadful manner, as appears by its ravages far beyond its banks. The bed of the river is wide and full of gravel, and the channel very ſhifting. In 1746 the Duke of Cumberland paſſed this river at Belly church, near Caſtle Gordon, when the channel was ſo deep as to take an officer, from whom Mr Pennant had the account, and who was ſix feet four inches high, up to the breaſt. The banks are here very high and ſteep; ſo that had not the rebels been infatuated in ſuch a manner as to neglect oppoſition, the paſſage muſt have been attended with conſiderable loſs. On this river there is a great ſalmon-fiſhery; about 1700 barrels full are caught in the ſeaſon, and the ſhore was formerly rented for about 1200l. per annum: now it is probably doubled.

SPHACELUS, in *Surgery* and *Medicine*, an abſolute and perfect corruption or death of the parts.

SPHÆRANTHUS, a genus of plants belonging to the

the claſs of ſyngeneſia, and to the order of polygamia ſegregata; and in the natural ſyſtem arranged under the 49th order, *Compoſitæ*. See BOTANY *Index*.

SPHAGNUM, BOG-MOSS, a genus of plants belonging to the claſs of cryptogamia and order of muſci. See BOTANY *Index*.

Os SPHENOIDES, the ſeventh bone of the cranium or ſkull. See ANATOMY, N° 11.

SPHERE, is a ſolid contained under one uniform round ſurface, every point of which is equally diſtant from a certain point in the middle called its *centre*; and is formed by the revolution of a ſemicircle about its diameter. See GEOMETRY.

Projection of the SPHERE. See PROJECTION.

SPHERE, in *Aſtronomy*, that concave orb or expanſe which inveſts our globe, and in which the heavenly bodies appear to be fixed, and at an equal diſtance from the eye.

The better to determine the places of the heavenly bodies in the ſphere, ſeveral circles are ſuppoſed to be deſcribed on the ſurface thereof, hence called the *circles of the ſphere*: of theſe ſome are called *great circles*, as the equinoctial, ecliptic, meridian, &c. and others *ſmall circles*, as the tropics, parallels, &c. See GEOGRAPHY; and ASTRONOMY, *paſſim*.

Armillary SPHERE. See GEOGRAPHY.

SPHERE *of Activity of a Body*, is that determinate ſpace or extent to which, and no farther, the effluvia continually emitted from that body reach; and where they operate according to their nature.

SPHERES, in *Optics*, the ſame with metalline mirrors, for teleſcopes or other purpoſes. See MIRROR.

SPHEROID, in *Geometry*, a ſolid approaching to the figure of a ſphere. It is generated by the entire revolution of a ſemi-ellipſis about its axis. When the revolution is made round the largeſt axis, the ſpheroid is called *prolate*; and when round the ſhorteſt, *oblate*. This laſt is the figure of the earth, and probably of all the planets.

SPHEX, ICHNEUMON WASP, or *Savage*; a genus of inſects belonging to the order of *hymenopteræ*. See ENTOMOLOGY *Index*.

SPHINCTER, in *Anatomy*, a term applied to a kind of circular muſcles, or muſcles in form of rings, which ſerve to cloſe and draw up ſeveral orifices of the body, and prevent the exerction of the contents.

SPHINX, in fabulous hiſtory, a monſter which had the head and breaſts of a woman, the body of a dog, the tail of a ſerpent, the wings of a bird, the paws of a lion, and a human voice. It ſprang from the union of Orthos with the Chimæra, or of Typhon with Echidna. The Sphinx had been ſent into the neighbourhood of Thebes by Juno, who wiſhed to puniſh the family of Cadmus, which ſhe perſecuted with immortal hatred, and it laid this part of Bœotia under continual alarms, by propoſing enigmas, and devouring the inhabitants, if unable to explain them. In the midſt of their conſternation the Thebans were told by the oracle, that the ſphinx would deſtroy herſelf as ſoon as one of the enigmas ſhe propoſed was explained. In this enigma ſhe wiſhed to know what animal walked on four legs in the morning, two at noon, and three in the evening. Upon this Creon king of Thebes promiſed his crown and his ſiſter Jocaſta in marriage to him who could deliver his country from the monſter by a ſucceſsful explanation of the enigma. It was at laſt happily explained by Oedipus, who obſerved, that man walked on his hands and feet when young, or in the morning of life; at the noon of life he walked erect; and in the evening of his days he ſupported his infirmities upon a ſtick. (*Vid. Oedipus*). The ſphinx no ſooner heard this explanation than ſhe daſhed her head againſt a rock, and immediately expired. Some mythologiſts wiſh to unriddle the fabulous traditions about the ſphinx by the ſuppoſition that one of the daughters of Cadmus, or Laius, infeſted the country of Thebes by her continual depredations, becauſe ſhe had been refuſed a part of her father's poſſeſſions. The lion's paw expreſſed, as they obſerve, her cruelty, the body of the dog her laſciviouſneſs, her enigmas the ſnares ſhe laid for ſtrangers and travellers, and her wings the diſpatch ſhe uſed in her expeditions.

Among the Egyptians the ſphinx was the ſymbol of religion, by reaſon of the obſcurity of its myſteries; and on the ſame account the Romans placed a ſphinx in the pronaos or porch of their temples. Sphinxes were uſed by the Egyptians to ſhow the beginning of the water's riſing in the Nile: with this view, as it had the head of a woman and body of a lion, it ſignified that the Nile began to ſwell in the months of July and Auguſt, when the ſun paſſes through the ſigns of Leo and Virgo. There are ſeveral of theſe ſtill to be ſeen; one in particular, near the pyramids, much ſpoken of by the ancients; being of a prodigious ſize, and cut out of the rock; the head and neck appear only at preſent, the reſt of the body being hid in the ſand. This, according to Thevenot, is 26 feet high, and 15 feet from the ear to the chin: but Pliny aſſures us, the head was no leſs than 102 feet in circumference, and 62 feet high from the belly, and that the body was 143 feet long, and was thought to be the ſepulchre of King Amaſis.

The learned Mr. Bryant * obſerves, that the ſphinx ſeems to have been originally a vaſt rock of different ſtrata; which, from a ſhapeleſs maſs, the Egyptian faſhioned into an object of beauty and veneration. The Egyptians uſed this figure in their building; from them the Greeks derived it, and afterwards improved it into an elegant ornament. It is alſo frequently uſed in modern architecture.

It is proper to obſerve, that the ſphinx of the Egyptians is ſaid in the Aſiatic Reſearches † to have been found in India. Colonel Pearſe was told by Murari Pandit, a man of learning among the Hindoos, that the ſphinx, there called *ſingh*, is to appear at the end of the world, and as ſoon as he is born will prey on an elephant: he is therefore figured ſeizing an elephant in his claws; and the elephant is made ſmall, to ſhow that the *ſingh*, even a moment after his birth, will be very large in proportion to it. But in oppoſition to this account given by Murari Pandit, the late Sir William Jones, the learned and illuſtrious preſident of the Aſiatic Society, was aſſured by ſeveral Brahmans, that the figure taken for a ſphinx was a repreſentation of a lion ſeizing a young elephant. This point therefore requires farther inveſtigation.

SPHINX, *HAWK-Moth*, a genus of inſects belonging to the order of *lepidopteræ*. See ENTOMOLOGY *Index*.

SPIGELIA, WORM-GRASS, a genus of plants belonging,

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* *Ancient Mythology*, vol. iii. p. 532.

† Vol. ii. p. 334.

longing to the claſs of pentandria; and in the natural ſyſtem arranged under the 47th order, *Stellatæ*. See BOTANY and MATERIA MEDICA *Index*.

SPICE, any kind of aromatic drug that has hot and pungent qualities; ſuch are pepper, nutmeg, ginger, cinnamon, cloves, &c.

SPICE-Iſlands, in the Eaſt Indies. See BANDA, *MOLUCCA-Iſlands*, and CEYLON.

SPIDER. See ARANEA, ENTOMOLOGY *Index*.

SPIDERWORT. See PHALANGIUM, } BOTANY
SPIGNEL. See ATHAMANTA, } *Index*.

SPIKE, or *Oil of SPIKE*, a name given to an eſſential oil diſtilled from lavender, and much uſed by the varniſh-makers and the painters in enamel.

SPIKENARD. See NARDUS, BOTANY *Index*.

SPILANTHUS, a genus of plants belonging to the claſs of ſyngeneſia. See BOTANY *Index*.

SPINA CERVINA, an old name for rhamnus catharticus. See RHAMNUS, BOTANY *Index*.

SPINA Ventoſa, in *Surgery*, that ſpecies of corruption of the bones which takes its riſe in the internal parts, and by degrees enlarges the bone, and raiſes it into a tumor. See SURGERY.

SPINACIA, SPINAGE, a genus of plants belonging to the claſs of diœcia; and in the natural ſyſtem arranged under the 12th order, *Holoraceæ*. See BOTANY *Index*; and for an account of the method of cultivating ſpinage in the garden, ſee GARDENING.

SPINAGE, or SPINACH. See SPINACIA.

SPINÆ, in *Botany*, thorns, rigid prickles: a ſpecies of *arma*, growing on various parts of certain plants for their defence; *ſpinæ ramorum arcent pecora*. On the branches we find examples in the pyrus, prunus, citrus, hippophaes, gmelina, rhamnus, lycium, &c.; on the leaves, in the aloe, agave, yucca, ilex, hippomane, theophraſta, carlina, &c.; on the calyx, in the carduus cnicus, centaurea, moluccella, galeopſis, &c.; on the fruit, in the trapa, tribulus, murex, ſpinacia, agrimonia, datura, &c.

SPINAL MARROW. See ANATOMY *Index*.

SPINALIS, in *Anatomy*, the name of ſeveral muſcles, &c. of the ſpine.

SPINDLE, in *Geometry*, a ſolid body generated by the revolution of ſome curve line about its baſe or double ordinate; in oppoſition to a conoid, which is generated by the rotation of the curve about its axis or abſciſs, perpendicular to its ordinate. The ſpindle is denominated circular, elliptic, hyperbolic, or parabolic, according to the figure of its generating curve.

SPINDLE-TREE. See EUONYMUS, BOTANY *Index*.

SPINE, SPINA DORSI. See ANATOMY, N° 30.

SPINE. See SPINÆ.

SPINET, or SPINNET, a muſical inſtrument ranked in the ſecond or third place among harmonious inſtruments. It conſiſts of a cheſt or belly made of the moſt porous and reſinous wood to be found, and a table of fir glued on ſlips of wood called *ſummers*, which bear on the ſides. On the table are raiſed two little prominences or bridges, wherein are placed ſo many pins as there are chords or ſtrings to the inſtrument. It is played on by two ranges of continued keys, the former range being the order of the diatonic ſcale, and that behind the order of the artificial notes or ſemitones. The keys are ſo many flat pieces of wood, which, touched and preſſed down at the end, make the other raiſe a jack which ſtrikes and ſounds the ſtrings by means of the end of a crow's quill, wherewith it is armed. The 30 firſt ſtrings are of braſs, the other more delicate ones of ſteel or iron-wire; they are all ſtretched over the two bridges already mentioned. The figure of the ſpinet is a long ſquare or parallelogram; ſome call it an *harp couched*, and the harp an *inverted ſpinet*. See the article HARP.

This inſtrument is generally tuned by the ear, which method of the practical muſicians is founded on a ſuppoſition that the ear is a perfect judge of an octave and a fifth. The general rule is to begin at a certain note, as C, taken towards the middle of the inſtrument, and tuning all the octaves up and down, and alſo the fifths, reckoning ſeven ſemitones to each fifth, by which means the whole is tuned. Sometimes to the common or fundamental play of the ſpinet is added another ſimilar one in uniſon, and a third in octave to the firſt, to make the harmony the fuller; they are either played ſeparately or together by means of a ſtop: theſe are called *double* or *triple ſpinets*; ſometimes a play of violins is added, by means of a bow, or a few wheels parallel to the keys, which preſs the ſtrings and make the ſound laſt as long as the muſician pleaſes, and heighten and ſoften them more or leſs, as they are more or leſs preſſed. The harpſichord is a kind of ſpinet, only with another diſpoſition of the keys (ſee the article HARPSICHORD). The inſtrument takes its name from the ſmall quill ends which touch the ſtrings, reſembling *ſpinæ* or thorns.

SPINIFEX, a genus of plants belonging to the claſs of *polygamia*. See BOTANY *Index*.

SPINNING, in *Commerce*, the act or art of reducing ſilk, flax, hemp, wool, hair or other matters, into thread. Spinning is either performed on the wheel, or with a diſtaff and ſpindle, or with other machines proper for the ſeveral kinds of working. Hemp, flax, nettle-thread, and other like vegetable matters, are to be wetted in ſpinning: ſilks, wools, &c. are ſpun dry, and do not need water; yet there is a way of ſpinning or reeling ſilk as it comes off the caſes or balls, where hot and even boiling water is to be uſed (ſee SILK). The vaſt variety, and the importance of thoſe branches of our manufactures, which are produced from cotton, wool, and flax, ſpun into yarn, together with the cheapneſs of proviſions, and the low price of labour in many foreign countries, which are our rivals in trade, have occaſioned many attempts at home to render ſpinning more eaſy, cheap, and expeditious; for which ſee *COTTON-Spinning* and *COTTON MILLS*.

To give an intelligible and accurate deſcription of a cotton mill would be abundant employment for a volume. Our limits admit of nothing like this; but as we are certain that many of our readers have viewed a cotton mill with wonder, but not with intelligence, or with leiſure to trace the ſteps by which the wool from the bag ultimately aſſumes the form of a very fine thread. Bewildered by ſuch a complication of machinery, all in rapid motion, very few, we imagine, are able to recollect with diſtinctneſs and intelligence the eſſential part of the progreſs by which the form of the cotton is ſo wonderfully changed. Such readers will not think a page or two miſemployed, if they are thereby able to underſtand this particular, to which all the reſt of the proceſs is ſubſervient.

We paſs over the operation of carding, by which all the clots and inequalities of the cotton wool are removed, and the whole is reduced to an uniform thin fleece, about 20 inches broad. This is gradually detached from the finiſhing card, and, if allowed to hang down from it, would pile up on the floor as long as the mill continues to work; but it is guided off from the card, very tenderly, in a horizontal direction, by laying its detached end over a roller, which is ſlowly turned round by the machine. Another roller lies above the fleece, preſſing it down by its weight. By this preſſure, a gentle hold is taken of the fleece, and therefore the ſlow motion of the rollers draws it gently from the card at the ſame rate as it is diſengaged by the comb; but between the card and the rollers a ſet of ſmooth pins are placed in two rows, leading from the card to the rollers, and gradually approaching each other as we approach the rollers. By theſe pins the broad fleece is hemmed in on both ſides, and gradually contracted to a thick roll; and in this ſtate paſſes between the rollers, and is compreſſed in a pretty firm flat riband, about two inches broad, which falls off from the rollers, and piles up in deep tinplate cans ſet below to receive it.

It is upon this ſtripe or riband of cotton wool that the operation of ſpinning begins. The general effect of the ſpinning proceſs is to draw out this maſſive roll, and to twiſt it as it is drawn out. But this is not to be done by the fingers, pulling out as many cotton fibres at once as are neceſſary for compoſing a thread of the intended fineneſs, and continuing this manipulation regularly acroſs the whole end of the riband, and thus, as it were, nibbling the whole of it away. The fingers muſt be directed, for this purpoſe, by an attentive eye. But in performing this by machinery, the whole riband muſt be drawn out together, and twiſted as it is drawn. This requires great art, and very delicate management. It cannot be done at once; that is, the cotton roll cannot firſt be ſtretched or drawn out to the length that is ultimately produced from a tenth of an inch of the roll, and then be twiſted. There is not coheſion enough for this purpoſe; we ſhould only break off a bit of the roll, and could make no farther uſe of it. The fibres of cotton are very little implicated among each other in the roll, becauſe the operation of carding has laid them almoſt parallel in the roll; and though compreſſed a little by its contraction from a fleece of 20 inches to a riband of only two, and afterwards compreſſed between the diſcharging rollers of the carding machine, yet they cohere ſo ſlightly, that a few fibres may be drawn out without bringing many others along with them. For theſe reaſons, the whole thickneſs and breadth of two or three inches of the riband is ſtretched to a very minute quantity, and then a very ſlight degree of twiſt is given it, viz. about three turns in the inch; ſo that it ſhall now compoſe an extremely ſoft and ſpungy cylinder, which cannot be called a thread or cord, becauſe it has ſcarcely any firmneſs, and is merely rounder and much ſlenderer than before, being ſtretched to about thrice its former length. It is now called ſlab, or roove.

Although it be ſtill extremely tender, and will not carry a weight of two ounces, it is much more coheſive than before, becauſe the twiſt given to it makes all the longitudinal fibres bind each other together, and compreſs thoſe which lie athwart; therefore it will require more force to pull a fibre from among the reſt, but ſtill not nearly enough to break it. In drawing out a ſingle fibre, others are drawn out along with it; and if we take hold of the whole aſſemblage, in two places, about an inch or two inches aſunder, we ſhall find that we may draw it to near twice its length without any riſk of its ſeparating in any intermediate part, or becoming much ſmaller in one part than another. It ſeems to yield equably over all.

Such is the ſtate of the ſlab or roove of the firſt formation. It is uſually called the *preparation*; and the operation of ſpinning is conſidered as not yet begun. This preparation is the moſt tedious, and requires more attendance and hand labour than any ſubſequent part of the proceſs. For the ſtripes or ribands from which it is made are ſo light and bulky, that a few yards only can be piled up in the cans ſet to receive them. A perſon muſt therefore attend each thread of ſlab, to join freſh ſtripes as they are expended. It is alſo the moſt important in the manufacture: for as every inch of the ſlab meets with preciſely the ſame drawing and the ſame twiſting in the ſubſequent parts of the proceſs, therefore every inequality and fault in the ſlab (indeed in the fleece as it quits the finiſhing card) will continue through the whole manufacture. The ſpinning of cotton yarn now divides into two branches. The firſt, performed by what are called *jennies*, perfectly reſembles the ancient ſpinning with the diſtaff and ſpindle; the other, called *ſpinning of twiſt*, is an imitation of the ſpinning with the fly-wheel. They differ in the ſame manner as the ſpinning with the old wool or cotton wheel differs from the ſpinning with the flax-wheel. Mr Arkwright's chief invention, the ſubſtitution of machinery for the immediate work of the human finger, is ſeen only in the manufacture of twiſt. We ſhall therefore confine our attention to this.

The reſt of the proceſs is little more than a repetition of that gone through in making the firſt ſlab or roove. It is formed on bobins. Theſe are ſet on the back part of the drawing frame; and the end of the ſlab is brought forwards toward the attending workman. As it comes forward, it is ſtretched or drawn to about four-thirds of its former length, or lengthened one-third; and is then twiſted about twice as much as before, and in this ſtate wound up on another bobin. In ſome mills two rooves, after having been properly drawn, are brought together through one hole, and twiſted into one; but we believe that, in the greater number of mills, this is deferred to the ſecond drawing. It is only after the firſt drawing that the produce of the operation gets the name of *ſlab*; before this it is called *preparation*, or *roove*, or by ſome other name. The ſlab is ſtill a very feeble, ſoft, and delicate yarn, and will not carry much more weight than it did before in the form of roove. The perfection of the ultimate thread or yarn depends on this extreme ſoftneſs; for it is this only which makes it ſuſceptible of an equable ſtretching; all the fibres yielding and ſeparating alike.

The next operation is the *ſecond drawing*, which no way differs from the firſt, except in the different proportionings of the lengthening, and the proportion between the lengthening and the ſubſequent twiſt. On theſe points we cannot give any diſtinct information. It is different in different mills, and with different ſpecies of cotton wool, as may be eaſily imagined. The immediate mechaniſm or manipulation muſt be ſkilfully accommodated to the nature of that friction which the fibres of cotton exert on each other, enabling one of them to pull others along with it. This is greatly aided by the contorted curled form of a cotton fibre, and a conſiderable degree of elaſticity which it poſſeſſes. In this reſpect it greatly reſembles woollen fibres, and differs exceedingly from thoſe of flax: and it is for this reaſon that it is ſcarcely poſſible to ſpin flax in this way: its fibres become lank, and take any ſhape by the ſlighteſt compreſſion, eſpecially when damp in the ſlighteſt degree. But beſides this, the ſurface of a cotton fibre has a harſhneſs or roughneſs, which greatly augments their mutual friction. This is probably the reaſon why it is ſo unfit for tents and other dreſſings for wounds, and is refuſed by the ſurgeon even in the meaneſt hoſpitals. But this harſhneſs and its elaſticity fit it admirably for the manufacture of yarn. Even the ſhortneſs of the fibre is favourable; and the manufacture would hardly be poſſible if the fibre were thrice as long as it generally is. If it be juſt ſo long that in the finiſhed thread a fibre will rather break than come out from among the reſt, it is plain that no additional length can make the yarn any ſtronger with the ſame degree of compreſſion by twining. A longer fibre will indeed give the ſame firmneſs of adherence with a ſmaller compreſſion. This would be an advantage in any other yarn; but in cotton yarn the compreſſion is already as ſlight as can be allowed; were it leſs, it would become woolly and rough by the ſmalleſt uſage, and is already too much diſpoſed to teazle out. It can hardly be uſed as ſewing thread. Now ſuppoſe the fibres much longer; ſome of them may chance to be ſtretched along the ſlab through their whole length. If the ſlab is pulled in oppoſite directions, by pinching it at each end of ſuch fibres, it is plain that it will not ſtretch till this fibre be broken or drawn out; and that while it is in its extended ſtate, it is acting on the other fibres in a very unequal manner, according to their poſitions, and renders the whole apt to ſeparate more irregularly. This is one great obſtacle to the ſpinning of flax by ſimilar machinery; and it has hitherto prevented (we believe) the working up of any thing but the *ſhorts* or tow, which is ſeparated from the long fine flax in the operation of hatcheling.

A third, and ſometimes even a fourth, drawing is given to the ſlab formed on the bobins of this ſecond operation. The ſlab produced is now a ſlender, but ſtill extremely ſoft cord, ſuſceptible of conſiderable extenſion, without riſk of ſeparation, and without the ſmalleſt chance of breaking a ſingle fibre in the attempt. In one or more of the preparatory drawings now deſcribed, two, and ſometimes three ſlabs, of a former drawing, are united before the twiſt is given them. The practice is different in different mills. It is plain, that unleſs great care be taken to preſerve the ſlab extremely ſoft and compreſſible during the whole proceſs, the ſubſequent drawing becomes more precarious, and we run a riſk of at laſt making a bad looſe thread inſtead of a uniform and ſimple yarn. Such a thread will have very little lateral connection, and will not bear much handling without ſeparating into ſtrands. The perfection of the yarn depends on having the laſt ſlab as free of all appearance of ſtrands as poſſible.

The laſt operation is the ſpinning this ſlab. This hardly differs from the foregoing drawings in any thing but the twiſt that is given it after the laſt ſtretching in its length. This is much greater than any of the preceding, being intended to give the yarn hardneſs and firmneſs, ſo that it will now break rather than ſtretch any more.

The reader, moderately acquainted with mechanics, cannot but perceive that each of the operations now deſcribed, by which the roove is changed into the ſoft ſlab, and each of theſe into one ſlenderer and ſomewhat firmer, by alternately teazling out and twining the ſoft cord, is a ſubſtitute for a ſingle pull of the finger and thumb of the ſpinſter, which ſhe accommodates preciſely to the peculiar condition of the lock of wool which ſhe touches at the moment. She can follow this through all its irregularities; and perhaps no two ſucceeding plucks are alike. But when we cannot give this momentary attention to every minute portion, we muſt be careful to introduce the roove in a ſtate of perfect uniformity; and then every inch being treated in the ſame manner, the final reſult will be equable—the yarn will be uniform.

We are now to deſcribe the mechaniſm by which all this is effected. But we do not mean to deſcribe a cotton mill; we only mean to deſcribe what comes into immediate contact with the thread; and in ſo doing, to confine ourſelves to what is neceſſary for making the reader perceive its ability to perform the required taſk. We ſee many caſes where individuals can apply this knowledge to uſeful purpoſes. More than this would, we think, be improper, in a national point of view.

Plate ccccxci fig. 1.

Let ABC (fig. 1.) repreſent the ſection of a roller, whoſe pivot D does not turn in a pivot hole, but in the bottom of a long narrow notch DE, cut in an iron ſtandard. *a b c* is the ſection of another iron roller, whoſe pivot *d* is in the ſame notches at each end, while the roller itſelf lies or reſts on the roller ABC below it. The ſurfaces of theſe rollers are fluted lengthwiſe like a column: only the flutings are very ſmall and ſharp, like deep ſtrokes of engraving very cloſe together. It is plain, that if the roller ABC be made to turn ſlowly round its axis by machinery, in the direction ABC (as expreſſed by the dart), the roughneſs of the flutings will take hold of the ſimilar roughneſs of the upper roller *a b c*, and carry it round alſo in the direction of the dart, while its pivots are engaged in the notches DE, which they cannot quit. If therefore we introduce the end F of the cotton ſtring or riband, formed by the carding machine, it will be pulled in by this motion, and will be delivered out on the other ſide at H, conſiderably compreſſed by the weight of the upper roller, which is of iron, and is alſo preſſed down by a lever which reſts on its pivots, or other proper places, and is loaded with a weight. There is nothing to hinder this motion of the riband thus compreſſed between the rollers, and it will therefore be drawn through from the cans. The compreſſed part at H would hang down, and be piled up on the floor as it is drawn through; but it is not permitted to hang down in this manner, but is brought to another pair of ſharp fluted iron rollers K and L. Suppoſing this pair of rollers to be of the ſame diameter, and to turn round in the ſame time, and in the ſame direction, with the rollers ABC, *a b c*; it is plain that K and L drag in the compreſſed riband at I, and would deliver it on the other ſide at M, ſtill more compreſſed. But the roller K is made (by the wheelwork) to turn round more ſwiftly than

than ABC. The difference of velocity at the ſurface of the rollers is, however, very ſmall, ſeldom exceeding one part in 12 or 15. But the conſequence of this difference is, that the ſkein of cotton HI will be lengthened in the ſame proportion; for the upper rollers preſſing on the under ones with a conſiderable force, their ſharp flutings take good hold of the cotton between them; and ſince K and L take up the cotton faſter than ABC and *a b c* deliver it out, it muſt either be forcibly pulled through between the firſt rollers, or it muſt be ſtretched a little by the fibres ſlipping among each other, or it muſt break. When the extenſion is ſo very moderate as we have juſt now ſaid, the only effect of it is merely to begin to draw the fibres (which at preſent are lying in every poſſible direction) into a more favourable poſition for the ſubſequent extenſions.

The fibres being thus drawn together into a more favourable poſition, the cotton is introduced between a third pair of rollers O, P, conſtructed in the ſame way, but ſo moved by the wheelwork that the ſurface of O moves nearly or fully twice as faſt as the ſurface of K. The roller P being alſo well loaded, they take a firm hold of the cotton, and the part between K and O is nearly or fully doubled in its length, and now requires a little twining to make it roundiſh, and to conſolidate it a little.

It is therefore led ſloping downwards into a hole or eye in the upper pivot of the firſt fly, called a *jack*. This turns round an upright axis or ſpindle; the lower end of which has a pulley on it to give it motion by means of a band or belt, which paſſes round a drum that is turned by the machinery. This jack is of a very ingenious and complicated conſtruction. It is a ſubſtitute for the fly of the common ſpinning wheel. If made preciſely in the form of that fly, the thread, being ſo very bulky and ſpongy, and unable to bear cloſe packing on the bobin, would ſwag out by the whirling of the fly, and would never coil up. The bobin therefore is made to lie horizontally; and this occaſions the complication, by the difficulty of giving it a motion round a horizontal axis, in order to coil up the twiſted roove. Mr Arkwright has accompliſhed this in a very ingenious manner; the eſſential circumſtances of which we ſhall here briefly deſcribe. A is a roller of hard wood, having its ſurface cut into ſharp flutes longitudinally. On the axis, which projects through the ſide of the general frame, there is a pulley P, connected by a band with another pulley Q, turning with the horizontal axis QR. This axis is made to turn by a contrivance which is different in every different cotton mill. The ſimpleſt of all is to place above the pulley C (which is turned by the great band of the machinery, and thus gives motion to the jack), a thin circular diſc D, looſe upon the axis, ſo as to turn round on it without obſtruction. If this diſc exceed the pulley in breadth about $\frac{1}{10}$th of an inch, the broad belt which turns the pulley will alſo turn it; but as its diameter is greater than that of the pulley, it will turn ſomewhat ſlower, and will therefore have a relative motion with reſpect to the axis QR. This can be employed, in order to give that axis a very ſlow motion, ſuch as one turn of it for 20 or 30 of the jack. This we leave to the ingenuity of the reader. The bobin B, on which the roove is to be coiled up, lies on this roller, its pivots paſſing through upright ſlits in the ſides of the general frame. It lies on A, and is moved round by it, in the ſame manner as the uppermoſt of a pair of drawing rollers lies on the under one, and receives motion from it. It is evident that the fluted ſurface of A, by turning ſlowly round, and carrying the weight of the bobin, compreſſes a little the cotton that is between them; and its flutings, being ſharp, take a ſlight hold of it, and cauſe it to turn round alſo, and thus coil up the roove, pulling it in through the hole E in the upper pivot (which reſembles the fore pivot or eye of a ſpinning wheel fly) in ſo gentle a manner as to yield whenever the motion of the bobin is too great for the ſpeed with which the cotton ſkein is diſcharged by the rollers O and P.—N. B. The axis QR below, alſo gives motion to a guide within the jack, which leads the roove gradually from one end of the bobin to the other, and back again, ſo as to coil it with regularity till the bobin is full. The whole of this internal mechaniſm of the jack is commonly ſhut up in a tin cylinder. This is particularly neceſſary when the whirling motion muſt be rapid, as in the ſecond and third drawings. If open, the jacks would meet with much reſiſtance from the air, which would load the mill with a great deal of uſeleſs work.

The reader is deſired now to return to the beginning of the proceſs, and to conſider it attentively in its different ſtages. We apprehend that the deſcription is ſufficiently perſpicuous to make him perceive the efficacy of the mechaniſm to execute all that is wanted, and prepare a ſlab that is uniform, ſoft, and ſtill very extenſible; in ſhort, fit for undergoing the laſt treatment, by which it is made a fine and firm yarn.

As this part of the proceſs differs from each of the former, merely by the degree of twiſt that is given to the yarn, and as this is given by means of a fly, not materially different from that of the ſpinning wheel for flax, we do not think it at all neceſſary to ſay any thing more about it.

The intelligent reader is ſurely ſenſible that the yarn produced in this way muſt be exceedingly uniform. The uniformity really produced even exceeds all expectation; for even although there be ſome ſmall inequalities in the carded fleece, yet if theſe are not matted clots, which the card could not equaliſe, and only conſiſt of a little more thickneſs of cotton in ſome places than in others, when ſuch a piece of the ſtripe comes to the firſt roller, it will be rather more ſtretched by the ſecond, and again by the bobin, after the firſt very ſlight twining. That this may be done with greater certainty, the weights of the firſt rooving rollers are made very ſmall, ſo that the middle part of the ſkein can be drawn through, while the outer parts remain faſt held.

It is ſaid that a pound of the fineſt Bourbon cotton has been ſpun into a yarn extending a few yards beyond 119 miles!

Theſe contrivances have in ſome parts of Scotland been applied to the ſpinning of flax.

SPINNING Wheel. A very conſiderable improvement has been made by Mr Antis of Fulneck near Leeds of the common ſpinning wheel. It is well known, that hitherto much time has been loſt by ſtopping the wheel in order to ſhift the thread from one ſtaple on the flyer to another; but in Mr Antis's wheel the bobin is made to move backwards and forwards, ſo as to prevent the neceſſity of this perpetual interruption, as well as to obviate

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Plate ccccxcix. fig. 2.

viate the danger of breaking the thread and loſing the end. This is effected by the axis of the great wheel being extended through the pillar next the ſpinner, and formed into a pinion of one leaf A (fig. 2.), which takes into a wheel B, ſeven inches diameter, having on its periphery 97 teeth; ſo that 97 revolutions of the great wheel cauſe one of the leſſer wheel. On this leſſer wheel is fixed a ring of wire *c c c*; which, being ſupported on ſix legs, ſtands obliquely to the wheel itſelf, touching it at one part, and projecting nearly three quarters of an inch at the oppoſite one: near the ſide of this wheel is an upright lever C, about 15 inches long, moving on a centre, three inches from its lower extremity, and connected at the top to a ſliding bar D; from which riſes an upright piece of braſs E, which working in the notch of a pulley drives the bobin F backward and forward, according as the oblique wire forces a pin G in or out, as the wheel moves round. To regulate and aſſiſt the alternate motion, a weight H hangs by a line to the ſliding bar, and paſſing over a pulley I riſes and falls as the bobin advances or recedes, and tends conſtantly to keep the pin in contact with the wire. It is evident, from this deſcription, that one ſtaple only is wanted to the flyer; which, being placed near the extremity K, the thread paſſing through it is by the motion of the bobin laid regularly thereon. For this invention the Society inſtituted at London for the Encouragement of Arts, &c. gave the author a premium of 20 guineas.

SPINOSUS CAULIS, in *Botany*, a ſtem covered with ſtrong woody prickles, whoſe roots are not ſuperficial, but proceeding from the body of the ſtem. When applied to a leaf, *ſpinoſum folium*, it indicates the margin running out into rigid points or prickles, *quod margine exit in acumina duriora, rigida, pungentia*.

SPINOUS, in *Botany*. See SPINOSUS.

SPINOUS Fiſhes, ſuch as have ſome of the rays of the back fins running out into thorns or prickles, as the perch, &c.

SPINOZA, BENEDICT, was born at Amſterdam the 24th November 1632. His father was a Jew of Portugal, by profeſſion a merchant. After being taught Latin by a phyſician, he applied himſelf for many years to the ſtudy of theology, and afterwards devoted himſelf entirely to philoſophy. He began very early to be diſſatisfied with the Jewiſh religion; and as his temper was open, he did not conceal his doubts from the ſynagogue. The Jews, it is ſaid, offered to tolerate his infidelity, and even promiſed him a penſion of a thouſand dollars per annum, if he would remain in their ſociety, and continue outwardly to practiſe their ceremonies. But if this offer was really made, he rejected it, perhaps from his averſion to hypocriſy, or rather becauſe he could not endure the reſtraint which it would have impoſed. He alſo refuſed being conſtituted heir to an independent fortune, to the prejudice of the natural claimants; and he learned the art of poliſhing glaſs for ſpectacles, that he might ſubſiſt independently of every one.

He would probably have continued in the ſynagogue for ſome time longer, had it not been for an accident. As he was returning home one evening from the theatre he was ſtabbed by a Jew: the wound was ſlight; but the attempt naturally led Spinoſa to conclude that the Jews had formed the deſign of aſſaſſinating him. After leaving the ſynagogue he became a Chriſtian, and frequented the churches of the Lutherans and Calviniſts. He now devoted himſelf more than ever to his favourite philoſophical ſpeculations; and finding himſelf frequently interrupted by the viſits of his friends, he left Amſterdam, and ſettled at the Hague, where he often continued for three months together without ever ſtirring from his lodging. During his reſidence in that city, his hoſteſs, who was a Lutheran, aſked him one day if ſhe could be ſaved while ſhe continued in her religion? "Yes (replied Spinoza) provided you join to your religion a peaceable and virtuous life." From this anſwer it has been concluded that he was a Chriſtian in appearance only, while in reality he regarded all religions as indifferent. But this concluſion would be too ſevere, even if the woman had been a Mahometan. His *Tractatus Theologico-politicus*, which was publiſhed about that time, is a better proof of his inſincerity than a thouſand ſuch concluſions; for this book contains all thoſe doctrines in embryo which were afterwards unfolded in his *Opera Poſthuma*, and which are generally conſidered as a ſyſtem of atheiſm.

His fame, which had now ſpread far and wide, obliged him ſometimes to interrupt his philoſophical reveries. Learned men viſited him from all quarters. While the prince of Conde commanded the French army in Utrecht, he intreated Spinoza to viſit him; and though he was abſent when the philoſopher arrived, he returned immediately, and ſpent a conſiderable time with him in converſation. The elector Palatine offered to make Spinoza profeſſor of philoſophy at Heidelberg; which, however, he declined.

He died of a conſumption at the Hague on the 21ſt February 1677, at the age of 45. His life was a perpetual contradiction to his opinions. He was temperate, liberal, and remarkably diſintereſted; he was ſociable, affable, and friendly. His converſation was agreeable and inſtructive, and never deviated from the ſtricteſt propriety.

The only edition of the works of Spinoza that we have ſeen is in two volumes ſmall 4to; the former of which was printed at Hamburg in the year 1670, and the latter we know not where, in 1677, a few months after his death. In the *Tractatus Theologico-politicus*, already mentioned, he treats of *prophecy* and *prophets*; and of the *call of the Hebrews*, whom he affirms to have been diſtinguiſhed from other nations only by the admirable form of their government, and the fitneſs of their laws for long preſerving their political ſtate. He is likewiſe of opinion, or at leaſt pretends to be ſo, that God may, in what we call a *ſupernatural way*, have given political inſtitutes to other nations as well as to the Hebrews, who were, he ſays, at no time a peculiar people to the Supreme Lord of heaven and earth; for, according to him, all hiſtory, ſacred and profane, teſtifies that every nation was bleſſed with the light of prophecy. That light, indeed, if his notions of it be juſt, was of very little value. He labours to prove, that the prophets were diſtinguiſhed from other men only by their piety and virtue; that their revelations depended wholly on their imaginations and the diſpoſitions of their minds; that they were often groſsly ignorant and highly prejudiced; that the ſpeculative opinions of one prophet are ſeldom in uniſon with thoſe of another; and that their writings are valuable to us only for the excellent rules which he acknowledges they contain reſpecting the practice of piety and virtue. He then proceeds to treat of the divine law and of miracles; and endeavours to prove that no miracle, in the proper ſenſe of the word, can have been at any time performed; becauſe every thing happens by a neceſſity of nature, the reſult of the divine decrees, which are from all eternity neceſſary themſelves. He acknowledges, that in the Scriptures, which he profeſſes to admit as true hiſtory, miracles are often mentioned; but he ſays that they were only ſingular events which the ſacred hiſtorians *imagined* to be miraculous: and he then gives ſome very extraordinary rules for interpreting the books of the Old and New Teſtaments where they treat of miracles, or appear to foretel future events. See our articles MIRACLE and PROPHECY.

Having thus diveſted the Scriptures of every thing characteriſtic of a revelation from heaven, he next calls in queſtion their authenticity. He affirms, in contradiction to the cleareſt internal evidence, that the Pentateuch and all the other hiſtorical books muſt have been written by one man; and that man, he thinks, could not have flouriſhed at a period earlier than that of Ezra. The grounds of this opinion are unworthy of the talents of Spinoza; for that he had talents is incontrovertible. His principal objection to the authenticity of the Pentateuch is, that Moſes is made to ſpeak of himſelf in the third perſon, and to talk of the Canaanites being then in the land; and becauſe he finds in his writings, as well as in the books of Joſhua, Judges, Ruth, Samuel, &c. places deſigned by names which he ſuppoſes they had not in the early ages of which theſe books contain the hiſtory, he concludes that theſe writings muſt be one compilation from ancient records made at a very late period; more eſpecially as the author often ſpeaks of things of great antiquity remaining to this day. The books of Eſther, Ezra, Nehemiah, and Chronicles, muſt have been compiled, he thinks, under the Maccabees; and he ſeems to conſider as of equal value with them the ſtory of Tobit, and the other two apocryphal treatiſes intitled the Wiſdom of Solomon and Eccleſiaſticus.

Theſe ſenſeleſs cavils, worthy only of one of thoſe modern freethinkers whoſe learning, in the opinion of Biſhop Warburton, is not ſufficient to carry them even to the confines of rational doubt, we have ſufficiently obviated in another place (ſee SCRIPTURE, Nº 8—31.). Spinoza urges them againſt the other books of the Old Teſtament. The prophecies of Iſaiah, Jeremiah, Ezekiel, Daniel, Hoſea, and Jonah, are, as we have them, only fragments, he ſays, of the writings of thoſe men compiled by the Phariſees under the ſecond temple from ancient and voluminous records.

In the midſt of this dogmatical ſcepticiſm, if we may uſe ſuch a phraſe, he bears ſuch a teſtimony to the laſt chapters of the book of Daniel, as we ſhould not have looked for in the writings either of a Jew or of a Deiſt. After detailing the various hypotheſes which in his time were held reſpecting the author and the intention of the book of *Job*; in which, he ſays, MOMUS is called SATAN, he proceeds in theſe words: "Tranſeo ad Danielis librum; hic ſine dubio ex cap. 8. ipſius Danielis ſcripta continet. Undenam autem priora ſeptem capita deſcripta fuerint, neſcio *;" thus admitting the famous prophecy of the ſeventy weeks. The canon of the Old Teſtament, he ſays, was finally ſettled by rabbins of the Phariſaical ſect, who wiſhed to exclude from it the books of *Proverbs*, *Eccleſiaſtes*, and *Ezekiel*, as they had actually excluded others of equal value; but the three books in queſtion were inſerted by the influence of two of the rabbis of greater wiſdom and integrity than the reſt.

That ſo paradoxical a writer, who had been originally a Jew, and was now almoſt a Deiſt, ſhould have treated the New Teſtament with as little ceremony as the Old, will not ſurpriſe the intelligent reader. He begins his remarks, however, with affirming, that no man can peruſe the Chriſtian Scriptures, and not acknowledge the apoſtles to have been prophets; but he thinks that their mode of propheſying was altogether different from that which prevailed under the Moſaic diſpenſation; and that the gift, whatever it was, forſook them the inſtant that they left off *preaching*, as their *writings* have to him every appearance of human compoſitions. This diſtinction between Chriſtian and Jewiſh prophecy is the more wonderful, that he founds it principally on the diſſimilarity of *ſtyle* viſible in the writings of the Old and New Teſtaments; though, in his ſecond chapter, which treats of the works of the Jewiſh prophets, he ſays expreſsly, "Stylus deinde prophetiæ pro eloquentia cujuſque prophetæ variabat, prophetiæ enim Ezekielis et Amoſis non ſunt, ut illæ Eſaiæ, Nachumi, eleganti, ſed rudiore ſtylo ſcriptæ." That the Hebrew ſcholar may be convinced of the truth of this remark, he recommends to him to ſtudy diligently the writings of theſe prophets, and to conſider the occaſions on which their prophecies were uttered: "Quæ ſi omnia rectè perpendentur (ſays he) facilè oſtendant, Deum nullum habere ſtylum peculiarem dicendi, ſed tantum pro eruditione, et capacitate prophetæ eatenus eſſe elegantem, compendioſum, ſeverum, rudem, prolixum, et obſcurum." Another objection brought by Spinoza againſt the prophecies of the New Teſtament ariſes from the authors of them having been at all times maſters of themſelves. This, ſays he, was peculiarly the caſe of St Paul, who often confirms his doctrine by *reaſoning*, which the Jewiſh prophets never condeſcended to do, as it would have ſubmitted their dogmas to the examination of *private judgment*. Yet, with ſingular inconſiſtency, he affirms, that the Jewiſh prophets could not know that the impreſſions made on their imaginations proceeded from God, but by a ſign given them, which by their own *reaſon* or *judgment* they knew would never be vouchſafed to an impious or a wicked man.

After theſe very free remarks on the Scriptures of the Old and New Teſtaments, he naturally enough expreſſes a ſuſpicion, that by thoſe who conſider the Bible as the epiſtle of God ſent from heaven to men, he will be thought to have ſinned againſt the Holy Ghoſt by vilifying his dictates. This leads him to inquire in what ſenſe the Scriptures are the word of God; and he gravely determines them to be ſo only as they *actually* contribute to make men more virtuous and holy. It is not enough that they are *calculated* to improve virtue and holineſs: for ſhould the words of the languages in which they are written acquire in proceſs of time a ſignification different from what they had originally; ſhould mankind loſe all knowledge of theſe languages; or even ſhould they agree to neglect the books, whether from ignorance or from wilfulneſs—thoſe books would ceaſe

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* T[illegible]tatus, [illegible]p. x. p. 1

to be the word of God, and become nothing better than waſte paper and ink; juſt as the two tables, which Moſes broke on obſerving the idolatry of his countrymen, were not the covenant between Jehovah and the Iſraelites, but merely two pieces of ſtone! The Scriptures, however, are the word of God, becauſe they teach the true religion of which God is the author; and they have taught it in ſuch a manner, he ſays, that it can never be loſt or corrupted whatever become of the books of the Old and New Teſtaments, or of the languages in which they are written. The whole of religion, as the Scriptures themſelves teſtify, conſiſts in the love of God above all things, and of our neighbours as ourſelves: whence it follows, that we muſt believe that God exiſts, and watcheth over all things by his providence; that he is omnipotent, and has decreed the pious to be ultimately happy, and the impious miſerable; and that our final ſalvation depends ſolely on His grace or favour. Theſe truths, with their neceſſary conſequences, are the word of God: they are clearly taught in the Scriptures, and can never be corrupted; but every thing elſe in theſe volumes is vain, he ſays, and of no greater importance to us than facts related in any other ancient and authentic hiſtory.

Such are the opinions which were entertained of revelation by a man, whom a critic, writing in a Chriſtian country, and profeſſing to be a zealous Chriſtian himſelf, has lately pronounced to have been a *choſen veſſel*. For what purpoſe he was *choſen* it is not eaſy to conceive. His religion, as it appears in the *Tractatus*, is the worſt kind of Deiſm, and his politics are ſuch as our monthly critics are not wont to teach, and ſuch as we truſt ſhall never be ſeriouſly taught by any Britiſh ſubject. By the law of nature, he ſays, every man before the formation of civil government has an unqueſtionable right to whatever appears eligible either to his reaſon or to his appetites; and may get poſſeſſion of it by *intreaty*, by *violence*, by *fraud*, or by *any other means* attended with leſs trouble to himſelf (*ſive vi, ſive dolo, ſive precibus, ſive quocunque demum modo facilius poterit*); and may treat as an enemy every perſon who ſhall attempt to obſtruct his purpoſe. But when men agree to devolve this right upon others, and to conſtitute a political ſtate, which both reaſon and appetite muſt perſuade them to do, then are they in duty bound to obey every mandate of the government, however abſurd it may be (*omnia mandata tametſi abſurdiſſima*), as long as that government can enforce its edicts, and no longer; for according to him, right and power are ſo inſeparably united, that when a government loſes its power, it has no longer the ſmalleſt claim to obedience. This doctrine, he ſays, is moſt *obviouſly* juſt when taught of democratical governments; but it is in fact equally true of monarchies and ariſtocracies: "Nam quiſquis ſummam habet poteſtatem, ſive unus ſit, ſive pauci, ſive denique omnes, certum eſt ei ſummum jus *quicquid velit imperandi*, competere: et præterea quiſquis poteſtatem ſe defendendi, ſive ſponte, ſive *vi coactus*, in alium tranſtulit, eum ſuo jure naturali planè ceſſiſſe, et conſequenter eidem ad omnia abſolutè parere decreviſſe quod omnia præſtare tenetur, quamdiu rex, ſive nobiles, ſive populus ſummam, quam acceperunt, poteſtatem, quæ juris transferendi fundamentum fuit, conſervant; nec his plura addere opus eſt *." We heartily agree with him, that to this precious concluſion it is needleſs to add a ſingle word.

Taking our leave therefore of his *Tractatus Theologico-politicus*, we ſhall now give our readers a ſhort account of his *Opera Poſthuma*. Theſe conſiſt of, 1. ETHICA, *more geometrico demonſtrata*; 2. POLITICA; 3. DE EMENDATIONE INTELLECTUS; 4. EPISTOLÆ, *et ad eas* RESPONSIONES; 5. COMPENDIUM GRAMMATICES LINGUÆ HEBRÆÆ.

The ETHICA are divided into five parts, which treat in order, *de* DEO; *de natura et origine* MENTIS; *de origine et natura* AFFECTUUM; *de* SERVITUTE *humana, ſeu de* AFFECTUUM VIRIBUS; *de* POTENTIA INTELLECTUS, *ſeu de* LIBERTATE *humana*. As the author profeſſes to tread in the footſteps of the geometers, and to deduce all his concluſions by rigid demonſtration from a few ſelf-evident truths, he introduces his work, after the manner of Euclid, with a collection of *definitions* and *axioms*. Theſe are couched in terms generally ambiguous; and therefore the reader will do well to conſider attentively in what ſenſe, if in any, they can be admitted; for it will not be found eaſy to grant his premiſes, and at the ſame time refuſe his concluſions. His definition of ſubſtance, for inſtance, is ſo expreſſed as to admit of two ſenſes; in one of which it is juſt, whilſt in the other it is the parent of the moſt impious abſurdity. We ſhall give it in his own words: "Per ſubſtantiam intelligo id, quod in ſe eſt, et per ſe concipitur: hoc eſt id, cujus conceptus non indiget conceptu alterius rei, à quo formari debeat." If by this be meant, that a ſubſtance is that which we can conceive by itſelf without *attending* to any thing elſe, or *thinking* of its formation, the definition, we believe, will be admitted by every reflecting mind as ſufficiently diſtinguiſhing the thing defined from an attribute, which, he ſays, is that which we perceive *of* a ſubſtance, and which we certainly cannot conceive as exiſting by itſelf. Thus the writer of this article can ſhut his eyes and contemplate in idea the ſmall 4to volume now before him, without attending to any thing elſe, or thinking of its paradoxical author, or even of the Great Being who created the matter both of him and of it; but he cannot for an inſtant contemplate the yellow colour of its vellum boards without thinking of triple extenſion, or, in other words, of body. The book therefore is a *ſubſtance*, becauſe conceivable by itſelf; the colour is an *attribute* or *quality*, becauſe it cannot be conceived by itſelf, but neceſſarily leads to the conception of ſomething elſe. But if Spinoza's meaning be, that nothing is a ſubſtance but what is conceived as exiſting from eternity, independent of every thing as a cauſe, his definition cannot be admitted; for every man conceives that which in himſelf thinks, and wills, and is conſcious, as a ſubſtance; at the ſame time that he has the beſt evidence poſſible that he exiſted not as a conſcious, thinking, and active being, from eternity.

His fourth axiom is thus expreſſed: "Effectus cognitio à cognitione cauſæ dependet, et eandem involvit;" and his fifth, "Quæ nihil commune cum ſe invicem habent, etiam per ſe invicem intelligi non poſſunt, ſive conceptus unius alterius conceptum non involvit." The former of theſe propoſitions, ſo far from being ſelf-evident, is not even true; and the latter is capable of two ſenſes very different from each other. That every effect

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* *Tractatus*, cap. xvi. p. 181.

Spinoza.

fect proceeds from *a cauſe*, is indeed an axiom; but ſurely we may know the effect accurately, though we be ignorant of the *particular* cauſe from which it proceeds (ſee PHILOSOPHY, N° 36; and PHYSICS, N° 91, &c.); nor does the knowledge of the one by any means involve the knowledge of the other. If different things have nothing in common, it is indeed true that the knowledge of one of them will not give us an *adequate conception* of the other; but it will in many caſes compel us to believe, that the other *exiſts* or has exiſted. A parcel of gunpowder lying at reſt has nothing in common with the velocity of a cannon-ball; yet when we know that a ball has been driven with velocity from a cannon, we infer with certainty that there has been a parcel of powder at reſt in the chamber of that cannon.

It is upon ſuch ambiguous definitions and axioms as theſe that Spinoza has raiſed his pretended demonſtrations, that one ſubſtance cannot produce another; that every ſubſtance muſt neceſſarily be infinite; that no ſubſtance exiſts or can be conceived beſides God; and that extended ſubſtance or body is one of the infinite *attributes* of God. We ſhall not waſte our own time or the reader's with a formal confutation of theſe impious abſurdities. We truſt they are ſufficiently confuted in other articles of this work (ſee METAPHYSICS, Part III. PROVIDENCE, and THEOLOGY, Part I.); and whoever wiſhes for a more particular examination of the author's principles, may find it in Dr Clarke's Demonſtration of the Being and Attributes of God. The truth, however, is, that no man will need the aſſiſtance of that eminent metaphyſician to diſcover the fallacy of the reaſoning by which they are attempted to be proved, if he affix *any one preciſe meaning* to the definitions and axioms, and adhere to that meaning ſteadily through the whole proceſs of the pretended demonſtrations.

By way of apology for this jargon, it has been lately ſaid, that "Spinoza takes the word *ſubſtance* in its moſt ſimple and perfect ſenſe; which is neceſſary, as he writes mathematically, and propoſes a ſimple idea as the foundation of his theory. What is the proper ſignification of a ſubſtance? Is it not that which ſtands alone, which has the cauſe of its exiſtence within itſelf? I wiſh that this ſimple meaning of the word could be univerſally admitted in philoſophy. Strictly ſpeaking, no worldly thing is a ſubſtance; ſince all mutually depend on each other, and finally on God, who, in this exalted ſenſe, is the only *ſubſtance*. The word *modification* ſounds harſh and improper, and therefore it cannot be expected to gain a place in philoſophy; but if the ſchool of Leibnitz may term matter the *appearance of ſubſtances*, why may not Spinoza be allowed a bolder term? Worldly ſubſtances are kept in union by divine power, as it was by divine power that they had exiſtence. They repreſent alſo, if you pleaſe, *modified* appearances of divine power; each according to the ſtation, the time, and the organs, in and with which it appears. The phraſe uſed by Spinoza is conciſe, and it gives an unity and ſimplicity to his whole ſyſtem, however ſtrange it may ſound in our ears."

Herder's Dialogues concerning God.

From this account of Spinoziſm, one who had never looked into the works of the author would be led to ſuppoſe that his ſyſtem is the ſame with that of Berkeley; which, denying the exiſtence of material ſubſtance, attributes all our perceptions of what we call the qualities of body to the immediate agency of the Deity on our minds (ſee METAPHYSICS, Part II. chap. 3.). But Spinoza's doctrine is very different. According to him, bodies are either attributes or affections of God; and as he ſays there is but one extended ſubſtance, he affirms that ſubſtance to be indiviſible, and employs a long ſcholium † to prove that thoſe are miſtaken who ſuppoſe it finite and not *eſſential to the Deity*. That we do not miſrepreſent his ſentiments, the learned reader will be convinced by the two following definitions, with which he introduces that part of his ethics which treats of the nature and origin of mind. 1. "Per corpus intelligo modum, qui Dei eſſentiam, quatenus, ut res extenſa conſideratur, certo et determinato modo exprimit." 2. "Ad eſſentiam alicujus rei id pertinere dico, quo dato res neceſſario ponitur, et quo ſublato res neceſſario tollitur; vel id, ſine quo res, et vice verſa quod ſine re nec eſſe nec concipi poteſt." In conformity with theſe definitions, he attempts to prove that God is an extended as well as a thinking ſubſtance; that as a thinking ſubſtance he is the cauſe of the *idea* of a circle, and as an extended ſubſtance of the *circle* itſelf; and that the minds of men are not ſubſtances, but certain modifications of the divine attributes; or, as he ſometimes expreſſes it. "Quod humanæ mentis actuale conſtituit, eſt idea rei ſingularis actu exiſtentis." Hence, he ſays, it follows that the human mind is a part of the intellect of the infinite God; ſo that when we ſpeak of the human mind perceiving this or that, we can only mean that God, not as he is infinite, but as he appears in the human mind or conſtitutes its eſſence, has this or that idea; and when we ſpeak of God's having this or that idea, we muſt conceive of Him not only as conſtituting the human mind, but as, together with it, having the idea of ſomething elſe (A). In another place he tells us, that the human mind is nothing but the *idea* which God has of the human body as actually exiſting; that this *idea* of the body, and the *body* itſelf, are one and the ſame thing; and that thinking and extended ſubſtances are in reality but one and the ſame ſubſtance, which is ſometimes comprehended under one attribute of the Deity, and ſometimes under another *.

† See his Prop. xv. &c.

Prop. vii. xi. Part ii.

* Prop. vii. xiii. xxi. Part ii.

If this impious jargon be not Atheiſm, or as it has been ſometimes called Pantheiſm, we know not what it is (ſee PANTHEISM). According to Spinoza, there is but one ſubſtance, which is extended, infinite, and indiviſible. That ſubſtance indeed he calls God; but he labours to prove that it is corporeal; that there is no difference between mind and matter; that both are attributes

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(A) Hinc ſequitur mentem humanam partem eſſe infiniti intellectus Dei; ac proinde cum dicimus, mentem humanam hoc vel illud percipere, nihil aliud dicimus quam quod Deus, non quatenus infinitus eſt, ſed quatenus per naturam humanæ mentis explicatur, ſive quatenus humanæ mentis eſſentiam conſtituit, hanc vel illam habet ideam: et cum dicimus Deum hanc vel illam ideam habere, non tantum, quatenus naturam humanæ mentis conſtituit; ſed quatenus ſimul cum mente humana alterius rei etiam habet ideam. *Corol.* prop. xi. part 2.

tributes of the Deity variouſly conſidered; that the human ſoul is a part of the intellect of God; that the ſame ſoul is nothing but the idea of the human body; that this idea of the body, and the body itſelf, are one and the ſame thing; that God could not exiſt, or be conceived, were the viſible univerſe annihilated; and therefore that the viſible univerſe is either the one ſubſtance, or at leaſt an eſſential attribute or modification of that ſubſtance. He ſometimes indeed ſpeaks of the *power* of this ſubſtance; but when he comes to explain himſelf, we find that by power he means nothing but blind neceſſity *; and though he frequently talks of the *wiſdom* of God, he ſeems to make uſe of the word without meaning. This we think evident from the long appendix to his 36th propoſition; in which he labours to prove that the notion of final cauſes is an idle figment of the imagination, ſince, according to him, nothing but the prejudices of education could have led men to fancy that there is any real diſtinction between *good* and *evil*, *merit* and *demerit*, *praiſe* and *reproach*, *order* and *confuſion*; that *eyes* were given them that they might be enabled to *ſee*; *teeth* for the purpoſe of chewing their *food*; *herbs* and *animals* for the *matter* of that *food*; that the *ſun* was formed to give light, or the *ocean* to nouriſh *fiſhes*. If this be true, it is impoſſible to diſcover wiſdom in the operations of his *one ſubſtance*; ſince, in common apprehenſion, it is the very characteriſtic of folly to act without any end in view.

Such are the reveries of that writer, whoſe works a German philoſopher of ſome name has lately recommended to the public, as calculated to convey to the mind more juſt and ſublime conceptions of God than are to be found in moſt other ſyſtems. The recommendation has had its effect. A literary journaliſt of our own, reviewing the volume in which it is given, feels a peculiar ſatisfaction from the diſcovery, that Spinoza, inſtead of a formidable enemy to the cauſe of virtue and religion, was indeed their warmeſt friend; and piouſly hopes that we ſhall become more cautious not to ſuffer ourſelves to be deceived by empty names, which thoſe who *cannot* reaſon (Sir Iſaac Newton and Dr Clarke perhaps) give to thoſe who can (Hobbes, we ſuppoſe, and Spinoza). But though we have the honour to think on this queſtion with our illuſtrious countrymen, we have no deſire to depict Spinoza as a *reprobate*, which the critic ſays has often been done by ignorance and enthuſiaſm. We admit that his conduct in active life was irreproachable; and for his ſpeculative opinions, he muſt ſtand or fall to his own Maſter.' His Ethics appear to us indeed a ſyſtem ſhockingly impious; and in the tract intitled POLITICA, *power* and *right* are confounded as in the former volume; but in the treatiſe DE INTELLECTUS EMENDATIONE, are ſcattered many precepts of practical wiſdom, as well as ſome judicious rules for conducting philoſophical inveſtigation; and we only regret, that the reader muſt wade to them through pages of fataliſm, ſcepticiſm, and palpable contradictions. His *Compendium Grammatices Linguæ Hebrææ*, though left imperfect, appears to have ſo much merit, that it is to be wiſhed he had fulfilled his intention of writing a philoſophical grammar of that language, inſtead of waſting his time on abſtruſe ſpeculations, which though they ſeem not to have been injurious to his own virtue, are certainly not calculated to promote the virtue of others, or to increaſe the ſum of human happineſs.

SPIRÆA, a genus of plants belonging to the claſs of icoſandria, and to the order of pentagynia; and in the natural ſyſtem arranged under the 26th order, *Pomaceæ*. See BOTANY *Index*.

SPIRAL, in *Geometry*, a curve line of the circular kind, which in its progreſs recedes from its centre.

SPIRE, in *Architecture*, was uſed by the ancients for the baſe of a column, and ſometimes for the aſtragal or tore; but among the moderns it denotes a ſteeple that continually diminiſhes as it aſcends, whether conically or pyramidally.

SPIRIT, in *Metaphyſics*, an incorporeal being or intelligence; in which ſenſe God is ſaid to be a ſpirit, as are angels and the human ſoul. See METAPHYSICS, Part III.

SPIRIT, in *Chemiſtry* and *Pharmacy*, a name applied to every volatile liquid which is not inſipid like phlegm or water; and hence the diſtinction into acid, alkaline, and vinous ſpirits.

SPIRIT of Wine. See ALCOHOL, CHEMISTRY *Index*; DISTILLATION, and MATERIA MEDICA *Index*.

SPIRITS, or ANIMAL SPIRITS. See ANATOMY, Part V. N° 136.

SPIRITUAL, in general ſomething belonging to or partaking of the nature of ſpirit. See SPIRIT.

SPIRITUOUS LIQUORS have in all nations been conſidered as a proper ſubject of heavy taxation for the ſupport of the ſtate. This has naturally occaſioned a nice examination of their ſtrength. It having been at laſt found that this was intimately connected with the ſpecific gravity, this has been examined with the moſt ſcrupulous attention to every circumſtance which could affect it, ſo that the duties might be exactly proportioned to the quantity of ſpirit in any ſtrong liquor, independent on every other circumſtance of flavour or taſte, or other valued quality. The chemiſt at laſt found that the baſis of all ſtrong liquors is the ſame, produced by the vinous fermentation of pure ſaccharine matter diſſolved in water. He alſo found, that whether this vegetable ſalt be taken as it is ſpontaneouſly formed in the juices of plants and fruits, or as it may be formed or extricated from farinaceous fruits and roots by a certain part of the proceſs of vegetation, it produces the ſame ardent ſpirit, which has always the ſame denſity in every mixture with water. The minute portions of aromatic oils, which are in ſome degree inſeparable from it, and give it a different flavour according to the ſubſtance from which it was obtained, are not found to have any ſenſible effect on its denſity or ſpecific gravity. This ſeems very completely eſtabliſhed in conſequence of the unwearied attempts of the manufacturers to leſſen the duties payable on their goods by mixtures of other ſubſtances, which would increaſe their denſity without making them leſs palatable. The vigilance of the revenue officers was no leſs employed to detect every ſuch contrivance. In ſhort, it is now an acknowledged point, that the ſpecific gravity is an accurate teſt of the ſtrength.

But though this is true in general, we cannot derive much benefit from it, unleſs we know the preciſe relation between the ſtrength and the denſity of a ſpirituous liquor. Do they increaſe *pari paſſu*, or by what

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* Prop. xxxiii. Part I.

law are they connected? It was natural to expect that equal additions of ardent ſpirits or alcohol to a given quantity of water would produce equal diminutions of denſity. Areometers were accordingly made on this principle above 200 years ago, as may be ſeen in the works of Gaſpar Schottus, Sturmius, Agricola, and other old authors. But when mathematical phyſics became more generally known, this was eaſily diſcovered to be erroneous; and it was ſhown (we think firſt by Mr Boyle) that equal additions to the ſpecific gravity would be produced by ſucceſſively taking out of any veſſel a certain meaſure of alcohol and replacing it with an equal meaſure of water. This was the moſt convenient diſcovery for all parties, becauſe then the duties payable on a caſk of ſpirits would be in the exact proportion of the diminution of its denſity. But it was ſoon found by thoſe who were appointed guardians of the revenue that this concluſion was erroneous, and that a mixture which appeared by this rule to contain 35 gallons of alcohol, did really contain 35½. This they found by actually making ſuch a mixture: 18 gallons of alcohol mixed with 18 of water produced only 35 gallons of ſpirits. The revenue officers, finding that this condenſation was moſt remarkable in mixtures of equal parts of water and the ſtrongeſt ſpirits which could then be procured, determined to levy the duties by this mixture; becauſe, whether the ſpirituous liquor was ſtronger or weaker than this, it would appear, by its ſpecific gravity, rather ſtronger than it really was. This ſagacious obſervation, and the ſimplicity of the compoſition, which could at all times be made for compariſon, ſeem to be the reaſons for our exciſe offices ſelecting this mode of eſtimating the ſtrength and levying the duties. A mixture of nearly equal meaſures of water and alcohol is called PROOF SPIRIT, and pays a certain duty per gallon; and the ſtrength of a ſpirituous liquor is eſtimated by the gallons, not of alcohol, but of proof ſpirit, which the caſk contains. But becauſe it might be difficult to procure at all times this proof ſpirit for compariſon, ſuch a mixture was made by order of the board of exciſe: and it was found, that when ſix gallons of it was mixed with one gallon of water, a wine gallon of the mixture weighed 7 pounds 13 ounces avoirdupois. The board therefore declared, that the ſpirituous liquor of which the gallon weighed 7 pounds 13 ounces ſhould be reckoned 1 to 6 or 1 in 7 under proof. This is but an awkward and complex formula; it was in order to ſuit matters to a mode of examination which had by time obtained the ſanction of the board. Mr Clarke, an ingenious artiſt of that time, had made a hydrometer incomparably more exact than any other, and conſtructed on mathematical principles fit for computation. This had a ſet of weights correſponding to the additions of water or proof ſpirit, and the mixture 1 to 6 or 1 in 7 was the only one which weighed an exact number of ounces per gallon without a fraction.

Thus ſtands the exciſe law; and Clarke's hydrometer is ſtill the inſtrument of authority, although others have been ſince conſtructed by DICAS, QUIN, and others, which are much more ingenious and convenient. The mathematician who examines Dicas's hydrometer, with its ſliding ſcale, by which it is adjuſted to the different temperatures, and points out the condenſations, will perceive a beautiful and ſagacious combination of quantities, which he will find it difficult to bring under any analytical formula. Perhaps Quin's may have ſome preference in reſpect of conveniency; but *facile inventis addere*. Mr Dicas's was original (A).

As naturaliſts became more accuſtomed to exact obſervations in every topic of inquiry, the condenſation which obtains in the mixture of different ſubſtances became more familiarly known. This evidently affects the preſent queſton; and both the exciſe and the diſtillers are intereſted in its accurate deciſion. This occaſioned an application to the Royal Society; and a moſt ſcrupulous examination of the ſtrength of ſpirituous liquors was made by Sir Charles Blagden and Mr Gilpin, of which they have given a very particular account in the Philoſophical Tranſactions for 1790 and 1792.

We have taken notice of this in the article SPECIFIC GRAVITY, mentioning ſuch circumſtances of the reſults as ſuited our purpoſes of phyſical diſcuſſion. At preſent

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(A) Among the various contrivances which have been thought of, among manufacturers and dealers, as well as for the purpoſes of revenue, for aſcertaining the ſpecific gravity, and conſequently the real ſtrength and value of high-priced and high-taxed liquids, we are perſuaded there is none equal, in point of accuracy, ſimplicity, and facility of application, to the areometrical beads lately announced to the public by Mrs Lovi of Edinburgh, under the privilege of a patent; and with this perſuaſion we have no heſitation in recommending them to thoſe to whom the uſe of a ſimple and accurate inſtrument is of great importance in determining the value of high-priced ſpirituous liquors. Our recommendation reſts not ſolely on our own opinion, but is ſupported by that of others who are well acquainted with ſuch ſubjects. We know, too, that the beads have been examined and compared by ſeveral intelligent manufacturers and dealers with ſome of the moſt accurate hydrometrical inſtruments, and after a fair trial, a decided preference has been given to the beads. The whole apparatus conſiſts of 100 beads, a ſliding rule, a thermometer, a glaſs jar and braſs hook, which are packed in a neat ſmall box; and it is accompanied with directions, which point out, 1. In what manner the real ſtrength of ſpirits may be aſcertained at any given temperature between 40° and 80°. 2. How much per cent. the ſpirit to be tried is over or under proof according to the practice of ſpirit-dealers; and, 3. The proportion ef water and the ſtrongeſt ſpirits or alcohol, according to the views and language of exciſemen. The advantages of theſe beads are, that being made of a ſubſtance which is little acted on by chemical agents, they are leſs liable to be injured by uſe, than inſtruments compoſed of metal; and when a bead happens to be broken, it can be eaſily replaced. They poſſeſs this farther advantage, that with the application of the thermometer, and the calculation of the ſliding-rule, the real ſtrength of the ſpirits may be taken at all temperatures. It has been ſuggeſted, that theſe beads, from their being leſs liable to change than other inſtruments, might be uſefully employed in checking the errors and variations of other hydrometers. Beads are prepared by Mrs Lovi on the ſame principle for aſcertaining the ſtrength of worts, acids, &c.

ſent we give the general reſult in the table of ſpecific gravity, as peculiarly belonging to ſpirituous liquors, affording the moſt exact account of their denſity in every ſtate of dilution of alcohol with water. And as the relation between the proportion of ingredients and the denſity is peculiar to every ſubſtance, ſo that ſcarcely any inference can be made from one to another, the reader will conſider the tables here given as characteriſtic with reſpect to alcohol. In all ſolutions of ſalts we found that the condenſation increaſes continually with the dilution, whereas it is greateſt when equal bulks of water and alcohol are mixed; yet we do not conſider this as an exception; for it is certain, that in the ſtrongeſt brine the ſaline ingredient bears but a ſmall proportion to the water—and when we mix two ſolutions, the condenſation is greateſt when they are nearly equal in bulk. But we think ourſelves entitled to infer, that alcohol is not a dilution of a ſubſtance in a quantity of water; but that water, in a certain proportion, not very diſtant from what we can produce by ſlow diſtillation, is an ingredient of alcohol, or is one of its component parts, and not merely a vehicle or menſtruum. We therefore imagine that proof ſpirit contains nearly equal bulks of water and ardent ſpirits.

The great difficulty in this examination aroſe from the very diſſimilar expanſions of water and alcohol by heat. This determined Sir Charles Blagden to eſtimate the proportions of ingredients by weight, and made it abſolutely neceſſary to give a ſcale of ſpecific gravity and ſtrength for every temperature. For it muſt be remarked, that the queſtion (whether in commerce or philoſophy) always is, "How many gallons of alcohol and of water, taken juſt now and mixed together, will produce a hundred gallons of the ſpirit we are examining?" The proportion of theſe two will be different according to the temperature of both. As many mixtures therefore muſt have been made in each proportion as there were temperatures conſidered; but by taking the ingredients by weight, and examining the denſity of the compound in one temperature, it is then heated and cooled, and its change of denſity obſerved. Calculation then can tell us the change in the proportion of the bulks or numbers of gallons in the mixture, by means of a previous table ſhowing the expanſions of water and of alcohol.

The alcohol ſelected for this examination had the ſpecific gravity 0.825. This is not the pureſt that can be procured; ſome was produced of 0.816, of 0.814, and 0.813, both obtained from rum, from brandy, and from malt ſpirit. We are informed that Dr Black has obtained it of the ſpecific gravity 0.8 by digeſting alcohol with fixed ammoniac (muriatic acid united with lime) made very dry. It dephlegmates alcohol very powerfully without decompoſing it, which always happens when we uſe cauſtic alkali. Alcohol of 0.825 was choſen becauſe expreſſed by a number of eaſy management in computation.

The examination commenced by aſcertaining the expanſions of water and alcohol. The temperature 60° of Fahrenheit's ſcale was ſelected for the general temperature of compariſon, being eaſy attainable even in cold weather, and allowing the examinator to operate at eaſe. The firſt and laſt compartments of the tables contain the weights and ſpecific gravities of alcohol and water for every fifth degree of heat from 30° to 100°. From theſe we have conſtructed the two following little tables of expanſion. The bulk of 1000 ounces, pounds, or other weight of water and of alcohol of the temperature 60°, occupies the bulks expreſſed in the tables for every other temperature. Water could not be eaſily or uſefully examined when of the temperature 30°, becauſe it is with great difficulty kept fluid in that temperature. It is very remarkable, that when it can be ſo kept, it expands inſtead of contracting; while cooling down from 35° or thereabouts, and as it approaches to 32°, it expands rapidly. We obſerve the ſame thing in the cryſtallization of Glauber ſalt, martial vitriol, and ſome others, which contain much water in their cryſtals. We obſerve, on the other hand, a remarkable contraction in the zeolite juſt before its beginning to ſwell into bubbles by a red heat.

Heat.	Bulk of 100,000 ounces.			
	Of Water.		Of Alcohol.	
		Diff.		Diff.
30°			119195	
35	99910		119514	319
40	99906	— 4	119839	325
45	99914	+ 8	120172	332
50	99932	18	120514	342
55	99962	30	120868	348
60	100000	38	121122	350
65	100050	50	121565	353
70	100106	56	121919	354
75	100170	64	122279	360
80	100241	71	122645	366
85	100320	79	123017	372
90	100404	84	123393	376
95	100500	96	123773	380
100	100608	108	124157	384

This being premiſed, the examination was conducted in the following manner. It was determined to mix 100 parts by weight of pure alcohol with five, ten, fifteen, twenty, parts of diſtilled water, till they were compounded in equal quantities, and then to mix 100 parts of diſtilled water with, 95, 90, 85, 80, &c. parts of alcohol, till they were mixed in the proportion of 100 to 5. Thus a ſeries of mixtures would be obtained, extending from pure alcohol to pure water. This ſeries would be ſuch, that the examinations would be moſt frequent in the caſes moſt uſual in the commerce of ſtrong liquors. A ſet of phials, fitted with ground ſtoppers, were provided, of ſizes fit to hold the intended mixtures. Theſe mixtures were made by ſuſpending the phial to the arm of a very nice balance, in the oppoſite ſcale of which (beſides the counterpoiſe of the phial) there was placed the weight 100. Spirit was then poured into the phial till it exactly balanced the weight 100. The weight for the water to be added was then put into the oppoſite ſcale, and water was poured into the phial by means of a ſlender glaſs funnel, by ſmall quantities at a time, and the phial frequently agitated to promote the mixture. When the additional weight was exactly balanced, the phial was taken off, its ſtopper put in, and leather tied over it, and it was ſet by, for at leaſt a month, that the mixture and the whole proceſs of condenſation might be completed. The ſame method

method was followed in the mixtures where the water was predominant.

When the ingredients of theſe mixtures were judged to have completely incorporated, their ſpecific gravity was examined by weighing with the moſt ſcrupulous preciſion the contents of a veſſel which held 2925 troy grains of water, of the temperature 60°. The balance was ſo exceedingly ſenſible, that the 50th part of a grain greatly deranged its poſition when loaded with the ſcales and their contents. It was conſtructed by Mr Ramſden, and ſome account of its exquiſite ſenſibility may be ſeen in the *Journal de Phyſique*, vol. xxxiii. This quantity of materials was therefore thought abundantly ſufficient for aſcertaining the denſity of the liquor. It is needleſs to detail the precautions which were taken for having the contents of the weighing bottle brought to the preciſe temperature proper for the experiment. They were ſuch as every perſon converſant with ſuch things is accuſtomed to take.—The bottle had a ſlender neck, and being put on a lathe, a mark was made round it with a diamond. The bottle was filled till the bottom of the hollow ſurface of the fluid was in the plane of this mark; and to judge of the accuracy attainable in filling the bottle, the operation was ſeveral times repeated and the contents weighed, without the difference of $\frac{1}{50}$th of a grain in 2925. The only ſource of error which was to be guarded againſt was air-bubbles adhering to the inſide of the bottle, or moiſture condenſing (in the experiments with low temperatures) on the outſide. Both of theſe were attended to as much as poſſible.

This method of determining the ſpecific gravity was preferred to the uſual method, obſerving the weight loſt by a lump of glaſs when ſuſpended in water; for Mr Gilpin had been enabled, by means of this nice balance, to diſcover, even in pure water and in alcohol, a want of perfect fluidity. Something like viſcidity rendered the motion of a lump of glaſs through the liquor ſenſibly ſluggiſh, ſo that when the balance was brought to a level, there was not a perfect equilibrium of weight: (See what we have ſaid of this matter in Specific Gravity). Mr Gilpin alſo tried the ingenious inſtrument propoſed for ſuch experiments by Mr Ramſden, and deſcribed by him in a pamphlet on this very ſubject; and he found the anomalies of experiment much greater than in this method by weighing.—Indeed the regular progreſſion of weights to be ſeen in the annexed tables is an unqueſtionable proof of the ſufficiency of the method; and it has the evident advantage of all other methods in point of ſimplicity and practicability without any uncommon apparatus. Any perſon poſſeſſed of a good ordinary balance and a ſet of exact weights may examine all queſtions of this kind, by weighing pure water and the liquor which he may have occaſion to examine in a common 6 or 8 ounce phial. For this reaſon, it is recommended (in preference to all hydrometers) to the board of exciſe to provide this ſimple apparatus in every principal office.

Every experiment was made at leaſt three times; and the mean reſult (which never differed one grain from the extreme) was taken.

From theſe experiments the annexed tables were conſtructed. The firſt is the ſimple abſtract of the experiments, containing the weights of the contents of the bottle of every mixture. The ſecond contains the ſpecific gravities deduced from them.

We have ſaid that the experiments appear ſurpriſingly accurate. This we ſaid on the authority of the regular progreſſion of the ſpecific gravity in any of the horizontal rows. In the ſeries, for inſtance, for the temperature 60°, the greateſt anomaly is in the mixture of 50 parts of ſpirit with 100 of water. The ſpecific gravity is 95804, wanting 3 or 4 of the regular progreſſion. This does not amount to 1 in 18000.

TABLE I. Weights at the different Degrees of Temperature.

Heat.	The pure Spirit	100 grains of ſpirit to 5 grains of water.	100 grains of ſpirit to 10 grains of water.	100 grains of ſpirit to 15 grains of water.	100 grains of ſpirit to 20 grains of water.	100 grains of ſpirit to 25 grains of water.	100 grains of ſpirit to 30 grains of water.	100 grains of ſpirit to 35 grains of water.	100 grains of ſpirit to 40 grains of water.	100 grains of ſpirit to 45 grains of water.	100 grains of ſpirit to 50 grains of water.	100 grains of ſpirit to 55 grains of water.	100 grains of ſpirit to 60 grains of water.	100 grains of ſpirit to 65 grains of water.
deg.	Grains.	Grains	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
30	2487.35	2519.92	2548.42	2573.80	2596.66	2617.30	2636.23	2653.73	2669.83	2684.74	2698.51	2711.14	2722.89	2733.87
35	2480.87	2513.43	2541.84	2567.26	2590.16	2610.87	2629.92	2647.47	2663.64	2678.60	2692.43	2705.14	2716.92	2727.87
40	2474.30	2506.75	2535.41	2560.74	2583.66	2604.50	2623.56	2641.08	2657.23	2672.30	2686.32	2698.94	2710.81	2721.83
45	2467.62	2500.14	2528.75	2554.09	2577.10	2597.98	2617.03	2634.64	2650.87	2666.04	2679.99	2692.77	2704.57	2715.62
50	2460.75	2493.33	2521.96	2547.47	2570.42	2591.38	2610.54	2628.21	2644.43	2659.55	2673.64	2686.54	2698.42	2709.48
55	2453.80	2486.37	2515.03	2540.60	2563.64	2584.65	2603.80	2621.50	2637.86	2653.04	2667.14	2679.98	2691.83	2702.98
60	2447.00	2479.56	2508.27	2533.83	2556.90	2577.95	2597.22	2615.03	2631.37	2646.53	2660.62	2673.55	2685.52	2696.73
65	2440.12	2472.75	2501.53	2526.99	2550.22	2571.24	2590.55	2608.37	2624.75	2640.01	2654.04	2667.07	2679.15	2690.32
70	2433.23	2465.88	2494.56	2520.03	2543.32	2564.47	2583.88	2601.67	2617.96	2633.32	2647.52	2660.63	2672.74	2684.02
75	2426.23	2458.78	2487.62	2513.08	2536.39	2557.61	2576.93	2594.80	2611.19	2626.55	2640.81	2653.99	2666.06	2677.34
80	2419.02	2451.67	2480.45	2506.08	2529.24	2550.50	2569.86	2587.93	2604.29	2619.72	2633.99	2647.12	2659.36	2670.69
85	2411.92	2444.63	2473.33	2499.01	2522.29	2543.54	2563.01	2580.93	2597.45	2613.02	2627.39	2640.60	2652.78	2664.16
90	2404.90	2437.62	2466.32	2491.99	2515.28	2536.63	2556.11	2574.02	2590.60	2606.16	2620.52	2633.74	2646.00	2657.41
95	2397.68	2430.33	2459.13	2484.74	2508.10	2529.46	2549.13	2567.03	2583.65	2599.24	2613.57	2626.94	2639.25	2650.63
100	2390.60	2423.22	2452.13	2477.64	2500.91	2522.30	2541.92	2559.96	2576.56	2592.14	2606.50	2619.75	2632.17	2643.75
Heat.	100 grains of ſpirit to 70 grains of water.	100 grains of ſpirit to 75 grains of water.	100 grains of ſpirit to 80 grains of water.	100 grains of ſpirit to 85 grains of water.	100 grains of ſpirit to 90 grains of water	100 grains of ſpirit to 95 grains of water.	100 grains of ſpirit to 100 grains of water.	95 grains of ſpirit to 100 grains of water.	90 grains of ſpirit to 100 grains of water.	85 grains of ſpirit to 100 grains of water.	80 grains of ſpirit to 100 grains of water.	75 grains of ſpirit to 100 grains of water.	70 grains of ſpirit to 100 grains of water.	65 grains of ſpirit to 100 grains of water.
deg.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
30	2744.20	2753.75	2762.72	2771.08	2778.99	2786.36	2793.22	2799.85	2806.61	2813.85	2821.35	2828.90	2836.39	2844.16
35	2738.13	2747.74	2756.91	2765.32	2773.22	2780.59	2787.54	2794.19	2801.14	2808.52	2816.07	2823.68	2831.36	2839.26
40	2732.24	2741.86	2750.96	2759.50	2767.48	2774.90	2781.84	2788.69	2795.70	2803.17	2810.73	2818.36	2826.31	2834.40
45	2726.09	2735.77	2744.82	2753.36	2761.42	2768.85	2775.94	2782.99	2789.99	2797.45	2805.08	2812.93	2821.00	2829.28
50	2719.93	2729.64	2738.74	2747.27	2755.37	2762.95	2770.14	2777.19	2784.30	2791.72	2799.58	2807.56	2815.71	2824.12
55	2713.60	2723.51	2732.64	2741.24	2749.27	2756.83	2764.09	2771.29	2778.54	2785.96	2793.82	2801.89	2810.23	2818.80
60	2707.40	2717.30	2726.52	2735.17	2743.28	2750.93	2758.17	2765.40	2772.70	2780.26	2788.25	2796.45	2804.85	2813.65
65	2701.05	2710.96	2720.25	2728.98	2737.09	2744.86	2752.21	2759.47	2766.73	2774.43	2782.62	2790.81	2799.38	2808.31
70	2694.76	2704.64	2713.87	2722.75	2730.94	2738.73	2746.06	2753.41	2760.75	2768.45	2776.72	2785.06	2793.80	2802.88
75	2688.14	2698.07	2707.49	2716.35	2724.64	2732.39	2739.89	2747.23	2754.73	2762.58	2770.93	2779.26	2788.00	2797.21
80	2681.50	2691.50	2700.94	2709.76	2718.12	2726.06	2733.53	2740.93	2748.42	2756.43	2764.87	2773.33	2782.14	2791.52
85	2674.95	2684.98	2694.53	2703.33	2711.86	2719.74	2727.25	2734.80	2742.31	2750.22	2758.80	2767.44	2776.33	2785.81
90	2668.29	2678.49	2687.99	2696.91	2705.37	2713.32	2721.01	2728.59	2736.23	2744.24	2752.76	2761.51	2770.59	2780.11
95	2661.51	2671.82	2681.34	2690.33	2698.86	2706.88	2714.61	2722.23	2729.89	2737.98	2746.57	2755.34	2764.57	2774.25
100	2654.76	2664.99	2674.62	2683.63	2692.25	2700.33	2708.04	2715.73	2723.35	2731.55	2740.43	2749.28	2758.48	2768.43
Heat.	60 grains of ſpirit to 100 grains of water.	55 grains of ſpirit to 100 grains of water.	50 grains of ſpirit to 100 grains of water.	45 grains of ſpirit to 100 grains of water.	40 grains of ſpirit to 100 grains of water.	35 grains of ſpirit to 100 grains of water.	30 grains of ſpirit to 100 grains of water.	25 grains of ſpirit to 100 grains of water.	20 grains of ſpirit to 100 grains of water.	15 grains of ſpirit to 100 grains of water.	10 grains of ſpirit to 100 grains of water.	5 grains of ſpirit to 100 grains of water.	Water.	
deg.	Grains.	Grains.	Grains.	Grains	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	
30	2852.03	2859.71	2867.12	2874.43	2881.34	2887.77	2894.22	2900.85	2908.21	2917.19	2928.80	2944.53		
35	2847.45	2855.32	2863.16	2870.87	2878.21	2885.06	2892.07	2899.31	2907.45	2916.95	2928.99	2945.02	2967.14	
40	2842.62	2850.88	2859.06	2867.08	2874.81	2882.30	2889.78	2897.61	2906.39	2916.41	2928.93	2945.25	2967.45	
45	2837.64	2846.16	2854.67	2863.04	2871.22	2879.22	2887.33	2895.67	2904.98	2915.55	2928.49	2945.20	2967.40	
50	2832.76	2841.52	2850.29	2858.96	2867.52	2875.98	2884.57	2893.58	2903.39	2914.42	2927.81	2944.73	2967.05	
55	2827.68	2836.69	2845.72	2854.75	2863.75	2872.67	2881.69	2891.11	2901.42	2913.02	2926.73	2943.98	2966.34	
60	2822.65	2831.90	2841.10	2850.50	2859.87	2869.15	2878.72	2888.62	2899.35	2911.32	2925.50	2942.98	2965.39	
65	2817.49	2826.90	2836.30	2845.97	2855.65	2865.45	2875.49	2885.85	2897.09	2909.43	2923.90	2941.69	2964.11	
70	2812.16	2821.78	2831.61	2841.42	2851.53	2861.63	2872.06	2882.90	2894.56	2907.33	2922.24	2940.13	2962.66	
75	2806.75	2816.63	2826.56	2836.80	2847.14	2857.70	2868.49	2879.67	2891.79	2905.04	2920.17	2938.33	2960.97	
80	2801.25	2811.23	2821.38	2831.92	2842.56	2853.38	2864.54	2876.22	2888.73	2902.35	2917.83	2936.31	2959.07	
85	2795.69	2805.85	2816.32	2827.12	2838.07	2849.28	2860.86	2872.88	2885.56	2899.55	2915.46	2934.14	2956.94	
90	2790.13	2800.40	2811.05	2822.15	2833.38	2844.81	2856.80	2869.16	2882.25	2896.58	2912.84	2931.77	2954.70	
95	2784.36	2794.91	2805.79	2817.08	2828.46	2840.26	2852.47	2865.15	2878.71	2898.44	2910.02	2929.15	2952.08	
100	2778.64	2789.32	2800.25	2811.80	2823.55	2835.30	2848.18	2861.12	2875.07	2890.04	2906.97	2926.28	2949.34	

TABLE II. Real Specific Gravities at the different Temperatures.

Heat.	The pure ſpirit.	100 grains of ſpirit to 5 grains of water.	100 grains of ſpirit to 10 grains of water.	100 grains of ſpirit to 15 grains of water.	100 grains of ſpirit to 20 grains of water.	100 grains of ſpirit to 25 grains of water.	100 grains of ſpirit to 30 grains of water.	100 grains of ſpirit to 35 grains of water.	100 grains of ſpirit to 40 grains of water.	100 grains of ſpirit to 45 grains of water.	100 grains of ſpirit to 50 grains of water.	100 grains of ſpirit to 55 grains of water.	100 grains of ſpirit to 60 grains of water.	100 grains of ſpirit to 65 grains of water.
deg.														
30	.83896	.84995	.85957	.86825	.87585	.88282	.88921	.89511	.90054	.90558	.91023	.91449	.91847	.92217
35	.83672	.84769	.85729	.86587	.87357	.88059	.88701	.89294	.89839	.90345	.90811	.91241	.91640	.92009
40	.83445	.84539	.85507	.86361	.87134	.87838	.88481	.89073	.89617	.90127	.90596	.91026	.91428	.91799
45	.83214	.84310	.85277	.86131	.86907	.87613	.88255	.88849	.89396	.89909	.90380	.90812	.91211	.91584
50	.82977	.84076	.85042	.85902	.86676	.87384	.88030	.88626	.89174	.89684	.90160	.90596	.90997	.91370
55	.82736	.83834	.84802	.85664	.86441	.87150	.87796	.88393	.88945	.89458	.89933	.90367	.90768	.91144
60	.82500	.83599	.84568	.85430	.86208	.86918	.87568	.88169	.88720	.89232	.89707	.90144	.90549	.90927
65	.82262	.83362	.84334	.85193	.85976	.86686	.87337	.87938	.88490	.89006	.89479	.89920	.90328	.90707
70	.82023	.83124	.84092	.84951	.85736	.86451	.87105	.87705	.88254	.88773	.89252	.89695	.90104	.90484
75	.81780	.82878	.83851	.84710	.85493	.86212	.86864	.87466	.88018	.88538	.89018	.89464	.89872	.90252
80	.81530	.82631	.83603	.84467	.85248	.85966	.86623	.87228	.87776	.88301	.88781	.89225	.89639	.90021
85	.81283	.82386	.83355	.84221	.85006	.85723	.86380	.86984	.87541	.88067	.88551	.88998	.89409	.89793
90	.81039	.82142	.83111	.83977	.84762	.85483	.86139	.86743	.87302	.87827	.88312	.88758	.89173	.89558
95	.80788	.81888	.82860	.83724	.84511	.85232	.85896	.86499	.87060	.87586	.88069	.88521	.88937	.89322
00	.80543	.81643	.82618	.83478	.84262	.84984	.85646	.86254	.86813	.87340	.87824	.88271	.88691	.89082

Heat.	100 grains of ſpirit to 70 grains of water.	100 grains of ſpirit to 75 grains of water.	100 grains of ſpirit to 80 grains of water.	100 grains of ſpirit to 85 grains of water.	100 grains of ſpirit to 90 grains of water.	100 grains of ſpirit to 95 grains of water.	100 grains of ſpirit to 100 grains of water.	95 grains of ſpirit to 100 grains of water.	90 grains of ſpirit to 100 grains of water.	85 grains of ſpirit to 100 grains of water.	80 grains of ſpirit to 100 grains of water.	75 grains of ſpirit to 100 grains of water.	70 grains of ſpirit to 100 grains of water.	65 grains of ſpirit to 100 grains of water.
deg.														
30	.92563	.92889	.93191	.93474	.93741	.93991	.94222	.94447	.94675	.94920	.95173	.95429	.95681	.95944
35	.92355	.92680	.92986	.93274	.93541	.93790	.94025	.94249	.94484	.94734	.94988	.95246	.95502	.95772
40	.92151	.92476	.92783	.93072	.93341	.93592	.93827	.94058	.94295	.94547	.94802	.95060	.95328	.95602
45	.91937	.92264	.92570	.92859	.93131	.93382	.93621	.93860	.94096	.94348	.94605	.94871	.95143	.95423
50	.91723	.92050	.92358	.92647	.92919	.93177	.93419	.93658	.93897	.94149	.94414	.94683	.94958	.95243
55	.91502	.91837	.92145	.92436	.92707	.92963	.93208	.93452	.93696	.93948	.94213	.94486	.94767	.95057
60	.91287	.91622	.91933	.92225	.92499	.92758	.93002	.93247	.93493	.93749	.94018	.94296	.94579	.94876
65	.91066	.91400	.91715	.92010	.92283	.92546	.92794	.93040	.93285	.93546	.93822	.94099	.94388	.94689
70	.90847	.91181	.91493	.91793	.92069	.92333	.92580	.92828	.93076	.93337	.93616	.93898	.94193	.94500
75	.90617	.90952	.91270	.91569	.91849	.92111	.92364	.92613	.92865	.93132	.93413	.93695	.93989	.94301
80	.90385	.90723	.91042	.91340	.91622	.91891	.92142	.92393	.92646	.92917	.93201	.93488	.93785	.94102
85	.90157	.90496	.90818	.91119	.91403	.91670	.91923	.92179	.92432	.92700	.92989	.93282	.93582	.93902
90	.89925	.90270	.90590	.90891	.91177	.91446	.91705	.91962	.92220	.92491	.92779	.93075	.93381	.93703
95	.89688	.90037	.90358	.90662	.90949	.91221	.91481	.91740	.91998	.92272	.92562	.92858	.93170	.93497
00	.89453	.89798	.90123	.90428	.90718	.90992	.91252	.91513	.91769	.92047	.92346	.92646	.92957	.93293

Heat.	60 grains of ſpirit to 100 grains of water.	55 grains of ſpirit to 100 grains of water.	50 grains of ſpirit to 100 grains of water.	45 grains of ſpirit to 100 grains of water.	40 grains of ſpirit to 100 grains of water.	35 grains of ſpirit to 100 grains of water.	30 grains of ſpirit to 100 grains of water	25 grains of ſpirit to 100 grains of water.	20 grains of ſpirit to 100 grains of water	15 grains of ſpirit to 100 grains of water	10 grains of ſpirit to 100 grains of water.	5 grains of ſpirit to 100 grains of water.	Water.	
deg.														
30	.96209	.96470	.96719	.96967	.97200	.97418	.97635	.97860	.98108	.98412	.98804	.99334		
35	.96048	.96315	.96579	.96840	.97086	.97319	.97556	.97801	.98076	.98397	.98804	.99344	1.00090	
40	.95878	.96159	.96434	.96706	.96967	.97220	.97472	.97737	.98033	.98373	.98795	.99345	1.00094	
45	.95705	.95993	.96280	.96563	.96840	.97110	.97384	.97666	.97980	.98338	.98774	.99338	1.00086	
50	.95534	.95831	.96126	.96420	.96708	.96995	.97284	.97589	.97920	.98293	.98745	.99316	1.00068	
55	.95357	.95662	.95966	.96272	.96575	.96877	.97181	.97500	.97847	.98239	.98702	.99284	1.00038	
60	.95181	.95493	.95804	.96122	.96437	.96752	.97074	.97409	.97771	.98176	.98654	.99244	1.00000	
65	.95000	.95318	.95635	.95962	.96288	.96620	.96959	.97309	.97688	.98106	.98594	.99194	.99950	
70	.94813	.95139	.95469	.95802	.96143	.96484	.96836	.97203	.97596	.98028	.98527	.99134	.99894	
75	.94623	.94957	.95292	.95638	.95987	.96344	.96708	.97086	.97495	.97943	.98454	.99066	.99830	
80	.94431	.94768	.95111	.95467	.95826	.96192	.96568	.96963	.97385	.97845	.98367	.98991	.99759	
85	.94236	.94579	.94932	.95297	.95667	.96046	.96437	.96843	.97271	.97744	.98281	.98912	.99681	
90	.94042	.94389	.94748	.95123	.95502	.95889	.96293	.96711	.97153	.97637	.98185	.98824	.99598	
95	.93839	.94196	.94563	.94944	.95328	.95327	.96139	.96568	.97025	.97523	.98082	.98729	.99502	
00	.93638	.93999	.94368	.94759	.95152	.95556	.95983	.96424	.96895	.97401	.97969	.98625	.99402	

We formerly obſerved, that the ſeries of mixtures choſen by Sir Charles Blagden, for the advantages attending it in making the experiment, was not ſuited for ſolving the queſtions which commonly occur in the ſpirit buſineſs. He accordingly ſuggeſts the propriety of forming tables in a convenient ſeries from the data furniſhed by theſe experiments, indicating the proportion of ingredients contained in ſome conſtant weight or bulk.

To facilitate the conſtruction of ſuch tables, it is neceſſary to conſider the ſubject in the moſt general manner. Therefore let a repreſent the conſtant number 100. Let w and s repreſent the quantities of water and ſpirit by weight in any mixture; that is, the pounds, ounces, or grains of each. Let x repreſent the quantity per cent. of ſpirits alſo by weight; that is, the number of pounds of ſpirits contained in 100 pounds of the mixture; and let y be its quantity per cent. in gallons, or the number of gallons contained in 100 gallons of the unmixed ingredients. Let m be the bulk of a pound of ſpirit of any given temperature, the bulk of a pound of water *of the ſame temperature* being accounted 1.

Then $w+s$ is the weight of any mixture, and $w+ms$ is its bulk.

We have the following proportions: 1. $w+s : s = a : x$, and $x = \frac{as}{w+s}$ (Equation 1ſt); and hence s may be found when x the per centage in weight is given, for $s = \frac{wx}{a-x}$ (Equation 2d).

2. $w+ms : ms = a : y$, and $y = a\frac{ms}{w+ms}$ (Equation 3d); and s may be found when y, the per centage in gallons, is given; for $s = \frac{my}{a-y}$ (Equation 4th).

The uſual queſtions which can be ſolved from theſe experiments are,

1. To aſcertain the quantity of ſpirits per cent. in bulk from obſervation of the ſpecific gravity, or to tell how many gallons of ſpirit are in 100 gallons of mixture.

Plate ccccxcix. fig. 1.

Look for the ſpecific gravity in the table, and at the head of the column will be found the w and s correſponding. If the preciſe ſpecific gravity obſerved is not in the tables, the s muſt be found by interpolation. And here it is proper to remark, that taking the ſimple proportional parts of ſpecific gravity will not be ſufficiently exact, eſpecially near the beginning or the end of the table, becauſe the denſities correſponding to the ſeries of mixtures does not change uniformly. We muſt have recourſe to the general rules of interpolation, by means of firſt and ſecond differences, or be provided with a ſubſidiary table of differences. A good deal of practice in computations of this kind ſuggeſted the following method of making ſuch interpolations with great diſpatch and abundant accuracy. On a plate of wood or metal, or ſtiff card-paper, draw a line EF (fig. 1.), as a ſcale of equal parts, repreſenting the leading or equable arithmetical ſeries of any table. (In the preſent caſe EF is the ſcale on which s is computed).—Through every point of diviſion draw the perpendiculars BA, EC, FD, &c. Make one of them AB more conſpicuous than the reſt, and diſtinguiſh the others alſo in ſuch ſort, that the eye ſhall readily catch their diſtance from the principal line AB. Let GPL be a thin ſlip of whalebone, of uniform breadth and thickneſs, alſo divided into equal parts properly diſtinguiſhable. Laſtly, let there be a pin P fixed near the middle of the principal line AB.

Now ſuppoſe that a value of s is to be interpolated by means of an obſerved ſpecific gravity not in the table. Look for the neareſt to it, and note its diſtance from the preceding and the following. Let theſe be PH and PK on the flexible ſcale. Alſo take notice of the lines K 10 and H 10, whoſe diſtances from AB are equal to the conſtant difference between the ſucceſſive values of S, or to any eaſily eſtimated multiple of it (as in the preſent caſe we have taken 10 and 10, inſtead of 5 and 5, the running difference of Sir Charles Blagden's table). Then, leaning the middle point P of the whalebone on the pin P in the board, bend it, and place it ſlantwiſe till the points K and H fall ſomewhere on the two parallels K 10 and H 10. No matter how oblique the poſition of the whalebone is. It will bend in ſuch a manner that its different points of diviſion (repreſenting different ſpecific gravities) will fall on the parallels which repreſent the correſponding values of s. We can ſay that all this may be done in leſs than half a minute, and leſs time than is neceſſary for inſpecting a table of proportional parts, and not the tenth part of that neceſſary for interpolating by ſecond differences. Yet it is exact enough (if of the ſize of a duodecimo page) for interpolating three decimal places. This is ten times more exact than the preſent caſe requires. To return from this digreſſion.

Having thus found s in the table, we get x or y by the equations $\frac{as}{w+s} = x$, and $a\frac{ms}{w+ms} = y$.

But here a material circumſtance occurs. The weight of alcohol s, and its per centage x, was rightly determined by the ſpecific gravity, becauſe it was interpolated between two values, which were experimentally connected with this ſpecific gravity. But in making the tranſition from x to y, we only give the per centage in gallons before mixture, but not the number of gallons of alcohol contained in an hundred gallons of mixed liquor. For when we have taken $\overline{a-y}$ and y inſtead of w and s, they will indeed make a ſimilar compound when mixed, becauſe the proportion of their ingredients is the ſame. But they will not make 100 gallons of this compound, becauſe there is a ſhrinking or condenſation by mixture, and the ſpecific gravity by which we interpolated s is the phyſical or real ſpecific gravity correſponding to w and s; while $\frac{w+s}{w \times ms}$, the ſpecific gravity implied in the value of y, is the mathematical denſity independent on this condenſation. Since therefore y, together with $\overline{a-y}$, make leſs than 100 gallons of the compound, there muſt in 100 gallons of it be more alcohol than is expreſſed by y.

Let G be the mathematical ſpecific gravity ($= \frac{w+s}{w+ms}$), and g the phyſical or real obſerved ſpecific gravity (which we cannot expreſs algebraically); and let z be the gallons of alcohol really contained in 100 gallons of the compound. The bulk being inverſely as the denſity or ſpecific gravity, it is evident that the bulk of the compound muſt be to 100 gallons as g to rituous quors.

to G. And ſince we want to make it ſtill up to 100 gallons, we muſt increaſe it in the proportion of G to g. And becauſe this augmentation muſt be of the ſame ſtrength with this contracted liquor, both ingredients muſt be increaſed in the proportion of G to g, and we muſt have $G : g = y : z$, and $z = g \times \frac{y}{G}$. Now, inſtead of y, write $a \frac{m\,s}{w + m\,s}$, and inſtead of $\frac{1}{G}$ write $\frac{w + m\,s}{w + s}$, which are reſpectively equal to them. This gives us $z = g\,a \times \frac{w + m\,s}{w + s} \times \frac{m\,s}{w + s}, = g\,a \times \frac{m\,s}{w + s}$.

All this will be illuſtrated by an example.

Suppoſe that we have obſerved the ſpecific gravity of a ſpirituous liquor of the temperature 60° to be 0.94128. Looking into Sir Charles Blagden's table, we find the gravities 0.94018 and 0.94296, and the s correſponding to them is 80 and 75, the water in each mixture being 100. By interpolation we obtain the s correſponding to 0.94128, viz. 78. At this temperature $m = \frac{1}{0.825}, = 1.21212$, and $m\,s = 94.54545$. Therefore $z = 0.94128 \times 100 \times \frac{94.54545}{194.54545}, = 49{,}997$, or very nearly 50.

We have ſeen even perſons not unacquainted with ſubjects of this kind puzzled by this ſort of paradox. z is ſaid to be the per centage of ſpirit in the compound. The compound has the ſame proportion of ingredients when made up to 100 gallons as before, when y was ſaid to be its per centage, and yet y and z are not the ſame. The fact is, that although z is the number of gallons of alcohol really contained in 100 gallons of the compound, and this alcohol is in the ſame proportion as before to the water, this proportion is not that of 50 to 50: for if the ingredients were ſeparated again, there would be 50 gallons of alcohol and 52,876 of water.

The proportion of the ingredients in their ſeparate ſtate is had by the 3d equation $y = a \frac{m\,s}{w + m\,s}$, which is equivalent to $G\,a \frac{m\,s}{w + s}$. For the preſent example y will be found 48.599, and $a - y$, or the water per cent. 51.401, making 100 gallons of unmixed ingredients. We ſee then that there has been added 1.398 gallons of alcohol; and ſince both ingredients are augmented in the proportion of G to g, there have alſo been added 1.478 of water, and the whole addition for making up the 100 gallons of compound is 2.876 gallons; and if the ingredients of the compound were ſeparate, they would amount to 102,876 gallons. This might have been found at the firſt, by the proportion, $G : g - G = 100$: (*The addition*).

The next queſtion which uſually occurs in buſineſs is to find what denſity will reſult from any propoſed mixture per gallon. This queſtion is ſolved by means of the equation $\frac{w\,y}{m\,(a - y)} = s$. In this examination it will be moſt convenient to make $w = a$. If the value of s found in this manner falls on a value in the tables, we have the ſpecific gravity by inſpection. If not, we muſt interpolate.

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N. B. The value of m, which is employed in theſe reductions, varies with the temperature. It is always obtained by dividing the ſpecific gravity of alcohol of that temperature by the ſpecific gravity of water of the ſame temperature. The quotient is the real ſpecific gravity of alcohol for that temperature. Both of theſe are to be had in the firſt and laſt compartments of Sir Charles Blagden's table.

Theſe operations for particular caſes give the anſwers to particular occaſional queſtions. By applying them to all the numbers in the table, tables may be conſtructed for ſolving every queſtion by inſpection.

There is another queſtion which occurs moſt frequently in the exciſe tranſactions, and alſo in all compoſitions of ſpirituous liquors, viz. What ſtrength will reſult from a mixture of two compounds of known ſtrength, or mixing any compound with water? To ſolve queſtions of this kind by the table ſo often quoted, we muſt add into one ſum the water per gallon of the different liquors. In like manner, take the ſum of the ſpirits, and ſay, as the ſum of the waters is to that of the alcohols, ſo is a to s; and operate with a and s as before.

Analogous to this is the queſtion of the duties. Theſe are levied on proof ſpirit; that is, a certain duty is charged on a gallon of proof ſpirit; and the gauger's buſineſs is to diſcover how many gallons of proof ſpirit there is in any compound. The ſpecification of proof ſpirit in our exciſe laws is exceedingly obſcure and complex. A gallon weighing 7 pounds 13 ounces (at 55°) is accounted 1 to 6 under proof. The gallon of water contains 58476 grains, and this ſpirit is 54688. Its denſity therefore is 0.93523 at 55°, or (as may be inferred from the table) 0.9335 at 60°. This denſity correſponds to a mixture of 100 grains of water with 93.457 of alcohol. If this be ſuppoſed to reſult from the mixture of 6 gallons of alcohol with 1 of water (as is ſuppoſed by the deſignation of 1 to 6 under proof), the gallon of proof ſpirits conſiſts of 100 parts of ſpirits by weight, mixed with 75 parts of water. Such a ſpirit will have the denſity 0.9162 nearly.

This being premiſed, in order to find the gallons of proof ſpirits in any mixture, find the quantity of alcohol by weight, and then ſay, as 100 to 175, ſo is the alcohol in the compound to the proof ſpirit that may be made of it, and for which the duties muſt be paid.

We have conſidered this ſubject at ſome length, becauſe it is of great importance in the ſpirit-trade to have theſe circumſtances aſcertained with preciſion; and becauſe the ſpecific gravity is the only ſure criterion that can be had of the ſtrength. Firing of gunpowder, or producing a certain bubble by ſhaking, are very vague teſts; whereas, by the ſpecific gravity, we can very ſecurely aſcertain the ſtrength within one part in 500, as will preſently appear.

Sir Charles Blagden, or Mr Gilpin, has publiſhed [*] a moſt copious ſet of tables, calculated from theſe valuable experiments. In theſe, computations are made for every unit of the hundred, and for every degree of the thermometer. But theſe tables are ſtill not in the moſt commodious form for buſineſs. Mr John Wilſon, an ingenious gentleman reſiding at Dundee, has juſt publiſhed

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[*] *Philoſ. Tranſac.* 1794.

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liſhed at Edinburgh tables ſomewhat ſimilar, founded on the ſame experiments. Both of theſe tables ſhow the quantities by meaſure correſponding to every unit by weight of Sir Charles Blagden's experiments, and for every degree of temperature. They alſo ſhow the per centage of alcohol, and the condenſation or the quantity loſt by mixture. But as they both retain the original ſeries of parts by weight, which is very unuſual, the ſpirit traders will find conſiderable difficulty in making uſe of them. Retaining this ſeries alſo cauſes all the per centage numbers (which are the only intereſting ones to the trader) to be fractional, and no anſwer can be had without a double interpolation.

We have therefore calculated a table in the form in which it muſt be moſt uſeful and acceptable to thoſe who are engaged in the ſpirit trade, ſhowing at once the ſpecific gravity which reſults from any proportion of admixture in hundredth parts of the whole. This anſwers immediately the chief queſtions in the terms in which they are uſually conceived and propoſed. The two firſt or leading columns ſhow the proportion in gallons, pints, or other cubic meaſures, of the mixture, the whole quantity being always 100. The ſecond column ſhows the correſponding ſpecific gravity: ſo that we can either find the proportion of the ingredients by the obſerved ſpecific gravity, or find the gravity reſulting from any proportion of the ingredients. A third column ſhows how much the hundred meaſures of the two ingredients fall ſhort of making an hundred meaſures of the compound. A ſimple proportion, which can be done without the pen, will determine what part of this deficiency muſt be made up by ſpirit. The uſe of this table muſt now be ſo familiar to the reader's mind, that we need not give further inſtructions about it.

This is followed by another ſimilar table, giving an immediate anſwer to the moſt uſual queſtion, "How many meaſures of alcohol are there really contained in 100 meaſures? This is alſo accompanied by a column of condenſation. It would have been ſomewhat more elegant, had the ſpecific gravities in this table made the equable ſeries and leading column. But we did not advert to this till we had computed the table, and the labour was too great to be repeated for ſlight reaſons. The tables are only for the temperature 60°. To this the ſpirituous liquors can always be brought in theſe climates; and in caſes where we cannot, a moment's inſpection of Sir Charles Blagden's table will point out very nearly (or exactly, by a ſhort computation) the neceſſary corrections.

Compound.		Specific Gravity.	Cond. per cent.
S.	W.		
100	0	0.8250	
99	1	0.8278	0.19
98	2	0.8306	0.33
97	3	0.8333	0.4
96	4	0.8360	0.5
95	5	0.8387	0.6
94	6	0.8413	0.7
93	7	0.8439	0.8
92	8	0.8465	1.9
91	9	0.8491	1.
90	10	0.8516	1.1
89	11	0.8542	1.2
88	12	0.8567	1.3
87	13	0.8592	1.4
86	14	0.8617	1.5
85	15	0.8641	1.5
84	16	0.8666	1.6
83	17	0.8690	1.7
82	18	0.8713	1.7
81	19	0.8737	1.7
80	20	0.8760	1.8
79	21	0.8764	1.9
78	22	0.8807	2.
77	23	0.8830	2.
76	24	0.8853	2.1
75	25	0.8876	2.1
74	26	0.8899	2.2
73	27	0.8921	2.2
72	28	0.8944	2.3
71	29	0.8966	2.3
70	30	0.8988	2.4
69	31	0.9010	2.5
68	32	0.9031	2.5
67	33	0.9053	2.5
66	34	0.9073	2.5
66	34	0.9073	2.5
65	35	0.9095	2.6
64	36	0.9116	2.6
63	37	0.9137	2.6
62	38	0.9157	2.6
61	39	0.9177	2.7
60	40	0.9198	2.7
59	41	0.9218	2.7
58	42	0.9238	2.7
57	43	0.9257	2.7
56	44	0.9277	2.8
55	45	0.9296	2.8
54	46	0.9316	2.8
53	47	0.9335	2.8
52	48	0.9353	2.8
51	49	0.9371	2.8
50	50	0.9388	2.8
49	51	0.9406	2.8
48	52	0.9423	2.8
47	53	0.9440	2.8
46	54	0.9456	2.7
45	55	0.9473	2.7
44	56	0.9489	2.7
43	57	0.9505	2.7
42	58	0.9520	2.7
41	59	0.9535	2.6
40	60	0.9549	2.6
39	61	0.9563	2.6
38	62	0.9577	2.5
37	63	0.9590	2.5
36	64	0.9603	2.4
35	65	0.9616	2.4
34	66	0.9628	2.3
33	67	0.9640	2.3
33	67	0.9640	2.3
32	68	0.9651	2.3
31	69	0.9662	2.2
30	70	0.9673	2.1
29	71	0.9683	2.
28	72	0.9693	1.9
27	73	0.9704	1.9
26	74	0.9713	1.8
25	75	0.9724	1.7
24	76	0.9734	1.6
23	77	0.9744	1.6
22	78	0.9754	1.5
21	79	0.9763	1.4
20	80	0.9773	1.3
19	81	0.9783	1.2
18	82	0.9793	1.2
17	83	0.9802	1.1
16	84	0.9812	1.
15	85	0.9822	0.9
14	86	0.9832	0.9
13	87	0.9842	0.8
12	88	0.9853	0.7
11	89	0.9863	0.7
10	90	0.9874	0.6
9	91	0.9886	0.5
8	92	0.9897	0.4
7	93	0.9909	0.3
6	94	0.9921	0.3
5	95	0.9933	0.2
4	96	0.9946	0.1
3	97	0.9959	0.07
2	98	0.9972	0.03
1	99	0.9985	0.01
0	100	1.0000	0.00

Spir. per cent.	Specific Gravity.	Contr.
100	0.82500	
99	0.82629	0.18
98	0.83142	0.34
97	0.83449	0.46
96	0.83750	0.57
95	0.84048	0.68
94	0.84339	0.8
93	0.84621	0.9
92	0.84900	1.01
91	0.85172	1.11
90	0.85443	1.21
89	0.85704	1.31
88	0.85971	1.39
87	0.86228	1.47
86	0.86483	1.54
85	0.86737	1.61
84	0.86987	1.67
83	0.87235	1.74
82	0.87481	1.81
81	0.87726	1.88
80	0.87969	1.94
79	0.88207	2.
78	0.88445	2.05
77	0.88676	2.11
76	0.88909	2.17
75	0.89140	2.22
74	0.89367	2.26
73	0.89593	2.31
72	0.89815	2.36
71	0.90035	2.41
70	0.90241	2.49
69	0.90464	2.47
68	0.90675	2.51
67	0.90885	2.55
66	0.91095	2.59
66	0.91095	2.59
65	0.91306	2.62
64	0.91511	2.64
63	0.91714	2.66
62	0.91914	2.68
61	0.92112	2.70
60	0.92308	2.72
59	0.92501	2.74
58	0.92692	2.76
57	0.92883	2.77
56	0.93072	2.78
55	0.93258	2.80
54	0.93436	2.81
53	0.93612	2.81
52	0.93786	2.82
51	0.93958	2.81
50	0.94128	2.79
49	0.94293	2.78
48	0.94455	2.76
47	0.94610	2.73
46	0.94768	2.71
45	0.94923	2.70
44	0.95074	2.68
43	0.95219	2.66
42	0.95364	2.63
41	0.95502	2.60
40	0.95636	2.58
39	0.95766	2.54
38	0.95894	2.49
37	0.96019	2.46
36	0.96141	2.43
35	0.96258	2.38
34	0.96371	2.33
33	0.96481	2.27
33	0.96481	2.27
32	0.96587	2.21
31	0.96691	2.15
30	0.96793	2.08
29	0.96894	2.00
28	0.96992	1.93
27	0.97089	1.86
26	0.97185	1.79
25	0.97280	1.71
24	0.97374	1.63
23	0.97468	1.56
22	0.97561	1.48
21	0.97654	1.4
20	0.97747	1.32
19	0.97841	1.24
18	0.97936	1.17
17	0.98032	1.08
16	0.98129	1.00
15	0.98228	.93
14	0.98328	.85
13	0.98430	.78
12	0.98634	.71
11	0.98640	.66
10	0.98748	.61
9	0.98858	.51
8	0.98973	.43
7	0.99091	.34
6	0.99211	.25
5	0.99334	.18
4	0.99461	.12
3	0.99591	.7
2	0.99725	.3
1	0.99861	.1
0	1.00000	.0

" In the firſt table, of which the ſole intention is to point out the proportion of ingredients, the ſpecific gravities are computed only to four places, which will always give the anſwer true to $\frac{1}{8000}$th part. In the laſt, which is more immediately intereſting to the merchant in his tranſactions with the exciſe office, the computation is carried one place further."

The conſideration of the firſt of theſe two tables will furniſh ſome uſeful information to the reader who is intereſted in the philoſophy of chemical mixture, and who endeavours to inveſtigate the nature of thoſe forces which connect the particles of tangible matter. Theſe vary with the diſtance of the particle; and therefore the law of their action, like that of univerſal gravitation, is to be diſcovered by meaſuring their ſenſible effects at their various diſtances. Their change of diſtance is ſeen in the change of denſity or ſpecific gravity.

Did the individual denſities of the water and ſpirit remain unchanged by mixture, the ſpecific gravity would change by equal differences in the ſeries of mixtures on which this table is conſtructed; for the bulk being always the ſame, the change of ſpecific gravity muſt be the difference between the weight of the gallon of water which is added and that of the gallon of ſpirit which is taken out. The whole difference of the ſpecific gravities of ſpirits and water being 1.750 parts in 10.000, the augmentation by each ſucceſſive change of a meaſure of ſpirit for a meaſure of water would be the 100dth part of this, or 17.5. But, by taking the ſucceſſive differences of denſity as they occur in the table, we ſee that they are vaſtly greater in the firſt additions of water, being then about 10; after which they gradually diminiſh to the medium quantity $17\frac{1}{2}$, when water and ſpirits are mixed in nearly equal bulks. The differences of ſpecific gravity ſtill diminiſh, and are reduced to 9, when about 75 parts of water are mixed with 25 of ſpirit. The differences now increaſe again; and the laſt, when 99 parts of water are mixed with one part of ſpirit, the difference from the ſpecific gravity of pure water is above 14.

The mechanical effect, therefore, of the addition of a meaſure of water to a great quantity of ſpirit is greater than the ſimilar effect of the addition of a meaſure of ſpirits to a great quantity of water. What we call mechanical effect is the local motion, the change of diſtance of the particles, that the corpuſcular forces may again be in equilibrio. Obſerve, too, that this change is greater than in the proportion of the diſtance of the particles; for the denſity of water is to that of ſpirits nearly as 6 to 5, and the changes of ſpecific gravity are nearly as 6 to 3.

We alſo ſee that the changing cauſe, which produces the abſolute condenſation of each ingredient, ceaſes to operate when 75 parts of water have been mixed with 25 of alcohol: for the variation of ſpecific gravity, from diminiſhing comes now to increaſe; and therefore, in this particular ſtate of compoſition, is equable. Things are now in the ſame ſtate as if we were mixing two fluids which did not act on each other, but were mutually diſſeminated, and whoſe ſpecific gravities are nearly as 9 to 10; for the variation 9 of ſpecific gravity may be conſidered as the 100th part of the whole difference, in the ſame manner as 17.7 would have been had water and alcohol ſuſtained no contraction.

The imagination is greatly aſſiſted in the contemplation of geometrical quantity by exhibiting it in its own form. Specific gravity, being an expreſſion of denſity (a notion purely geometrical), admits of this illuſtration.

Plate CCCCXCIX. fig. 2.

Therefore let AB (fig. 2.) repreſent the bulk of any mixture of water and alcohol. The ſpecific gravity of water may be repreſented by a line of ſuch a length, that AB ſhall be the difference between the gravities of alcohol and water. Suppoſe it extended upwards, towards *a*, till B *a* is to A *a* as 10,000 to 8250. It will ſuit our purpoſe better to repreſent it by a parallelogram *a* BF *e*, of any breadth BF. In this caſe the difference of the ſpecific gravities of alcohol and water will be expreſſed by the parallelogram ABFE. If there were no change produced in the denſity of one or both ingredients, the ſpecific gravity of the compound would increaſe as this parallelogram does, and AGHE would be the augmentation correſponding to the mixture of the quantity AG of alcohol with the quantity GB of water, and ſo of other mixtures. But, to expreſs the augmentation of denſity as it really obtains, we muſt do it by ſome curvilineal area DABCHD, which varies at the rate determined by Sir Charles Blagden's experiments. This area muſt be preciſely equal to the rectangle ABFE. It muſt therefore fall without it in ſome places, and be deficient in others. Let DMHKC be the curve which correſponds with theſe experiments. It is evident to the mathematical reader, that the ordinates LM, GH, IK, &c. of this curve are in the ultimate ratio of the differences of the obſerved ſpecific gravities. If A α, ω β, &c. are each = 5, the little ſpaces A ω δ D, ω β *b* δ, &c. will be preciſely equal to the differences of the ſpecific gravities 0.8250; 0.8387; 0.8516; &c. correſponding to the different mixtures of water and alcohol. The curve cuts the ſide of the parallelogram in K, where the ordinate GK expreſſes the mean variation of denſity 0.0017.5. IK is the ſmalleſt variation. The condenſation may be expreſſed by drawing a curve *dm* G *fk* parallel to DMGKF, making D *d* = AE. The condenſation is now repreſented by the ſpaces comprehended between this laſt curve and the abſciſſa AGB, reckoning thoſe negative which lie on the other ſide of it. This ſhows, not only that the condenſation is greateſt in the mixture AG × GB, but alſo that in mixing ſuch a compound with another AI × IB, there is a rarefaction. Another curve ANOPB may be drawn, of which the ordinates LN, GP, IO, &c. are proportional to the areas AL*md*, AG*m*D, AI*k*G*md* (= AG*md*—GI*k*), &c. This curve ſhows the whole condenſation.

This manner of repreſenting the ſpecific gravities of mixtures will ſuggeſt many curious inferences to ſuch as will conſider them in the manner of Boſcovich, with a view to aſcertain the nature of the forces of coheſion and chemical affinities: And this manner of viewing the ſubject becomes every day more promiſing, in conſequence of our improvements in chemical knowledge; for we now ſee, that mechaniſm, or motive forces, are the cauſes of chemical action. We ſee in almoſt every caſe, that chemical affinities are comparable with mechanical preſſures; becauſe the converſion of a liquid into a vapour or gas is prevented by atmoſpheric preſſure, and produced by the great chemical agent heat. The action of heat, therefore, or of the cauſe of heat, is a mechanical action, and the forces are common mechanical forces, with which we are familiarly acquainted.

"It may be alſo remarked in the column of contractions, that in the beginning the contractions augment nearly in the proportion of the quantity of ſpirits (but more ſlowly); whereas, in the end, the contractions are nearly in the duplicate proportion of the quantity of water. This circumſtance deſerves the conſideration of the philoſopher. We have repreſented it to the eye by the curve *α g h d*."

We ſhould here take ſome notice of the attempt made to elude ſome part of the duties, by adding ſome ingredient to the ſpirits. But our information on this ſubject is not very exact; and beſides it would be doing no ſervice to the trader to put fraud more in his power. There are ſome ſalts which make a very great augmentation of denſity, but they render the liquor unpalatable. Sugar is frequently uſed with this view; 16 grains of refined ſugar diſſolved in 1000 grains of proof ſpirits gave it no ſuſpicious taſte, and increaſed its ſpecific gravity from 0.920 to 0.925, which is a very great change, equivalent to the addition of 9 grains of water to a mixture of 100 grains of alcohol and 80 of water.

SPIRLING, a ſpecies of fiſh. See SALMO, ICHTHYOLOGY, p. 99.

SPITHEAD, a road between Portſmouth and the iſle of Wight, where the royal navy of Great Britain frequently rendezvous.

SPITTLE, in *Phyſiology*. See SALIVA.

SPITZBERGEN. See GREENLAND, Nº 10.

SPLACHNUM, a genus of plants belonging to the claſs of cryptogamia, and order of muſci. See BOTANY *Index*.

SPLEEN. See ANATOMY *Index*.

SPLEEN-Wort. See ASPLENIUM, BOTANY *Index*.

SPLENETIC, a perſon afflicted with an obſtruction of the ſpleen.

SPLENT, or SPLINT, among farriers, a callous inſenſible excreſcence, breeding on the ſhank-bone of horſes. See FARRIERY.

SPLICING, in the ſea-language, is the untwiſting the ends of two cables or ropes, and working the ſeveral ſtrands into one another by a fidd, ſo that they become as ſtrong as if they were but one rope.

SPOILS, whatever is taken from the enemy in time of war. Among the ancient Greeks, the ſpoils were divided among the whole army; only the general's ſhare was

was largeſt: but among the Romans, the ſpoils belonged to the republic.

SPOLETTO, a duchy of Italy, bounded on the north by the marquiſate of Ancona and duchy of Urbino, on the eaſt by Farther Abruzzo, on the ſouth by Sabina and the patrimony of St Peter, and on the weſt by Orvieto and Perugino. It is about 55 miles in length and 40 in breadth. It was anciently a part of Umbria, and now belongs to the pope.—The name of the capital city is alſo *Spoletto*. It was formerly a large place, but in 1703 was ruined by an earthquake; from whence it has never recovered itſelf.

SPOLIATION, in eccleſiaſtical law, is an injury done by one clerk or incumbent to another, in taking the fruits of his benefice without any right thereunto, but under a pretended title. It is remedied by a decree to account for the profits ſo taken. This injury, when the *jus patronatus*, or right of advowſon, doth not come in debate, is cognizable in the ſpiritual court: as if a patron firſt preſents A to a benefice, who is inſtituted and inducted thereto; and then, upon pretence of a vacancy, the ſame patron preſents B to the ſame living, and he alſo obtains inſtitution and induction. Now if A diſputes the fact of the vacancy, then that clerk who is kept out of the profits of the living, whichever it be, may ſue the other in the ſpiritual court for the ſpoliation, or taking the profits of his benefice. And it ſhall there be tried, whether the living were or were not vacant; upon which the validity of the ſecond clerk's pretenſions muſt depend. But if the right of patronage comes at all into diſpute, as if one patron preſented A, and another patron preſented B, there the eccleſiaſtical court hath no cognizance, provided the tithes ſued for amount to a fourth part of the value of the living, but may be prohibited at the inſtance of the patron by the king's writ of *indicavit*. So alſo if a clerk, without any colour of title, ejects another from his parſonage, this injury muſt be redreſſed in the temporal courts: for it depends upon no queſtion determinable by the ſpiritual law (as plurality of benefices or no plurality, vacancy or no vacancy), but is merely a civil injury.

SPONDEE, in ancient poetry, a foot conſiſting of two long ſyllables, as *omnes*.

SPONDIAS, BRASILIAN or JAMAICA PLUM, a genus of plants belonging to the claſs of decandria. See BOTANY *Index*.

SPONGIA, SPONGE; a genus of animals belonging to the claſs of vermes, and order of zoophyta. It is fixed, flexible, and very torpid, growing in a variety of forms, compoſed either of reticulated fibres, or maſſes of ſmall ſpines interwoven together, and clothed with a living gelatinous fleſh, full of ſmall mouths or holes on its ſurface, by which it ſucks in and throws out the water. Fifty ſpecies have already been diſcovered, of which 10 belong to the Britiſh coaſts. See HELMINTHOLOGY *Index*.

So early as the days of Ariſtotle ſponges were ſuppoſed to poſſeſs animal life; the perſons employed in collecting them having obſerved them ſhrink when torn from the rocks, thus exhibiting ſymptoms of ſenſation. The ſame opinion prevailed in the time of Pliny: But no attention was paid to this ſubject till Count Marſigli examined them, and declared them vegetables. Dr Peyſonell, in a paper which he ſent to the Royal Society in the year 1752, and in a ſecond in 1757, affirmed they were not vegetables, but the production of animals; and has accordingly deſcribed the animals, and the proceſs which they performed in making the ſponges. Mr Ellis, in the year 1762, was at great pains to diſcover theſe animals. For this purpoſe he diſſected the ſpongia urens, and was ſurpriſed to find a great number of ſmall worms of the genus of nereïs or ſea ſcolopendra, which had pierced their way through the ſoft ſubſtance of the ſponge in queſt of a ſafe retreat. That this was really the caſe, he was fully aſſured of, by inſpecting a number of ſpecimens of the ſame ſort of ſponge, juſt freſh from the ſea. He put them into a glaſs filled with ſea-water; and then, inſtead of ſeeing any of the little animals which Dr Peyſonell deſcribed, he obſerved the papillæ or ſmall holes with which the papillæ are ſurrounded contract and dilate themſelves. He examined another variety of the ſame ſpecies of ſponge, and plainly perceived the ſmall tubes inſpire and expire the water. He therefore concluded that the ſponge is an animal, and that the ends or openings of the branched tubes are the mouths by which it receives its nouriſhment, and diſcharges its excrements.

SPONSORS, among Chriſtians, are thoſe perſons who, in the office of baptiſm, anſwer or are ſureties for the perſons baptized.

SPONTANEOUS, a term applied to ſuch motions of the body and operations of the mind as we perform of ourſelves without any conſtraint.

SPOON-BILL. See PLATALEA, ORNITHOLOGY *Index*.

SPOONING, in the ſea-language, is ſaid of a ſhip, which being under ſail in a ſtorm at ſea, is unable to bear it, and conſequently forced to go right before the wind.

SPORADES, among ancient aſtronomers, a name given to ſuch ſtars as were not included in any conſtellation.

SPORADIC DISEASES, among phyſicians, are ſuch as ſeize particular perſons at any time or ſeaſon, and in any place; in which ſenſe they are diſtinguiſhed from epidemical and endemical diſeaſes.

SPOTS, in *Aſtronomy*, certain places of the ſun's or moon's diſk, obſerved to be either more bright or dark than the reſt; and accordingly called *faculæ et maculæ*. See ASTRONOMY *Index*.

SPOTSWOOD, JOHN, archbiſhop of St Andrew's in Scotland, was deſcended from the lairds of Spotſwood in the Merſe, and was born in the year 1565. He was educated in the univerſity of Glaſgow, and ſucceeded his father in the parſonage of Calder when but 18 years of age. In 1601 he attended Lodowick duke of Lennox as his chaplain, in an embaſſy to the court of France for confirming the ancient amity between the two nations, and returned in the ambaſſador's retinue through England. When he entered into the archbiſhopric of Glaſgow, he found there was not 100l. ſterling of yearly revenue left; yet ſuch was his care for his ſucceſſors, that he greatly improved it, and much to the ſatisfaction of his dioceſe. After having filled this ſee 11 years, he was raiſed to that of St Andrew's in 1615, and made primate and metropolitan of all Scotland. He preſided in ſeveral aſſemblies for reſtoring the ancient diſcipline, and bringing the church of Scotland to ſome degree of uniformity with that of England. He continued in high eſteem with King James I. nor was he leſs valued by

King Charles I. who was crowned by him in 1633, in the abbey-church of Holyroodhouſe. In 1635, upon the death of the earl of Kinnoul chancellor of Scotland, our primate was advanced to that poſt; but had ſcarcely held it four years, when the confuſions beginning in Scotland, he was obliged to retire into England; and being broken with age, grief, and ſickneſs, died at London in 1639, and was interred in Weſtminſter-abbey. He wrote A Hiſtory of the Church of Scotland from the year 203 to the reign of King James VI. in folio.

SPOUT, or *Water-Spout*. See *WATER-Spout*.

Spout-Fiſh. See SOLEN, CONCHOLOGY *Index*.

SPRAT, DR THOMAS, biſhop of Rocheſter, was born in 1636. He had his education at Oxford, and after the Reſtoration entered into holy orders. He became fellow of the Royal Society, chaplain to George duke of Buckingham, and chaplain in ordinary to King Charles II. In 1667 he publiſhed the Hiſtory of the Royal Society, and a Life of Mr Cowley; who, by his laſt will, left to his care his printed works and MSS. which were accordingly publiſhed by him. In 1668 he was inſtalled prebendary of Weſtminſter; in 1680, was appointed canon of Windſor; in 1683, dean of Weſtminſter; and in 1684, conſecrated to the biſhopric of Rocheſter. He was clerk of the cloſet to King James II.; in 1685, was made dean of the chapel royal; and the year following, was appointed one of the commiſſioners for eccleſiaſtical affairs. In 1692 his lordſhip, with ſeveral other perſons, was charged with treaſon by two men, who drew up an aſſociation, in which they whoſe names were ſubſcribed declared their reſolution to reſtore King James; to ſeize the princeſs of Orange, dead or alive; and to be ready with 30,000 men to meet King James when he ſhould land. To this they put the names of Sancroft, Sprat, Marlborough, Saliſbury, and others. The biſhop was arreſted, and kept at a meſſenger's, under a ſtrict guard, for eleven days. His houſe was ſearched, and his papers ſeized, among which nothing was found of treaſonable appearance, except one memorandum, in the following words: *Thorough-paced doctrine*. Being aſked at his examination the meaning of the words, he ſaid that, about 20 years before, curioſity had led him to hear Daniel Burgeſs preach; and that being ſtruck with his account of a certain kind of doctrine, which he ſaid *entered at one ear, and pacing through the head went out at the other*, he had inſerted the memorandum in his table-book, that he might not loſe the ſubſtance of ſo ſtrange a ſermon. His innocence being proved, he was ſet at liberty, when he publiſhed an account of his examination and deliverance; which made ſuch an impreſſion upon him, that he commemorated it through life by an yearly day of thankſgiving. He lived to the 79th year of his age, and died May 20. 1713. His works, beſides a few poems of little value, are, "The Hiſtory of the Royal Society;" "The Life of Cowley;" "The Anſwer to Sorbiere;" "The Hiſtory of the Rye-houſe Plot;" "The Relation of his own Examination;" and a volume of "Sermons." Dr Johnſon ſays, "I have heard it obſerved with great juſtneſs, that every book is of a different kind, and that each has its diſtinct and characteriſtical excellence."

SPRAT. See CLUPEA, ICHTHYOLOGY *Index*.

SPRAY, the ſprinkling of the ſea, which is driven from the top of a wave in ſtormy weather. It differs from ſpoon-drift, as being only blown occaſionally from the broken ſurface of a high wave; whereas the latter continues to fly horizontally along the ſea, without intermiſſion, during the exceſs of a tempeſt or hurricane.

SPRING, in *Natural Hiſtory*, a fountain or ſource of water riſing out of the ground.

Many have been the conjectures of philoſophers concerning the origin of fountains, and great pains have been taken both by the members of the Royal Society and thoſe of the Academy of Sciences at Paris, in order to aſcertain the true cauſe of it. It was Ariſtotle's opinion, and held by moſt of the ancient philoſophers after him, that the air contained in the caverns of the earth, being condenſed by cold near its ſurface, was thereby changed into water; and that it made its way through, where it could find a paſſage. But we have no experience of any ſuch tranſmutation of air into water.

Thoſe who imagine that fountains owe their origin to waters brought from the ſea by ſubterraneous ducts, give a tolerable account how they loſe their ſaltneſs by percolation as they paſs through the earth: but they find great difficulty in explaining by what power the water riſes above the level of the ſea to near the tops of mountains, where ſprings generally abound; it being contrary to the laws of hydroſtatics, that a fluid ſhould riſe in a tube above the level of its ſource. However, they have found two ways whereby they endeavour to extricate themſelves from this difficulty. The one is that of Des Cartes, who imagines, that after the water is become freſh by percolation, it is raiſed out of the caverns of the earth in vapour towards its ſurface; where meeting with rocks near the tops of mountains in the form of arches or vaults, it ſticks to them, and runs down their ſides, (like water in an alembic), till it meets with proper receptacles, from which it ſupplies the fountains. Now this is a mere hypotheſis, without foundation or probability: for, in the firſt place, we know of no internal heat of the earth to cauſe ſuch evaporation; or if that were allowed, yet it is quite incredible that there ſhould be any caverns ſo ſmooth and void of protuberances as to anſwer the ends of an alembic, in collecting and condenſing the vapours together in every place where fountains ariſe. There are others (as Varenius, &c.) who ſuppoſe that the water may riſe through the pores of the earth, as through capillary tubes, by attraction. But hereby they ſhow, that they are quite unacquainted with what relates to the motion of a fluid through ſuch tubes: for when a capillary tube opens into a cavity at its upper end, or grows larger and larger, ſo as to ceaſe to be capillary at that end, the water will not aſcend through that tube into the cavity, or beyond where the tube is capillary; becauſe that part of the periphery of the cavity, which is partly above the ſurface of the water and partly below it, is not of the capillary kind. Nay, if the cavity is continually ſupplied with water, it will be attracted into the capillary tube, and run down it as through a funnel, if the lower end is immerged in the ſame fluid, as in this caſe it is ſuppoſed to be.

It has been a generally received opinion, and much eſpouſed by Mariotte (a diligent obſerver of nature), that the riſe of ſprings is owing to the rains and melted ſnow. According to him, the rain-water which falls upon the hills and mountains, penetrating the ſurface, Spring. meets with clay or rocks contiguous to each other; along which it runs, without being able to penetrate them, till, being got to the bottom of the mountain, or to a conſiderable diſtance from the top, it breaks out of the ground, and forms ſprings.

In order to examine this opinion, Mr Perrault, De la Hire, and D. Sideleau, endeavoured to make an eſtimate of the quantity of rain and ſnow that falls in the ſpace of a year, to ſee whether it would be ſufficient to afford a quantity of water equal to that which is annually diſcharged into the ſea by the rivers. The reſult of their inquiries was, that the quantity of rain and ſnow which fell in a year into a cylindrical veſſel would fill it (if ſecured from evaporating) to the height of about nineteen inches. Which quantity D. Sideleau ſhowed, was not ſufficient to ſupply the rivers; for that thoſe of England, Ireland, and Spain, diſcharge a greater quantity of water annually, than the rain, according to that experiment, is able to ſupply. Beſides which, another obſervation was made by them at the ſame time, viz. that the quantity of water raiſed in vapour, one year with another, amounted to about thirty-two inches, which is thirteen more than falls in rain: a plain indication that the water of fountains is not ſupplied by rain and melted ſnow.

Thus the true cauſe of the origin of fountains remained undiſcovered, till Dr Halley, in making his celeſtial obſervations upon the tops of the mountains at St Helena, about 800 yards above the level of the ſea, found, that the quantity of vapour which fell there (even when the ſky was clear) was ſo great, that it very much impeded his obſervations, by covering his glaſſes with water every half quarter of an hour; and upon that he attempted to determine by experiment the quantity of vapour exhaled from the ſurface of the ſea, as far as it riſes from heat, in order to try whether that might be a ſufficient ſupply for the water continually diſcharged by fountains. The proceſs of his experiment was as follows: He took a veſſel of water ſalted to the ſame degree with that of ſea water, in which he placed a thermometer; and by means of a pan of coals brought the water to the ſame degree of heat, which is obſerved to be that of the air in our hotteſt ſummer; this done, he fixed the veſſel of water with the thermometer in it to one end of a pair of ſcales, and exactly counterpoiſed it with weights on the other: then, at the end of two hours, he found, by the alteration made in the weight of the veſſel, that about a ſixtieth part of an inch of the depth of the water was gone off in vapour; and therefore, in twelve hours, one tenth of an inch would have gone off. Now this accurate obſerver allows the Mediterranean ſea to be forty degrees long; and four broad, (the broader parts compenſating for the narrower, ſo that its whole ſurface is 160 ſquare degrees); which, according to the experiment, muſt yield at leaſt 5,280,000,000 tons of water: In which account no regard is had to the wind and the agitation of the ſurface of the ſea, both which undoubtedly promote the evaporation.

It remained now to compare this quantity of water with that which is daily conveyed into the ſame ſea by the rivers. The only way to do which was to compare them with ſome known river; and accordingly he takes his computation from the river Thames; and, to avoid all objections, makes allowances, probably greater than what were abſolutely neceſſary. Spring.

The Mediterranean receives the following conſiderable rivers, viz. the Iberus, the Rhone, the Tyber, the Po, the Danube, the Nieſter, the Boryſthenes, the Tanais, and the Nile. Each of theſe he ſuppoſes to bring down ten times as much water as the Thames, whereby he allows for ſmaller rivers which fall into the ſame ſea. The Thames, then, he finds by meaſuration to diſcharge about 20,300,000 tons of water a-day. If therefore the above-ſaid nine rivers yield ten times as much water as the Thames doth, it will follow, that all of them together yield but 1827 millions of tons in a day, which is but little more than one-third of what is proved to be raiſed in vapour out of the Mediterranean in the ſame time. We have therefore from hence a ſource abundantly ſufficient for the ſupply of fountains.

Now having found that the vapour exhaled from the ſea is a ſufficient ſupply for the fountains, he proceeds in the next place to conſider the manner in which they are raiſed; and how they are condenſed into water again, and conveyed to the ſources of ſprings.

In order to this he conſiders, that if an atom of water was expanded into a ſhell or bubble, ſo as to be ten times as big in diameter as when it was water, that atom would become ſpecifically lighter than air; and therefore would riſe ſo long as the warmth which firſt ſeparated it from the ſurface of the water ſhould continue to diſtend it to the ſame degree; and conſequently, that vapours may be raiſed from the ſurface of the ſea in that manner, till they arrive at a certain height in the atmoſphere, at which they find air of equal ſpecific gravity with themſelves. Here they will float till, being condenſed by cold, they become ſpecifically heavier than the air, and fall down in dew; or being driven by the winds againſt the ſides of mountains (many of which far ſurpaſs the uſual height to which the vapours would of themſelves aſcend), are compelled by the ſtream of the air to mount up with it to the tops of them; where being condenſed into water, they preſently precipitate, and gleeting down by the crannies of the ſtones, part of them enters into the caverns of the hills; which being once filled, all the overplus of water that comes thither runs over by the loweſt place, and breaking out by the ſides of the hills forms ſingle ſprings. Many of theſe running down by the valleys between the ridges of the hills, and coming to unite, form little rivulets or brooks; many of theſe again meeting in one common valley, and gaining the plain ground, being grown leſs rapid, become a river; and many of theſe being united in one common channel, make ſuch ſtreams as the Rhine and the Danube; which latter, he obſerves, one would hardly think to be a collection of water condenſed out of vapour, unleſs we conſider how vaſt a tract of ground that river drains, and that it is the ſum of all thoſe ſprings which break out on the ſouth ſide of the Carpathian mountains, and on the north ſide of the immenſe ridge of the Alps, which is one continued chain of mountains from Switzerland to the Black ſea.

Thus one part of the vapours which are blown on the land is returned by the rivers into the ſea from whence it came. Another part falls into the ſea before it reaches the land; and this is the reaſon why the rivers do not return ſo much water into the Mediterranean as is raiſed in vapour. A third part falls on the low lands, where it affords nouriſhment to plants; yet it does not reſt there, but is again exhaled in vapour by the action of the ſun, and is either carried by the winds to the ſea to fall in rain or dew there, or elſe to the mountains to become the ſources of ſprings.

However, it is not to be ſuppoſed that all fountains are owing to one and the ſame cauſe; but that ſome proceed from rain and melted ſnow, which, ſubſiding through the ſurface of the earth, makes its way into certain cavities, and thence iſſues out in the form of ſprings; becauſe the waters of ſeveral are found to increaſe and diminiſh in proportion to the rain which falls: that others again, eſpecially ſuch as are ſalt, and ſpring near the ſea-ſhore, owe their origin to ſea-water percolated through the earth; and ſome to both theſe cauſes: though without doubt moſt of them, and eſpecially ſuch as ſpring near the tops of high mountains, receive their waters from vapours, as before explained.

This reaſoning of Dr Halley's is confirmed by more recent obſervations and diſcoveries. It is now found, that though water is a tolerable conductor of the electric fluid, dry earth is an electric *per ſe*, conſequently the dry land muſt always be in an electrified ſtate compared with the ocean, unleſs in ſuch particular caſes as are mentioned under the article EARTHQUAKE, N° 82. It is alſo well known, that ſuch bodies as are in an electrified ſtate, whether *plus* or *minus*, will attract vapour, or other light ſubſtances that come near them. Hence the vapours that are raiſed from the ocean muſt neceſſarily have a tendency to approach the land in great quantity, even without the aſſiſtance of the wind, though this laſt muſt undoubtedly contribute greatly towards the ſame purpoſe, as Dr Halley juſtly obſerves. In like manner, the higher grounds are always in a more electrified ſtate than the lower ones: and hence the vapours having once left the ocean and approached the ſhore, are attracted by the high mountains; of which Mr Pennant gives an inſtance in Snowdon. Hence we may ſee the reaſon why ſprings are ſo common in the neighbourhood of mountains, they being ſo advantageouſly formed in every reſpect for collecting and condenſing the vapours into water.

The heat of ſprings is generally the ſame with the mean temperature of the atmoſphere. The mean temperature of the ſouth of England is 48°; in Scotland, near Edinburgh, it is 45°; in the north of Ireland it is 48°, and on the ſouth coaſt about 51°. At Upſal, in Sweden, it is 43°, and in Paris 53°. According to accurate experiments made by eminent philoſophers, the heat of the ſprings in theſe different countries correſponds with the medium temperature. We have not heard that ſimilar experiments have been made in other countries, or we ſhould have been careful to collect them. We do not, however, doubt but they have been made in moſt countries of Europe; yet we ſuſpect little attention has been paid to this ſubject within the tropical regions.

Though this coincidence of the heat of ſprings with the mean temperature of the climate where they flow, ſeems to be a general fact, yet it admits of many exceptions. In many parts of the world there are ſprings which not only exceed the mean temperature, but even the ſtrongeſt meridian heat ever known in the torrid regions. The following table will give a diſtinct notion of the degrees of heat which different ſprings have been found to poſſeſs, according to the experiments of philoſophers. It is neceſſary to remark that experiments made upon the ſame ſprings, made by different perſons, vary a little from one another, which may be owing to many accidents eaſily accounted for. Where this is the caſe, we ſhall mention both the loweſt and higheſt degree of heat which has been aſcribed to the ſame ſpring, according to Fahrenheit's thermometer.

Places.	Springs.	Higheſt degree of heat.	Loweſt degree of heat.
Briſtol,	St Vincent's or the hot well,	84	76
Buxton,	Gentleman's bath,	82	
Matlock,		69	
Bath,	King's bath,	119	113
Aix-la-Chapelle.		146	136
Barege,		122	
Piſa,		104	
Caoline baths in Bohemia,	Prudel or furious,	165	
Iceland,	Geyzer,	212	

In cold countries where congelation takes place, the heat of the earth is conſiderably above the freezing point, and continues ſo through the whole year. From experiments that have been made in mines and deep pits, it appears that this heat is uniform and ſtationary at a certain depth. But as the heat of theſe ſprings far exceeds the common heat of the internal parts of the earth, it muſt be occaſioned by cauſes peculiar to certain places; but what theſe cauſes are it is no eaſy matter to determine. We are certain, indeed, that hot ſprings receive their heat from ſome ſubterranean cauſe; but it is a matter of difficulty to inveſtigate how this heat is produced and preſerved. Theories, however, have been formed on this ſubject. The ſubterranean heat has been aſcribed to the electrical fluid, and to a great body of fire in the centre of the earth: But we ſuſpect that the nature of the electrical fluid and its effects are not ſufficiently underſtood. As to the ſuppoſition that the heat of ſprings is owing to a central fire, it is too hypothetical to require any refutation. From what then does this heat originate, and whence is the fuel which has produced it for ſo many ages? To enable us to anſwer theſe queſtions with preciſion, more information is neceſſary than we have hitherto obtained reſpecting the ſtructure of the internal parts of the earth. It is peculiarly requiſite that we ſhould be made acquainted with the foſſils which are moſt common in thoſe places where hot ſprings abound. We ſhould then perhaps diſcover that hot ſprings always paſs through bodies of a combuſtible nature. It is well known to chemiſts, that when water is mixed with the vitriolic acid, a degree of heat is produced ſuperior to that of boiling water. It is alſo an eſtabliſhed fact, that when water meets with pyrites, that is, a mixture of ſulphur and iron, a violent inflammation takes place. If, therefore, we could prove that theſe materials exiſt in the ſtrata from which hot ſprings are derived, we ſhould be enabled to give a ſatisfactory account of this curious phenomenon. As ſome apology for this ſuppoſition, we may add, that moſt of the hot ſprings mentioned above have been found by analyſis to be impregnated with ſulphur, and ſome of them with iron.

y's Let- from many Swit- land.

iron. It muſt, however, be acknowledged, that the hot ſprings of Iceland, which are 212°, the heat of boiling water, according to an accurate analyſis of their contents by the ingenious Dr Black, were neither found to contain iron nor ſulphur. It will therefore, perhaps, be neceſſary that we ſhould wait with patience, and continue to collect facts, till the ſciences of chemiſtry and mineralogy ſhall be ſo far advanced as to enable us to form a permanent theory on this ſubject.

Springs are of different kinds. Some are perennial, or continue to flow during the whole year; others flow only during the rainy ſeaſon; ſome ebb and flow. At Torbay there is one of this kind, which ebbs and flows five or ſix inches every hour. There is another near Coriſo in Italy, which ebbed and flowed three times a-day in the time of Pliny, and continues to do ſo ſtill. A ſpring near Henly ſometimes flows for two years together, and then dries up for an equal period. For the ingredients found in ſprings, ſee *MINERAL-Waters*.

SPRING, in *Mechanics*, denotes a thin piece of tempered ſteel, or other elaſtic ſubſtance, which being wound up ſerves to put machines in motion by its elaſticity, or endeavours to unbend itſelf; ſuch is the ſpring of a watch, clock, or the like.

SPRING, *Ver*, in coſmography, denotes one of the ſeaſons of the year; commencing, in the northern parts of the world, on the day the ſun enters the firſt degree of Aries, which is about the 10th day of March, and ending when the ſun leaves Gemini; or, more ſtrictly and generally, the ſpring begins on the day when the diſtance of the ſun's meridian altitude from the zenith, being on the increaſe, is at a medium between the greateſt and leaſt. The end of the ſpring coincides with the beginning of ſummer. See SUMMER.

Elater SPRING, in *Phyſics*, denotes a natural faculty or endeavour of certain bodies, to return to their firſt ſtate, after having been violently put out of it by compreſſing or bending them. This faculty is, by philoſophers, uſually denominated *elaſtic force*, or *elaſticity*.

SPRING-Tide. See ASTRONOMY *Index*, and TIDE.

Burning SPRINGS. See *BURNING Springs*.

SPRINGER, or *SPRING-Bok*. See CAPRA, MAMMALIA *Index*.

SPRIT, a ſmall boom or pole which croſſes the ſail of a boat diagonally, from the maſt to the upper hindmoſt corner of the ſail, which it is uſed to extend and elevate; the lower end of the ſprit reſts in a ſort of wreath or collar called the *ſmotter*, which encircles the maſt in that place.

SPRITSAIL. See SAIL and SHIP.

SPRITSAIL-Topſail. See SAIL and SHIP.

SPRUCE-TREE. See PINUS, BOTANY *Index*.

SPRUCE Beer, a cheap and wholeſome liquor, which is thus made: Take of water 16 gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the reſerved cold part, which ſhould be previouſly put into a barrel or other veſſel; then add 16 pounds of treacle or molaſſes, with a few table ſpoonfuls of the eſſence of ſpruce, ſtirring the whole well together; add half a pint of yeaſt, and keep it in a temperate ſituation, with the bung hole open, for two days, till the fermentation be abated. Then cloſe it up or bottle it off, and it will be fit for being drunk in a few days afterwards. In North America, and perhaps in other countries, where the black and white ſpruce firs abound, inſtead of adding the *eſſence* of the ſpruce at the ſame time with the molaſſes, they make a decoction of the leaves and ſmall branches of theſe trees, and find the liquor equally good. It is a powerful antiſcorbutic, and may prove very uſeful in long ſea voyages.

SPUNGE, or SPONGE. See SPONGIA.

SPUNGING, in *Gunnery*, the cleaning of the inſide of a gun with a ſponge, in order to prevent any ſparks of fire from remaining in it, which would endanger the life of him that ſhould load it again.

SPUN-YARN, among ſailors, is a kind of line made from rope yarn, and uſed for ſeizing or faſtening things together.

SPUNK. See BOLETUS, BOTANY *Index*.

SPUR, a piece of metal conſiſting of two branches encompaſſing a horſeman's heel, and a rowel in form of a ſtar, advancing out behind to prick the horſe.

SPUR-Winged Water-Hen. See PARRA, ORNITHOLOGY *Index*.

SPURGE. See EUPHORBIA,
SPURGE-Laurel. See DAPHNE, } BOTANY *Index*.
SPURREY. See SPERGULA,

SPY, a perſon hired to watch the actions, motions, &c. of another; particularly what paſſes in a camp. When a ſpy is diſcovered, he is hanged immediately.

SQUADRON, in military affairs, denotes a body of horſe whoſe number of men is not fixed; but is uſually from 100 to 200.

SQUADRON of Ships, either implies a detachment of ſhips employed on any particular expedition, or the third part of a naval armament.

SQUADS, in a military ſenſe, are certain diviſions of a company into ſo many ſquads, generally into three or four. The uſe of forming companies into as many ſquads of inſpection as it has ſerjeants and corporals, is proved by thoſe regiments who have practiſed that method; as by it the irregularity of the ſoldiers is conſiderably reſtrained, their dreſs improved, and the diſcipline of the regiment in general moſt remarkably forwarded. Every officer ſhould have a roll of his company by ſquads.

SQUALL, a ſudden and violent blaſt of wind uſually occaſioned by the interruption and reverberation of the wind from high mountains. Theſe are very frequent in the Mediterranean, particularly that part of it which is known by the name of the *Levant*, as produced by the repulſion and new direction which the wind meets with in its paſſage between the various iſlands of the Archipelago.

SQUALUS, the SHARK; a genus of fiſhes arranged by Linnæus under the claſs of amphibia, and the order of nantes, but by Gmelin referred to the claſs of piſces, and order of chondropteryii. See ICHTHYOLOGY *Index*.

SQUAMARIA. See LATHRÆA, BOTANY *Index*.

SQUAMOUS, in *Anatomy*, a name given to the ſpurious or falſe ſutures of the ſkull, becauſe compoſed of ſquamæ or ſcales like thoſe of fiſhes.

SQUARE, in *Geometry*, a quadrilateral figure both equilateral and equiangular. See GEOMETRY.

SQUARE Root. See ALGEBRA and ARITHMETIC, N° 33. and 34.

Hollow SQUARE, in the military art, a body of foot drawn

drawn up with an empty ſpace in the middle, for the colours, drums, and baggage, faced and covered by the pikes every way to keep off the horſe.

Square, among mechanics, an inſtrument conſiſting of two rules or branches, faſtened perpendicularly at one end of their extremities, ſo as to form a right angle. It is of great uſe in the deſcription and menſuration of right angles, and laying down perpendiculars.

T. Square, or *Tee Square*, an inſtrument uſed in drawing, ſo called from its reſemblance to the capital letter T.

Square-Rigged, an epithet applied to a ſhip whoſe yards are very long. It is alſo uſed in contradiſtinction to all veſſels whoſe ſails are extended by ſtays or lateen-yards, or by booms and gaffs; the uſual ſituation of which is nearly in the plane of the keel; and hence,

Square-Sail, is a ſail extended to a yard which hangs parallel to the horizon, as diſtinguiſhed from the other ſails which are extended by booms and ſtays placed obliquely. This ſail is only uſed in fair winds, or to ſcud under in a tempeſt. In the former caſe, it is furniſhed with a large additional part called the *bonnet*, which is then attached to its bottom, and removed when it is neceſſary to scud. See Scudding.

SQUARING or *Quadrature of the Circle*, ſignifies the finding a ſquare exactly equal to the area of a given circle. This problem however has not been, and probably cannot be, ſtrictly reſolved by the commonly admitted principles of geometry; mathematicians having hitherto been unable to do more than to find a ſquare that ſhall differ from the area of any propoſed circle by as ſmall a quantity as they pleaſe. The quadrature of the circle is a problem of the ſame degree of difficulty, and indeed may be regarded as identical with another geometrical problem, namely, the *Rectification of the circle*, or the finding a ſtraight line equal to its circumference; for the area of a circle is equal to that of a rectangle contained by the radius and a ſtraight line equal to half the circumference (Geometry, Sect. VI. Prop. 3.): therefore, if a ſtraight line exactly equal to the circumference could be found, a rectilineal ſpace preciſely equal to the area might alſo be found, and the contrary. But although no perfectly accurate reſolution of the problem has been obtained under either form, we can always find approximate values of the area and circumference; and therefore it is now cuſtomary to apply the terms *quadrature* and *rectification* of the circle alſo to theſe.

The problem of the quadrature of the circle appears to have engaged the attention of geometers at a very early period; for we are told that Anaxagoras, who lived about 500 years before Chriſt, attempted its ſolution while confined in priſon on account of his philoſophical opinions. We are ignorant of the reſult of his reſearches; but although we cannot ſuppoſe they were attended with any ſucceſs, we may reaſonably conclude that we are indebted to them for the diſcovery of ſome of the properties of the figure, which are now known as elementary propoſitions in geometry.

Hippocrates of Chios was likewiſe engaged in trying to reſolve the ſame problem, and it was no doubt in the courſe of his inquiries into this ſubject that he diſcovered the quadrature of the curvilineal ſpace, which is now known by the name of the *Lune* of Hippocrates. The nature of this diſcovery may be briefly explained as follows. Let ABCD be a circle (Plate D. fig. 1.), H its centre, AC its diameter, ADC a triangle inſcribed in the ſemicircle, having its ſides AD, DC equal to one another. On D as a centre, with DA or DC as a radius, let the quadrantal arch AEC be deſcribed, then ſhall the curvilineal ſpace bounded by the ſemicircle ABC and the quadrantal arch AEC (which is the *Lune* of Hippocrates) be equal to the rectilineal triangle ADC. For becauſe circles are to one another as the ſquares of the radii (Geometry, Sect. VI. Prop. 4.); the circle having DA for its radius will be to the circle having HA for its radius as the ſquare of DA to the ſquare of HA, that is, as 2 to 1; hence the former of theſe circles will be double the latter, and conſequently one fourth of the former will be equal to one half of the latter; that is, the quadrant AECD will be equal to the ſemicircle ABC; from theſe equals take away the common ſpace bounded by the diameter AC and the arch AEC, and there will remain the triangle ADC equal to the lunular ſpace AECBA.

Plate D. fig. 1.

Although Hippocrates's diſcovery has led to no important concluſion either relating to the quadrature of the circle or that of any other curve, yet at the time it was made it might be regarded as of ſome conſequence, chiefly becauſe it ſhewed the poſſibility of exhibiting a rectilineal figure equal to a ſpace bounded by curve lines, a thing which we have reaſon to ſuppoſe was then done for the firſt time, and might have been fairly doubted, conſidering the inſuperable difficulty that was found to attend the quadrature of the circle or its rectification.

Ariſtotle ſpeaks of two perſons, viz. Bryſon and Antiphon, who about his time, or a little earlier, were occupied with the quadrature of the circle. The former appears, according to the teſtimony of Alexander Aprodiſeus, to have erred moſt egregiouſly; he having concluded that the circumference was exactly $3\frac{1}{4}$ times the diameter. And the latter ſeems to have proceeded pretty much in the ſame manner as Archimedes afterwards did in ſquaring the parabola, that is, by firſt inſcribing a ſquare in the circle, then an iſoſceles triangle in each of the ſegments of the curve, having for its baſe a ſide of the ſquare; and next again a ſeries of triangles in the ſegments, having for their baſes the ſides of the former ſeries, and ſo on: this mode of procedure, however, could not be attended with any ſucceſs, as it is well known that the ſpaces thus formed do not, as in the caſe of the parabola, admit of being abſolutely ſummed.

It may naturally be ſuppoſed that Archimedes exerted his utmoſt efforts to reſolve this problem; and probably it was only after long meditation on the ſubject that he loſt all hopes of ſucceſs, and contented himſelf with that approximation to the ratio of the diameter to the circumference which is contained in his treatiſe *De Circuli Dimenſione*, which has been preſerved from the period in which he wrote, about 250 years before Chriſt, to the preſent times. He found his approximation to the ratio, by ſuppoſing a regular polygon of 96 ſides to be deſcribed about the circle, and another of the ſame number of ſides to be inſcribed in it, and by ſhewing that the perimeter of the circumſcribing polygon was leſs than $3\frac{10}{70}$ or $3\frac{1}{7}$ times the diameter, but that the perimeter of the inſcribed figure was greater than $3\frac{10}{70}$ times the

SQUARING or Quadrature of the Circle. PLATE D.

Fig. 1.

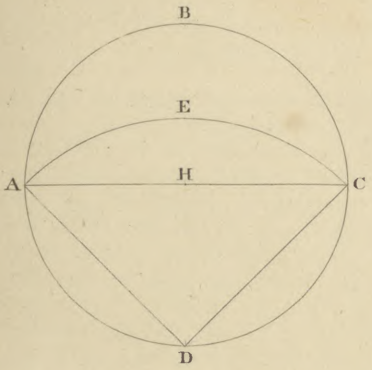
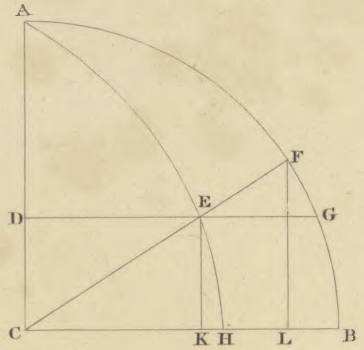


Fig. 2.



STARCH. Manufacture of.

Fig. 1.

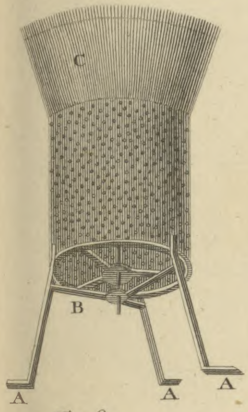


Fig. 6.

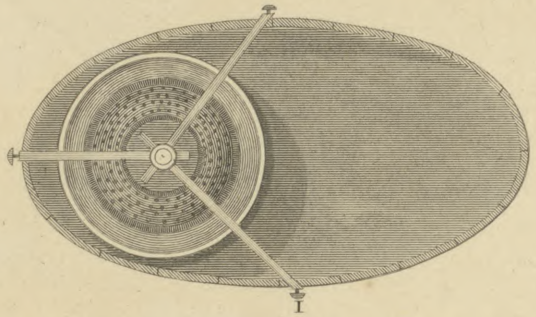


Fig. 4.

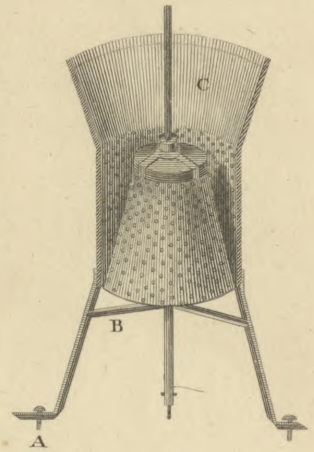


Fig. 2.

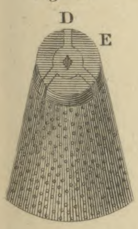


Fig. 7.

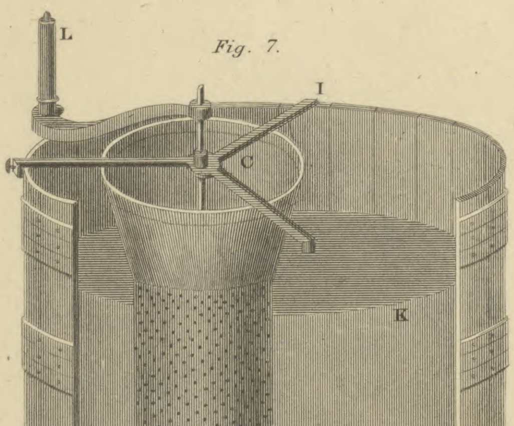


Fig. 3.

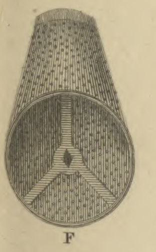
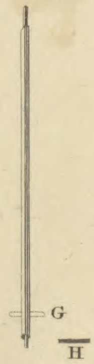


Fig 5



E. Mitchell sculpt

the diameter; now the circumference of the circle being leſs than the perimeter of the one polygon but greater than that of the other, it follows that the circumference muſt be leſs than $3\frac{1}{7}$ times the diameter, but greater than $3\frac{10}{71}$ times; ſo that, taking the firſt of theſe limits as being expreſſed by the ſmalleſt numbers, the circumference will be to the diameter as $3\frac{1}{7}$ to 1, or as 22 to 7 nearly.

Although the approximate ratio inveſtigated by Archimedes be the oldeſt known to have been found in the weſtern world, yet one more accurate ſeems to have been known at a much earlier period in India. This we learn from the *Inſtitutes of Akbar* (*Ayeen Akberry*) where it is ſaid that the Hindoos ſuppoſe the diameter of a circle to be to its circumference as 1250 to 3927. Now this ratio, which is the ſame as that of 1 to 3.1416, when found in the ſimpleſt and moſt elementary manner muſt have required the inſcription of a polygon of 768 ſides in the circle, and muſt have been attended with nine extractions of the ſquare root, each carried as far as ten places of figures.

We learn from Simplicius that Nicomedes and Apollonius both attempted to ſquare the circle, the former by means of a curve which he called the *Quadratrix*; the invention of which, however, is aſcribed to Dinoſtratus, and the latter alſo by the help of a curve denominated the ſiſter to the tortuous line or *ſpiral*, and which was probably no other than the quadratrix of Dinoſtratus; the nature of which, and the manner of its application to the ſubject in queſtion, we ſhall briefly explain.

Let AFB be a quadrant of a circle (fig. 2.) and C its centre; and conceive the radius CF to revolve uniformly about C from the poſition CA until at laſt it coincide with CB; while at the ſame time a line DG is carried with an uniform motion from A towards CB; the former line continuing always parallel to the latter, until at laſt they coincide; both motions being ſuppoſed to begin and end at the ſame inſtant. Then the point E in which the revolving radius CF and the moveable line DG interſect one another will generate a certain curve line AEH, which is the *Quadratrix* of Dinoſtratus.

Draw EK, FL both perpendicular to CB; then becauſe the radius AC and the quadrantal arch AFB are uniformly generated in the ſame time by the points D and F, the contemporaneous ſpaces deſcribed will have to one another the ſame ratio as the whole ſpaces; that is, AD : AF :: AC : AB; hence we have AC : AB :: DC, or EK : FB. Now as the moveable point F approaches to B, the ratio of the ſtraight line EK to the arch FB will approach to, and will manifeſtly be ultimately the ſame as the ratio of the ſtraight line EK to the ſtraight line FL, which again is equal to the ratio of CE to CF; therefore the ratio of the radius AC to the quadrantal arch AFB is the limit of the ratio of CE to CF, and conſequently equal to the ratio of CH to CB, H being the point in which the quadratrix meets CB. Since therefore CH : CB :: CA or CB : quad. arch AFB, if by any means we could determine the point H, we might then find a ſtraight line equal to the quadrantal arch, (by finding a third proportional to CH and CB) and conſequently a ſtraight line equal to the circumference. The point H, however, cannot be determined by a geometrical conſtruction, and therefore all the ingenuity evinced by the perſon who firſt thought of this method of rectifying the circle (which certainly is conſiderable) has been unavailing.

The Arabs, who ſucceeded the Greeks in the cultivation of the ſciences, would no doubt have their pretended ſquares of the circle. We however know nothing more than that ſome one of them believed he had diſcovered that the diameter being unity, the circumference was the ſquare root of 10; a very groſs miſtake; for the ſquare root of 10 exceeds 3.162; but Archimedes had demonſtrated that the circumference was leſs than 3.143.

It appears that, even during the dark ages, ſome attempts were made at the reſolution of this famous problem, which however have always remained in manuſcripts buried in the duſt of old libraries. But upon the revival of learning the problem was again agitated by different writers, and particularly by the celebrated Cardinal De Cuſa, who diſtinguiſhed himſelf by his unfortunate attempt to reſolve it. His mode of inveſtigation, which had no ſolid foundation in geometry, led him to conclude, that if a line equal to the ſum of the radius of a circle and the ſide of its inſcribed ſquare were made the diameter of another circle, and an equilateral triangle were inſcribed in this laſt, the perimeter of this triangle would be equal to the circumference of the other circle. This pretended quadrature of the cardinal's was refuted by Regiomontanus; and indeed the taſk was not difficult; for, according to his conſtruction, the diameter being 1, the circumference was greater than $3\frac{1}{7}$; a concluſion which muſt be abſurd, ſeeing that Archimedes had demonſtrated that it muſt be leſs than that number.

It would be treſpaſſing too much upon the patience of our readers, were we to mention all the abſurd and erroneous attempts which have been made during the laſt three centuries to ſquare the circle. In a ſupplement to Montucla's excellent work, *Hiſtoire des Mathematiques*, we find upwards of forty pretenders to the honour of this diſcovery enumerated. Theſe were almoſt all very ignorant of geometry; and many of them were wild viſionaries, pretending to diſcover inexplicable relations between the plain truths of mathematics and the moſt myſterious doctrines of religion. If thoſe who have ſought the quadrature of the circle had been previouſly initiated in the doctrines of geometry, although they miſſed attaining the object they had in view, yet they could not have failed to have extended the boundaries of the ſcience by the diſcovery of many new propoſitions. From ſuch perſons, however, as have generally purſued this inquiry, no improvement whatever of the ſcience was to be expected; although, indeed, in ſome inſtances, it has derived advantage from the labours of ſuch as have undertaken to expoſe the abſurdity of their concluſions; as in the caſe of Metius, who in refuting the quadrature of one *Simon à Quercu*, found a much nearer approximation to the ratio of the diameter to the circumference than had been previouſly known, at leaſt in Europe, viz. that of 113 to 355, which reduced to decimals is the ſame as the ratio of 1 to 3.1415929, differing from the truth only in the ſeventh place of decimals.

Among the moſt remarkable of thoſe who have recorded their own folly by publiſhing erroneous reſolutions of the problem, we may reckon the celebrated Joſeph Scaliger. Full of ſelf-conceit, he believed that, entering

entering upon the ſtudy of geometry, he could not fail to ſurmount by the force of his genius thoſe obſtacles which had completely ſtopt the progreſs of all preceding inquirers. He gave the reſult of his meditations to the world in 1592, under the title *Nova Cyclometria;* but he was refuted by Clavius, by Vieta, and others, who ſhewed that the magnitude he had aſſigned to the circumference was a little *leſs* than the perimeter of the inſcribed polygon of 192 ſides, which proved beyond a doubt that he was wrong. Scaliger, however, was not to be convinced of the abſurdity of his concluſion; and indeed, in almoſt every inſtance, pretenders to this diſcovery have not been more remarkable for their folly in committing abſurd blunders, than for their obſtinacy in maintaining that they were in the right, and all who held a contrary opinion in an error.

The famous Hobbes came alſo upon the field about the year 1650, with pretenſions not only to the quadrature of the circle, but alſo to the triſection of an angle, the rectification of the parabola, &c.; but his pretended ſolutions were refuted by Dr Wallis. And this circumſtance afforded him occaſion to write not only againſt geometers, but even againſt the ſcience of geometry itſelf.

We find it recorded by *Montucla*, as a ſort of phenomenon, that one Richard White, an Engliſh Jeſuit, having happened upon what he conceived to be a quadrature of the circle, which he publiſhed under the title, *Chryſaeſpis ſeu Quadratura Circuli*, ſuffered himſelf at laſt to be convinced by ſome of his friends that he was wrong both in his quadrature of the circle, and in his rectification of the ſpiral. But a ſolution of the ſame problem found out by one Mathulen of Lyons, did not produce in the end ſo much advantage to its author. This man in 1728 announued to the learned world that he had diſcovered both the quadrature of the circle and a perpetual motion; and he was ſo certain of the truth of theſe diſcoveries, that he conſigned 1000 *ecus* (about 125l.) to be paid to any one who ſhould demonſtrate that he was deceived in either. The taſk was not difficult. Nicole of the Academy of Sciences demonſtrated that he was wrong, and he himſelf allowed it; but he heſitated to pay the money, which Nicole had relinquiſhed in favour of the *Hotel Dieu* of Lyons. The affair went before a court of juſtice, which adjudged the money to be paid, as Nicole had deſtined it, to the poor. At a later period, viz. in 1753, the Chevalier de Cauſans, a French officer, and a man who was never expected to be a mathematician, ſuddenly found a quadrature of the circle in procuring a circular piece of turf to be cut; and riſing from one truth to another, he explained by his quadrature the doctrine of original ſin, and the Trinity. He engaged himſelf by a public writing to depoſit with a notary the ſum of 300,000 francs, to be wagered againſt ſuch as ſhould oppoſe him, and he actually lodged 10,000, which were to devolve to him who ſhould demonſtrate his error. This was eaſily done, as it reſulted from his diſcovery that a circle was equal to its circumſcribing ſquare, that is, a part to the whole! Some perſons came forward to anſwer his challenge, and in particular a young lady ſued him at one of the courts of law; but the French king judged that the Chevalier's fortune ought not to ſuffer on account of his whim; for, ſetting aſide this piece of folly, in every other reſpect he was a worthy man. The procedure was therefore ſtopt, and the wager declared void.

We ſhall not enter farther into the hiſtory of theſe vain and abſurd attempts to reſolve this important problem, but proceed to ſtate what has actually been done by men of ſound minds and real mathematical acquirements towards its ſolution. And in the firſt place it may be obſerved that the problem admits of being propoſed under two different forms: for it may be required to find either the area of the whole circle, or, which is the ſame thing, the length of the whole circumference; or elſe to find the area of any propoſed ſector or ſegment, or, which is equivalent, the length of the arch of the ſector or ſegment. The former is termed the *definite* and the latter the *indefinite* quadrature of the circle. The latter evidently is more general than the former, and includes it as a particular caſe. Now if we could find by any means a finite algebraic equation that ſhould expreſs the relation between any propoſed arch of a circle, and ſome known ſtraight line, or lines, the magnitude of one or more of which depended on that arch, then we would have an abſolute rectification of the arch, and conſequently a rectification or quadrature alſo of the whole circle. We here ſpeak of an analytical ſolution of the problem; the ancients, however, who were almoſt entirely ignorant of this branch of mathematical ſcience, muſt have endeavoured to treat it entirely upon geometrical principles. It is now well known, however, that all geometrical problems may be ſubjected to analyſis; and that it is only by ſuch a mode of proceeding they have in many caſes been reſolved.

With reſpect to the definite quadrature of the circle, it is commonly underſtood that no unexceptionable demonſtration of its impoſſibility has hitherto been publiſhed. It is true that James Gregory, in his *vera circuli et Hyberbolæ quadratura*, has given what he conſidered as ſuch a demonſtration; but it has been objected to, particularly by Huygens, one of the beſt geometers of his time. We are, however, certain that the ratio of the diameter to the circumference, as alſo, that the ratio of the ſquare of the diameter to the ſquare of a ſtraight line equal to the circumference, cannot be expreſſed by rational numbers, for this has been ſtrictly demonſtrated by Lambert in the Berlin Memoirs for 1761. A demonſtration is alſo given in Legendre's *Geometrie*. As to the indefinite quadrature, if Newton's demonſtration of the 28th lemma of the firſt book of his *Principia* be correct, the thing ought to be abſolutely impoſſible. For the object of that propoſition is to prove that in no oval figure whatever, that returns into itſelf, can the area cut off by ſtraight lines at pleaſure be univerſally found by an equation of a finite dimenſion, and compoſed of a finite number of terms. If this be true, then it will be impoſſible to expreſs any ſector of a circle taken at pleaſure in finite terms. It is however to be remarked, that the accuracy of the reaſoning by which Newton has attempted to eſtabliſh the truth of the general propoſition has been queſtioned by no leſs a geometer than D'Alembert; and indeed we know one oval curve, which returns into itſelf, and which according to Newton's propoſition ought therefore not to admit of an indefinite quadrature; yet this is by no means the caſe, for it does really admit of ſuch a quadrature. The curve we mean is the *lemniſcata*, the equation of which is $(x^2+y^2)^2=a^2(x^2-y^2)$, where x and y denote its coordinates,

ordinates, and *a* is put for a given line. The figure of the curve is nearly that of the numeral character 8. Upon the whole then we may infer that an unexceptionable demonſtration of the impoſſibility of expreſſing either the whole circle, or any propoſed ſector of it, by a finite equation, is ſtill among the *deſiderata* of mathematics.

We come now to ſpeak of the different methods which have been found for approximating to the area or to the circumference. We have already noticed the approximation to the ratio of the diameter to the circumference found by Archimedes, and the earlier and more accurate approximation of the Indian mathematicians. Archimedes's ratio is the only one found by the ancients in the weſtern world that has deſcended to modern times, and it appears to have been the moſt accurate known, until about the year 1585, when Metius, in refuting a pretended quadrature, found the more accurate ratio of 113 to 355, as we have already noticed. About the ſame time Vieta and Adrianus Romanus publiſhed their ratios expreſſed in decimals, the former carrying the approximation to ten decimals inſtead of ſix, (which was the number of accurate figures expreſſed by Metius's ratio), and the latter extending it to 17 figures. Vieta alſo gave a kind of ſeries, which being continued to infinity, gave the value of the circle.

Theſe approximations, however, were far exceeded by that of Ludolph Van Ceulen, who in a work publiſhed in Dutch in 1610, carried it as far as 36 figures, ſhowing that if the diameter were unity, the circumference would be greater than 3.14159,26535,89793, 23846,26433,83279,50288, but leſs than the ſame number with the laſt figure increaſed by an unit. This work was tranſlated into Latin by Snellius, and publiſhed under the title, *De Circulo et Adſcriptis*. In finding this approximation, Van Ceulen followed the method of Archimedes, doubling continually the number of ſides of the inſcribed and circumſcribed polygons, until at length he found two which differed only by an unit in the 36th place of decimals in the numbers expreſſing their perimeters. This, however, muſt have been rather a work of patience than of genius; and indeed the labour muſt have been prodigious. He ſeems to have valued highly this ſingular effort, for in imitation of Archimedes, whoſe tomb was adorned with a ſphere and cylinder, in commemoration of his diſcovery of the proportion which theſe ſolids bear to one another, he requeſted that the ratio he had found might be inſcribed on his tomb; which was accordingly done.

Snellius found means to abridge greatly the labour of calculation by ſome very ingenious theorems; and although he did not go beyond Van Ceulen, yet he verified his reſult. His diſcoveries on this ſubject are contained in a work called *Willebrordi Snellii Cyclometricus de Circuli Dimenſione*, &c. *Lugd. Bat.* 1621.

Deſcartes found alſo a geometrical conſtruction, which being repeated continually, gave the circumference, and from which he might eaſily have deduced an expreſſion in the form of a ſeries.

Gregory of St Vincent diſtinguiſhed himſelf alſo on this ſubject. It is true he committed a great error in ſuppoſing he had diſcovered the quadrature of both the circle and hyperbola; but he had previouſly made ſo many beautiful geometrical diſcoveries, deduced with much elegance after the manner of the ancients, that it would be wrong to number him with thoſe abſurd pretenders which we have already noticed. Gregory's miſtake was the cauſe of a ſharp controverſy carried on between his diſciples on the one ſide, and by Huygens, Merſennus, and Leſtaud, on the other; and it was this that gave Huygens occaſion to conſider particularly the quadrature of the circle, and to inveſtigate various new and curious theorems relating to it, which are contained in his *Theoremata de Quadratura Hyperboles, Ellipſis et Circuli*, 1651; and in his work *De Circuli Magnitudine Inventa*, 1654. In particular he ſhowed, that if c denote the chord of an arch, and s its ſine, then the arch itſelf will be greater than $c+\frac{1}{3}(c-s)$, but leſs than $c+\frac{4c+s}{2c+3s}\times\frac{1}{3}(c-s)$: he alſo ſhowed that the arch is leſs than the ſum of $\frac{2}{3}$ of its ſine and $\frac{1}{3}$ of its tangent. Theſe theorems greatly ſhorten the labour of approximating to the ratio of the diameter to the circumference, by means of inſcribed and circumſcribed figures, inſomuch that by the inſcribed polygons of 6 and 12 ſides, we may obtain it to the ſame degree of accuracy as Archimedes did by the inſcribed and circumſcribed polygons of 96 ſides.

James Gregory, in his *Vera Circuli et Hyperbolæ Quadratura*, gave ſeveral curious theorems upon the relation of the circle to its inſcribed and circumſcribed polygons, and their ratios to one another; and by means of theſe he found with infinitely leſs trouble than by the ordinary methods, and even by thoſe of Snellius, the meaſure of the circle as far as 20 places of figures. He gave alſo, after the example of Huygens, conſtructions for finding ſtraight lines nearly equal to arches of a circle, and of which the degree of accuracy was greater. For example, he found that if A be put for the chord of an arch of a circle, and B for twice the chord of half the arch, and C be taken ſuch that $A+B : B :: 2B : C$, then the arch itſelf is nearly equal to $\frac{8C+8B-A}{15}$, but a little leſs, the error in the caſe of a complete ſemicircle being leſs than its $\frac{1}{3300}$ part; and when the arch does not exceed 120°, it is leſs than its $\frac{1}{40000}$ part; and finally, for a quadrant the error is not greater than its $\frac{1}{300000}$ part. And farther, that if D be ſuch that $A : B :: B : D$, then the arch is nearly equal to $\frac{12C+4B-D}{15}$, but a little greater, the error in the ſemicircle being leſs than its $\frac{1}{1000}$ part, and in a quadrant leſs than its $\frac{1}{60000}$ part.

The diſcoveries of Dr Wallis, delivered in his *Arithmetica Infinitorum* publiſhed in 1655, led him to a ſingular expreſſion for the ratio of the circle to the ſquare of its diameter. He found that the former was to the latter as 1 to the product

$$\frac{3\times3\times5\times5\times7\times7\times9\times9\times11\times11\ \&c.}{2\times4\times4\times6\times6\times8\times8\times10\times10\times12}$$

the fractions $\frac{3}{2}$, $\frac{3}{4}$, $\frac{5}{4}$, $\frac{5}{6}$, &c. being ſuppoſed infinite in number. The products being ſuppoſed continued to infinity, we have the ratio exactly; but if we ſtop at any finite number of terms, as muſt neceſſarily be the caſe in its application, the reſult will be alternately too great and too ſmall, according as we take an odd or an even number of terms of the numerator and denominator. Thus

Thus the fraction $\frac{1}{2}$ is too great; on the other hand, $\frac{3\times3}{2\times4}=\frac{9}{8}$ is too ſmall, and $\frac{3\times3\times5}{2\times4\times4}=\frac{45}{32}$ too great, and ſo on. But to approach as near as poſſible in each caſe, Wallis directs to multiply the product by the ſquare root of a fraction formed by adding to unity the reciprocal of the laſt factor in either its numerator or denominator; then the reſult, although much nearer, will be too great if the number whoſe reciprocal is taken be the laſt in the numerator, but too ſmall if it be the number in the denominator. Thus the following ſeries of expreſſions will give approximate values of the infinite product $\frac{3\times3\times5\times5\times7\times7\,\&c.}{2\times4\times4\times6\times6\times8\times8}$ which are alternately too great and too ſmall.

$$\frac{3\cdot3\cdot5\cdot5}{2.4.4.6}\sqrt{(1+\tfrac{1}{5})};\ \frac{3\cdot3\cdot5\cdot5}{2.4.4.6}\sqrt{(1+\tfrac{1}{6})};$$

$$\frac{3\cdot3\cdot5\cdot5\cdot7\cdot7}{2.4.4.6.6.8}\sqrt{(1+\tfrac{1}{7})};\ \frac{3\cdot3\cdot5\cdot5\cdot7\cdot7}{2.4.4.6.6.8}\sqrt{(1+\tfrac{1}{8})};\ \&c.$$

theſe values, alternately too great and too ſmall, fall between the known limits.

An expreſſion of another kind for the ratio of the circle to the ſquare of the diameter was found by Lord Brounker. He ſhowed that the circle being unity, the ſquare of the diameter is expreſſed by the continued fraction

$$1+\cfrac{1}{2+\cfrac{9}{2+\cfrac{25}{2+\cfrac{49}{2+,\&c.}}}}$$

which is ſuppoſed to go on to infinity, the numerators 1, 9, 25, 49, &c. being the ſquares of the odd numbers 1, 3, 5, 7, &c. By taking two, three, four, &c. terms of this fraction, we ſhall have a ſeries of approximate values which are alternately greater and leſs than its accurate value.

Such were the chief diſcoveries relating to the quadrature of the circle made before the time of Newton: many others, however, were quickly added by that truly great man, as well as by his contemporaries. In particular, Newton himſelf ſhowed that if s denote the ſine, and v the verſed ſine of an arch, then the radius being unity, the arch is equal to either of the following ſeries,

$$s+\frac{1.s^3}{2.3}+\frac{1.3s^5}{2.4.5}+\frac{1.3.5s^7}{2.4.6.7}+\frac{1.3.5.7s^9}{2.4.6.8.9}+,\ \&c.$$

$$\sqrt{2v}\times\left(1+\frac{1.v}{2.3.2}+\frac{1.3v^2}{2.4.5.2^2}+\frac{1.3.5v^3}{2.4.6.7.2^3}+\frac{1.3.5.7v^4}{2.4.6.8.9.2^4}+,\ \&c.\right).$$

And James Gregory found that t being put for the tangent, the arch is expreſſed by the very ſimple ſeries

$$t-\frac{t^3}{3}+\frac{t^5}{5}-\frac{t^7}{7}+\frac{t^9}{9}-,\ \&c.$$

We have inveſtigated the firſt of theſe ſeries at § 140, and the third at § 137, of the article FLUXIONS: the ſecond is eaſily obtained from the firſt by conſidering that ſince the ſine of an arch is half the chord of twice the arch, that is, half of a mean proportional between the diameter and verſed ſine of twice the arch; we have therefore only to multiply the firſt ſeries by 2, and to ſubſtitute $\frac{1}{2}\sqrt{2v}$ inſtead of s, and we get the ſecond ſeries.

By taking $s=\frac{1}{2}$, then, becauſe in this caſe the arch contains 30°, we have half the circumference to the radius 1, or the whole circumference to the diameter 1, expreſſed by the infinite ſeries

$$3\left(1+\frac{1}{2.3.2^2}+\frac{1.3}{2.4.5.2^4}+\frac{1.3.5}{2.4.6.7.2^6}+\frac{1.3.5.7}{2.4.6.8.9.2^8}+,\ \&c.\right).$$

And by ſuppoſing that in the third ſeries $t=1$, in which caſe the arch is one-eighth of the circumference, we have the ſame things expreſſed by the ſeries

$$4\left(1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\frac{1}{11}+,\ \&c.\right).$$

which was given by Leibnitz as a quadrature of the circle in the Leipſic Acts in the year 1682; but was diſcovered by him 1673. Gregory, however, had found the ſeries under its general form ſeveral years before. By the firſt of theſe two numeral ſeries we can readily compute the circumference of the circle to a tolerable degree of accuracy; but the ſecond is altogether inapplicable in its preſent form on account of the ſlowneſs of its convergency; for Newton has obſerved that to exhibit its value exact to twenty places of figures, there would be occaſion for no leſs than five thouſand millions of its terms, to compute which would take up above a thouſand years.

The ſlowneſs of the convergency has ariſen from our ſuppoſing $t=1$. If we had ſuppoſed t greater than 1, then the ſeries would not have converged at all, but on the contrary diverged. But by giving to t a value leſs than 1, then the rate of convergency will be increaſed, and that ſo much the more, as t is ſmaller.

If we ſuppoſe the arch of which t is the tangent to be 30°, then t will be $\sqrt{\frac{1}{3}}=\frac{1}{3}\sqrt{3}$, and therefore half the circumference to radius unity, or the circumference to the diameter unity, which in this caſe is $6t\left(1-\frac{t^2}{3}+\frac{t^4}{5}-\frac{t^6}{7}+\frac{t^8}{9}-,\ \&c.\right)$ will be,

$$\sqrt{12}\left(1-\frac{1}{3\cdot3}+\frac{1}{5\cdot3^2}-\frac{1}{7\cdot3^3}+\frac{1}{9\cdot3^4}-,\ \&c.\right).$$

By means of this ſeries, in an hour's time the circumference may be found to be nearly 3.141592653590, which is true to 11 decimal places, and is a very conſiderable degree of accuracy, conſidering the ſmallneſs of the labour. But Mr Machin, enticed by the eaſineſs of the proceſs, was induced, about the beginning of the laſt century, to continue the approximation as far as 100 places of figures, thus finding the diameter to be to the circumference as 1 to 3.14159,26535,89793, 23846,26433,83279,50288,41971,69399,37510,58209 74944,59230,78164,06286,20899,86280,34825,34211 70680. After him, De Lagny continued it as far as

128 figures. But he has alſo been outdone; for in Radcliffe's library at Oxford, there is a manuſcript in which it is carried as far as 150 figures!

Although this laſt ſeries, which was firſt propoſed by Dr Halley, gives the ratio of the diameter to the circumference with wonderful facility when compared with the operoſe method employed by Van Ceulen, yet others have been ſince found which accompliſh it with ſtill greater eaſe. In Halley's ſeries we have to compute the irrational quantity $\surd 12$, becauſe of the irrational value which it was neceſſary to give to t in order to render it ſufficiently ſmall, and at the ſame time an exact part of the whole circumference; but Mr Machin contrived, by a very ingenious artifice, to reduce the computation of an arch of 45°, and conſequently the length of the whole circumference, to two ſeries which contain only rational quantities, and which at the ſame time converge with great rapidity. The nature of this artifice, and the manner in which it occurred to its author, is explained by Dr Hutton in his very excellent treatiſe on Menſuration, as follows: "Since the chief advantage (in the application of Gregory's ſeries to the rectification of the circle) conſiſts in taking ſmall arches, whoſe tangents ſhall be numbers eaſy to manage, Mr Machin very properly conſidered, that ſince the tangent of 45° is 1, and that the tangent of any arch being given, the tangent of the double of that arch can eaſily be had; if there be aſſumed ſome ſmall ſimple number as the tangent of an arch, and then the tangent of the double arch be continually taken, until a tangent be found nearly equal to 1, which is the tangent of 45°, by taking the tangent anſwering to the ſmall difference of 45° and this multiple, there would be found two very ſmall tangents, viz. the tangent firſt aſſumed, and the tangent of the difference between 45° and the multiple arch; and that therefore the lengths of the arches correſponding to theſe two tangents being calculated, and the arch belonging to the tangent firſt aſſumed being ſo often doubled as the multiple directs, the reſult, increaſed or diminiſhed by the other arch, according as the multiple ſhould be below or above it, would be the arch of 45°.

"Having thus thought of his method, by a few trials he was lucky enough to find a number (and perhaps the only one) proper for his purpoſe; viz. knowing that the tangent of $\frac{1}{4}$ of 45° is nearly $=\frac{1}{5}$, he aſſumed $\frac{1}{5}$ as the tangent of an arch. Then, ſince if t be the tangent of an arch, the tangent of the double arch will be $\frac{2t}{1-t^2}$, the radius being 1; the tangent of the double arch to that of which $\frac{1}{5}$ is the tangent will be $\frac{5}{12}$, and the tangent of the double of this arch will be $\frac{120}{119}$, which being very nearly equal to 1, ſhews, that the arch which is equal to four times the firſt arch is very near 45°. Then, ſince the tangent of the difference between an arch of 45°, and an arch greater than 45°, whoſe tangent is T, is $\frac{T-1}{T+1}$, we ſhall have the tangent of the difference between 45°, and the arch whoſe tangent is $\frac{120}{119}$ equal to $\frac{1}{239}$. Now, by calculating from the general ſeries the arches whoſe tangents are $\frac{1}{5}$ and $\frac{1}{239}$, (which may be quickly done by reaſon of the ſmallneſs and ſimplicity of the numbers), and taking the latter arch from four times the former, the remainder will be the arch of 45°."

If we ſubſtitute $\frac{1}{5}$ inſtead of t in the general ſeries, we ſhall have the arch whoſe tangent is $\frac{1}{5}$ expreſſed by the ſeries $\frac{1}{5}-\frac{1}{3\cdot 5^3}+\frac{1}{5\cdot 5^5}-\frac{1}{7\cdot 5^7}+$, &c.; and, in like manner, by ſubſtituting $\frac{1}{239}$ for t, we get the arch whoſe tangent is $\frac{1}{239}$ expreſſed by the ſeries $\frac{1}{239}-\frac{1}{3\cdot 239^3}+\frac{1}{5\cdot 239^5}-\frac{1}{7\cdot 239^7}+$, &c. Now, ſince four times the arch to tan. $\frac{1}{5}$ diminiſhed by the arch to tan. $\frac{1}{239}$ is equal to the arch to tan. 1, that is, to the arch of 45°, or $\frac{1}{4}$ of the ſemicircumference; therefore, half the circumference of a circle to rad. $=1$, or the whole circumference, the diameter being 1, is equal to

$$16\left(\frac{1}{5}-\frac{1}{3\cdot 5^3}+\frac{1}{5\cdot 5^5}-\frac{1}{7\cdot 5^7}+\frac{1}{9\cdot 5^9}-,\ \&c.\right)$$

$$-4\left(\frac{1}{239}-\frac{1}{3\cdot 239^3}+\frac{1}{5\cdot 239^5}-\frac{1}{7\cdot 239^7}+\frac{1}{9\cdot 239^9}-,\ \&c.\right)$$

and this is Machin's ſeries for the rectification of the circle.

The happy idea which Machin had conceived of reducing the rectification of the arch whoſe tangent is unity to that of two arches whoſe tangents are ſmall rational fractions, having each unity for a numerator, appears alſo to have occurred to Euler; and the ſame thought has, ſince his time, been purſued by other mathematicians, who have contrived to reſolve an arch of 45° into three or more ſuch arches. We ſhall ſhew how this may be done, beginning with the inveſtigation of the following problem.

PROBLEM. Suppoſing n, x, and y, to denote three whole numbers, ſuch, that the arch whoſe tangent is $\frac{1}{n}$ is equal to the ſum of two arches whoſe tangents are $\frac{1}{x}$ and $\frac{1}{y}$, radius being unity, it is required to determine all poſſible values of the numbers x and y in terms of the number n.

Solution. It is manifeſt from the formula for the tangent of the ſum of two arches (ALGEBRA, § 368.) that $\frac{1}{n}=\frac{\frac{1}{x}+\frac{1}{y}}{1-\frac{1}{xy}}$; hence we have $\frac{1}{n}=\frac{x+y}{xy-1}$, and $nx+ny=xy-1$, and $y(x-n)=nx+1$; and, laſtly, $y=\frac{nx+1}{x-n}=n+\frac{n^2+1}{x-n}$. Now, as by hypotheſis, y is a whole number, it is manifeſt that $\frac{n^2+1}{x-n}$ muſt be a whole number; therefore, $x-n$ muſt be a diviſor of n^2+1. Let p be any diviſor of n^2+1, and q the quotient, that is, let $pq=n^2+1$, then $x-n=p$, and $x=n+p$: And ſince $\frac{n^2+1}{x-n}=\frac{pq}{p}=q$, therefore $y=n+q$; thus the values of x and y are determined in terms of n as required; and by giving to p and q all poſſible values, we ſhall have all the values of x and y that can exiſt. This ſolution affords us the following theorem.

Theorem. Let n denote any whole number, and let n^2+1 be reſolved into any two factors p and q, (one of which may be unity), that is, let $pq=n^2+1$; the arch whoſe tangent is $\frac{1}{n}$ is equal to the ſum of the arches whoſe tangents are $\frac{1}{n+p}$, and $\frac{1}{n+q}$ reſpectively.

For the ſake of brevity, let $A\frac{1}{n}$ be put to denote the arch, having for its tangent $\frac{1}{n}$; then, according to this notation, our theorem will be expreſſed thus, $A\frac{1}{n}= A\frac{1}{n+p}+A\frac{1}{n+q}$. Let us now ſuppoſe $n=1$, then $n^2+1=2=1\times 2$, therefore, the only values which we can give in this caſe to p and q are $p=1$, $q=2$, and theſe being ſubſtituted, we have

$$A\,1=A\tfrac{1}{2}+A\tfrac{1}{3}.$$

From which it appears, that the arch whoſe tangent is unity (that is, $\frac{7}{8}$ of the circumference), is the ſum of the arches whoſe tangents are $\frac{1}{2}$ and $\frac{1}{3}$. This is Euler's theorem, and by means of it, putting $\frac{1}{2}$ and $\frac{1}{3}$ for t in the general ſeries $t-\frac{1}{3}t^3+\frac{1}{5}t^5-\frac{1}{7}t^7+$, &c. we get half the circumference to radius 1 equal to

$$4\left\{\begin{array}{l}\frac{1}{2}-\frac{1}{3\cdot 2^3}+\frac{1}{5\cdot 2^5}-\frac{1}{7\cdot 2^7}+\frac{1}{9\cdot 2^9}-\text{, \&c.}\\ +\frac{1}{3}-\frac{1}{3\cdot 3^3}+\frac{1}{5\cdot 3^5}-\frac{1}{7\cdot 3^7}+\frac{1}{9\cdot 3^9}-\text{, \&c.}\end{array}\right\}$$

Let us now ſuppoſe $n=2$, then $n^2+1=5=1\times 5$ hence the only values which p and q can have are 1 and 5; and in this caſe our general formula gives $A\frac{1}{2}=A\frac{1}{3}+A\frac{1}{7}$.

If now from the two equations

$$A1=A\tfrac{1}{2}+A\tfrac{1}{3};\qquad A\tfrac{1}{2}=A\tfrac{1}{3},+A\tfrac{1}{7},$$

we eliminate ſucceſſively $A\frac{1}{2}$ and $A\frac{1}{3}$, we ſhall obtain the two following:

$$A\,1=2\,A\tfrac{1}{3}+A\tfrac{1}{7};\qquad A\,1=2\,A\tfrac{1}{2}-A\tfrac{1}{7}.$$

From the firſt of theſe it appears that $\frac{1}{8}$ of the circumference is equal to the ſum of twice the arch to tan. $\frac{1}{3}$, and once the arch to tan. $\frac{1}{7}$; and from the ſecond, that the ſame quantity is equal to the exceſs of twice the arch to tan. $\frac{1}{2}$ above the arch to tan. $\frac{1}{7}$; and from each of theſe, an expreſſion for the whole circumference may be obtained analogous to that which we have found above from Euler's formula, but which will converge faſter, and therefore is better.

The reſolution of an arch of 45° into three other arches, may be effected by means of our general formula, as follows: Put $n=3$, then $n^2+1=10=1\times 10$ $=2\times 5$, hence we have $p=1$, and $q=10$, and alſo $p=2$, and $q=5$; therefore, ſubſtituting, we get two different values of $A\frac{1}{3}$, viz.

$$A\tfrac{1}{3}=A\tfrac{1}{4}+A\tfrac{1}{13};\qquad A\tfrac{1}{3}=A\tfrac{1}{5}+A\tfrac{1}{8}.$$

From theſe, and the equation $A\,1=2A\frac{1}{3}+A\frac{1}{7}$, we get, by exterminating $A\frac{1}{3}$, the two following expreſſions for $A\,1$, an arch of 45°.

$$A1=2A\tfrac{1}{4}+A\tfrac{1}{7}+2A\tfrac{1}{13};\qquad A1=2A\tfrac{1}{5}+A\tfrac{1}{7}+2A\tfrac{1}{8}.$$

Theſe give each an expreſſion for the circumference compoſed of three ſeries. The labour, however, of computing by either of them, particularly the latter, will probably be leſs than by any of the formulas compoſed of two ſeries, on account of the greater degree of quickneſs with which the ſeries will converge. All the preceding formulas have been inveſtigated in different ways by different mathematicians. That, however, which we are about to inveſtigate, we believe, is new. Let n in the general formula be taken equal to 5; then $n^2+1=26=1\times 26=2\times 13$, therefore $p=1$, $q=26$, alſo $p=2$, $q=13$, hence we find $A\frac{1}{5}=A\frac{1}{6}+A\frac{1}{31}$, and alſo $A\frac{1}{5}=A\frac{1}{7}+A\frac{1}{18}$. From this laſt equation, and the equation $A\,1=2\,A\frac{1}{5}+A\frac{1}{7}+2A\frac{1}{8}$, let $A\frac{1}{5}$ be eliminated, and the reſult is

$$A\,1=3\,A\tfrac{1}{7}+2A\tfrac{1}{8}+2A\tfrac{1}{18}.$$

This appears to be the moſt convenient expreſſion of any we have yet found, becauſe the fractions are ſmaller, while at the ſame time two of the denominators conſiſt of only one figure, and the third, which conſiſts of two, admits of being reſolved into factors. By the ſame mode of reaſoning we have found this expreſſion

$$A1=2A\tfrac{1}{8}+3A\tfrac{1}{9}+2A\tfrac{1}{18}+3A\tfrac{1}{32},$$

which conſiſts of four terms; but for the ſake of brevity we omit its inveſtigation.

We ſhall now apply the formula $A1=3A\frac{1}{7}+2A\frac{1}{8}+2A\frac{1}{18}$ to the actual calculation of the arch of 45°, the radius of the circle being unity.

I. Calculation of the length of the arch whoſe tangent is $\frac{1}{7}$.

In this caſe, becauſe $t=\frac{1}{7}$, we have

$$A\frac{1}{7}=\frac{1}{7}-\frac{1}{3\cdot 7^3}+\frac{1}{5\cdot 7^5}-\frac{1}{7\cdot 7^7}+\frac{1}{9\cdot 7^9}-\text{, \&c.}$$

$$\frac{1}{7}=.1428571428571 \qquad \frac{1}{3\cdot 7^3}=.0009718172983$$

$$\frac{1}{5\cdot 7^5}=.0000118998037 \qquad \frac{1}{7\cdot 7^7}=.0000001734665$$

$$\frac{1}{9\cdot 7^9}=.0000000027534 \qquad \frac{1}{11.7^{11}}=.0000000000460$$

$$\frac{1}{13\cdot 7^{13}}=.0000000000008 \qquad .0009719908108$$

$+.1428690454150$ amount of poſitive terms.
$-.0009719908108$ amount of negative terms.

$$A\frac{1}{7}=.1418970546042$$

II. Calculation of the length of the arch whoſe tangent is $\frac{1}{8}$.

Here $t=\frac{1}{8}$, therefore,

$$A\frac{1}{8}=\frac{1}{8}-\frac{1}{3.8^3}+\frac{1}{5.8^5}-\frac{1}{7.8^7}+\text{, \&c.}$$

$$\frac{1}{8} = .1250000000000 \qquad \frac{1}{3.8^3} = .0006510416667$$

$$\frac{1}{5.8^5} = .0000061035156 \qquad \frac{1}{7.8^7} = .0000000681196$$

$$\frac{1}{9.8^9} = .0000000008278 \qquad \frac{1}{11.8^{11}} = .0000000000106$$

$$\frac{1}{13.8^{13}} = .0000000000001 \qquad .0006511097969$$

$$+.1250061043435$$
$$-.0006511097969$$

$$A\frac{1}{8} = .1243549945466$$

III. Calculation of the arch whoſe tangent is $\frac{1}{18}$.

Here $t = \frac{1}{18}$, therefore,

$$A\frac{1}{18} = \frac{1}{18} - \frac{1}{3.18^3} + \frac{1}{5.18^5} - \frac{1}{7.18^7} +, \&c.$$

$$\frac{1}{18} = .0555555555556 \qquad \frac{1}{3.18^3} = .0000571559214$$

$$\frac{1}{5.18^5} = .0000001058443 \qquad \frac{1}{7.18^7} = .0000000002333$$

$$\frac{1}{9.18^9} = .0000000000006 \qquad .0000571561547$$

$$+.0555556614005$$
$$-.0000571561547$$

$$A\frac{1}{18} = .0554985052458$$

$$3A\tfrac{1}{7} = .4256911638126$$
$$2A\tfrac{1}{8} = .2487099890932$$
$$2A\tfrac{1}{18} = .1109970104916$$

$\frac{1}{8}$ of the circum. or $A1 = .785398163397$

Thus by a very eaſy calculation we have obtained one-fourth of the circumference true to 12 decimal places; and indeed by this method we may find an approximate value of the ratio of the diameter to the circumference to 200 places of figures with, perhaps, as much eaſe as Vieta or Romanus found it to 10 or 15 figures. We have already obſerved that Van Ceulen deſired that his quadrature, which extended only to 35 decimals, might be inſcribed on his tomb; from which we may reaſonably infer that the time and labour he had beſtowed in the calculation muſt have been very great; but by an artifice of the kind we have been explaining, Euler in 18 hours verified Lagny's quadrature of 128 figures.

In concluding this article we ſhall briefly notice ſome ſeries for the indefinite rectification of the circle, which have juſt appeared in the ſixth volume of the Edinburgh Philoſophical Tranſactions. They are given by Mr W. Wallace of the Royal Military College, in a paper entitled, *New Series for the Quadrature of the Conic Sections, and the Computation of Logarithms.* Theſe ſeries do not give the arch directly, but only its reciprocal, or the powers of that reciprocal; it is however evident, that any one of theſe being known, the arch itſelf becomes immediately known. The firſt ſeries is as follows. Let a denote any arch of a circle, and let its tangent, the tangents of its half, &c. be briefly denoted by tan. a, tan. $\frac{1}{2}a$, &c. Then ſhall

$$\frac{1}{a} = \frac{1}{\tan. a} + \tfrac{1}{2}\tan. \tfrac{1}{2}a + \tfrac{1}{4}\tan. \tfrac{1}{4}a + \tfrac{1}{8}\tan. \tfrac{1}{8}a$$
$$+ \tfrac{1}{16}\tan. \tfrac{1}{16}a \ldots\ldots + T + T' + S.$$

Here the arches a, $\frac{1}{2}a$, $\frac{1}{4}a$, $\frac{1}{8}a$, &c. conſtitute a geometrical progreſſion, having the number of its terms infinite, and their common ratio $\frac{1}{2}$. The letters T and T′ are put for any two adjoining terms (after the firſt) of the ſeries, and S is put for the ſum of all the terms following theſe; and this ſum is always contained between two limits, one of which is $\frac{1}{3}$ of the latter of the two terms T T′, and the other is a third proportional to their difference; and the laſt of the two being always leſs than the firſt of theſe limits, but greater than the ſecond. As a ſpecimen of the way of applying this ſeries, we ſhall give the calculation of the length of an arch of 90° to ſix decimal places. In this caſe $\frac{1}{\tan. a} = \text{cotan. } a = 0$, tan. $\frac{1}{2}a = 1$, the remaining quantities tan. $\frac{1}{4}a$, tan. $\frac{1}{8}a$, &c. are to be computed from tan. $\frac{1}{2}a$ by this formula, $\tan. \tfrac{1}{2}A = \sqrt{\left(\frac{1}{\tan.^2 A} + 1\right)} - \frac{1}{\tan. A}$.

Accordingly we find

$$\tan. \tfrac{1}{2}a = 1. \qquad \tan. \tfrac{1}{16}a = .0984914$$
$$\tan. \tfrac{1}{4}a = .4142136 \qquad \tan. \tfrac{1}{32}a = .0491268$$
$$\tan. \tfrac{1}{8}a = .1989123 \qquad \tan. \tfrac{1}{64}a = .0245486$$

$$\tfrac{1}{2}\tan. \tfrac{1}{2}a = .5000000$$
$$\tfrac{1}{4}\tan. \tfrac{1}{4}a = .1035534$$
$$\tfrac{1}{8}\tan. \tfrac{1}{8}a = .0248640$$
$$\tfrac{1}{16}\tan. \tfrac{1}{16}a = .0061557$$
$$T = \tfrac{1}{32}\tan. \tfrac{1}{32}a = .0015352$$
$$T' = \tfrac{1}{64}\tan. \tfrac{1}{64}a = .0003836$$

$$\left.\begin{array}{l} S < .0001278{,}7 \\ S > .0001277{,}7 \end{array}\right\} \text{ Hence } S = .0001278$$

$$\frac{1}{a} = .6366197$$

$$\text{Arch of } 90° = a = 1.570796$$

The ſecond ſeries given in this paper is expreſſed as follows. Let coſ. a, coſ. $\frac{1}{2}a$, &c. denote the coſine of the arch, the coſine of its half, &c. Then

$$\frac{1}{a^2} = \frac{1}{4}\,\frac{1 + \text{coſ. } a}{1 - \text{coſ. } a} + \frac{1}{6}$$
$$-\left(\frac{1}{4^2}\,\frac{1 - \text{coſ. } \frac{1}{2}a}{1 + \text{coſ. } \frac{1}{2}a} + \frac{1}{4^3}\,\frac{1 - \text{coſ. } \frac{1}{4}a}{1 + \text{coſ. } \frac{1}{4}a}\right.$$
$$\left. + \frac{1}{4^4}\,\frac{1 - \text{coſ. } \frac{1}{8}a}{1 + \text{coſ. } \frac{1}{8}a} \ldots\ldots + T + T' + S\right).$$

Here, as before, the letters T, T′ denote any two adjacent terms of the ſeries in the parentheſis, and S is put for the ſum of all the following terms, which in this caſe is always leſs than $\frac{1}{15}$T′, but greater than a third proportional to T—T′ and T′. This ſecond ſeries converges

verges quicker than the firſt, and is beſides better adapted to calculation, becauſe the coſines of the ſeries of arches $\frac{1}{2}a$, $\frac{1}{4}a$, &c. are more eaſily deduced from the coſine of a and one another than the tangents. The formula in this caſe being $\text{coſ.}\ \frac{1}{2}\text{A} = \sqrt{\left(\frac{1+\text{coſ. A}}{2}\right)}$.

There are various other ſeries for the rectification of any arch of a circle given in the ſame paper, ſome of which converge faſter than either of the two we have here ſpecified, and all have the property of being applicable to every poſſible caſe, and of having very ſimple limits, between which the ſum of all their terms following any propoſed term are always contained. It may alſo be obſerved that the principles from which they are deduced are of the moſt ſimple and elementary kind, inſomuch that the author has ſtated it as his opinion, that their inveſtigation might even be admitted into and form a part of the elements of geometry.

SQUATINA. See SQUALUS, ICHTHYOLOGY *Index*.

SQUILL. See SCILLA, BOTANY and MATERIA MEDICA *Index*.

SQUILLA, the name of a ſpecies of cancer. See CANCER, ENTOMOLOGY *Index*.

SQUINTING. See MEDICINE, N° 383.

SQUIRREL. See SCIURUS, MAMMALIA *Index*.

STABBING, in *Law*. The offence of mortally ſtabbing another, though done upon ſudden provocation, is puniſhed as murder; the benefit of clergy being taken away from it by ſtatute. (See MURDER). For by Ja. I. c. 8. when one thruſts or ſtabs another, not then having a weapon drawn, or who hath not then firſt ſtricken the party ſtabbing, ſo that he dies thereof within ſix months after, the offender ſhall not have the benefit of clergy, though he did it not of malice aforethought. This ſtatute was made on account of the frequent quarrels and ſtabbings with ſhort daggers between the Scotch and the Engliſh, at the acceſſion of James I.; and being therefore of a temporary nature, ought to have expired with the miſchief which it meant to remedy. For, in point of ſolid and ſubſtantial juſtice, it cannot be ſaid that the mode of killing, whether by ſtabbing, ſtrangling, or ſhooting, can either extenuate or enhance the guilt; unleſs where, as in the caſe of poiſoning, it carries with it internal evidence of cool and deliberate malice. But the benignity of the law hath conſtrued the ſtatute ſo favourably in behalf of the ſubject, and ſo ſtrictly when againſt him, that the offence of ſtabbing now ſtands almoſt upon the ſame footing as it did at the common law. Thus, (not to repeat the caſes mentioned under MANSLAUGHTER, of ſtabbing an adultereſs, &c. which are barely manſlaughter, as at common law), in the conſtruction of this ſtatute it hath been doubted, whether, if the deceaſed had ſtruck at all before the mortal blow given, this does not take it out of the ſtatute, though in the preceding quarrel the ſtabber had given the firſt blow; and it ſeems to be the better opinion, that this is not within the ſtatute. Alſo it hath been reſolved, that the killing a man, by throwing a hammer or other weapon, is not within the ſtatute; and whether a ſhot with a piſtol be ſo or not is doubted. But if the party ſlain had a cudgel in his hand, or had thrown a pot or a bottle, or diſcharged a piſtol at the party ſtabbing, this is a ſufficient reaſon for having a weapon drawn on his ſide within the words of the ſtatute.

Blackſt. Comment. vol. iv. p. 193.

STACHYS, HEDGE-NETTLE, or ALL-HEAL, a genus of plants belonging to the claſs of didynamia, and order of gymnoſpermia; and in the natural ſyſtem arranged under the 42d order, *Verticillatæ*. See BOTANY *Index*.

STADIUM, an ancient Greek long meaſure, containing 125 geometrical paces, or 625 Roman feet, correſponding to our furlong. The word is ſaid to be formed from the Greek word ϛασις, "a ſtation," or ιϛημι, "to ſtand," becauſe it is reported that Hercules having run a ſtadium at one breath, ſtood ſtill at the end of it. The Greeks uſually meaſured diſtances by ſtadia, which they called ϛαδιασμος. Stadium alſo ſignified the courſe on which their races were run.

STADTHOLDER, formerly the principal magiſtrate or governor of the Seven United Provinces. Although this office is now aboliſhed by the uſurped influence of France, our readers will probably not be ill pleaſed with a ſhort account of the ſeveral powers and claims connected with it. To render that account the more intelligible, we ſhall trace the office of a ſtadtholder from its origin.

The Seven Provinces of the Low Countries were long governed by princes inveſted with the ſovereignty, though limited in their powers, and under various titles; as *Counts of Holland*, *Dukes of Guelder*, *Biſhop of Utrecht*, &c. When theſe countries fell to the princes of the houſe of Burgundy, and afterwards to thoſe of Auſtria, who had many other dominions, the abſence of the ſovereign was ſupplied by a ſtadtholder or governor, veſted with very ample powers. Theſe ſtadtholders or lieutenants had the adminiſtration of the government, and preſided in the courts of juſtice, whoſe juriſdiction was not at that time confined merely to the trial of cauſes, but extended to affairs of ſtate. The ſtadtholders ſwore allegiance to the princes at their inauguration, jointly with the ſtates of the provinces they governed. They likewiſe took an oath to the ſtates, by which they promiſed to maintain their fundamental laws and privileges.

It was upon this footing that William the Firſt, prince of Orange, was made governor and lieutenant-general of Holland, Zealand, and Utrecht, by Philip the Second, upon his leaving the Low Countries to go into Spain. The troubles beginning ſoon after, this prince found means to bring about an union, in 1576, between Holland and Zealand; the ſtates of which two provinces put into his hands, as far as was in their power, the ſovereign authority (for ſo long time as they ſhould remain in war and under arms), upon the ſame footing as Holland had intruſted him with it the year before. In 1581 the ſame authority was again renewed to him by Holland, as it was ſoon after by Zealand likewiſe; and in 1584, being already elected count of Holland, upon certain conditions he would have been formally inveſted with the ſovereignty, had not a wretch, hired and employed by the court of Spain, put an end to his life by a horrid aſſaſſination.

In the preamble of the inſtruments by which the ſtates in 1581 conferred the ſovereign authority upon Prince William the Firſt, we find theſe remarkable words, which are there ſet down as fundamental rules: "That all republics and communities ought to preſerve

ſerve, maintain, and fortify themſelves by unanimity; which being impoſſible to be kept up always among ſo many members, often differing in inclinations and ſentiments, it is conſequently neceſſary that the government ſhould be placed in the hands of one ſingle chief magiſtrate." Many good politicians, and the greateſt part of the inhabitants of theſe provinces, ſince the eſtabliſhment of the republic, looked upon the ſtadtholderian government as an eſſential part of her conſtitution; nor has ſhe been without a ſtadtholder but twice, that is to ſay, from the end of 1650 to 1672, and again from March 1702 till April 1747. The provinces of Frieſland and Groningen, with Ommelands, had always a ſtadtholder without interruption: their inſtructions may be ſeen in Aitzema; but formerly the powers of the ſtadtholder of theſe provinces were confined within narrower bounds, and till William the Fourth there was no ſtadtholder of the ſeven provinces together.

The ſtadtholder could not declare war or make peace, but he had, in quality of captain-general of the union, the command in chief of all the forces of the ſtate (A); and military perſons were obliged to obey him in every thing that concerned the ſervice. He was not limited by inſtructions; but he had the important power of giving out orders for the march of troops, and the diſpoſition of all matters relative to them. He not only directed their marches, but provided for the garriſons, and changed them at pleaſure. All military edicts and regulations came from him alone; he conſtituted and authorized the high council of war of the United Provices, and, as captain-general of every province, diſpoſed of all military offices, as far as the rank of colonel incluſively. The higher poſts, ſuch as thoſe of velt-marſhals, generals, lieutenant-generals, major-generals, were given by the ſtates-general, who choſe the perſons recommended by his highneſs. He made the governors, commandants, &c. of towns and ſtrong places of the republic, and of the barrier. The perſons nominated preſented their inſtruments of appointment to their high mightineſſes, who provided them with commiſſions. The ſtates-general had likewiſe great regard to the recommendation of the prince ſtadtholder in the diſpoſition of thoſe civil employments which were in their gift.

The power of the ſtadtholder as high-admiral, extended to every thing that concerned the naval force of the republic, and to all the other affairs that were here within the juriſdiction of the admiralty. He preſided at theſe boards either in perſon or by his repreſentatives; and as chief of them all in general, and of every one in particular, he had power to make their orders and inſtructions be obſerved by themſelves and others. He beſtowed the poſts of lieutenant-admiral, vice-admiral, and rear-admiral, who commanded under him; and he made likewiſe poſt-captains.

The ſtadtholder granted likewiſe letters of grace, pardon, and abolition, as well for the crimes called *Communia Delicta*, as for military offences. In Holland and Zealand theſe letters were made out for crimes of the firſt ſort, in the name of the ſtates, with the advice of his highneſs. In military offences he conſulted the high council of war; and upon the *communia delicta* he took the advice of the courts of juſtice, of the counſellors, committees of the provinces, of the council of ſtate, and the tribunals of juſtice in the reſpective towns, according to the nature of the caſe.

In the provinces of Holland and Zealand, the ſtadtholder elected the magiſtrates of the towns annually, out of a double number that were returned to him by the towns themſelves.

When any of theſe offices became vacant, which, at the time there was no governor, were in the diſpoſal of the ſtates of Holland, or as formerly in that of the chamber of accounts, the ſtadtholder had his choice of two, or, in ſome caſes, of three candidates, named by their noble and great mightineſſes. He choſe likewiſe the counſellors, inſpectors of the dykes of Rynland, Delfland, and Scheeland, out of three perſons preſented to him by the boards of the counſellors inſpectors; which boards were of very ancient eſtabliſhment in Holland.

His highneſs preſided in the courts of Holland, and in the courts of juſtice of the other provinces; and his name was placed at the head of the proclamations and acts, called in Dutch *Mandamenten*, or *Proviſion van Juſtitie*. In Overyſſel and in the province of Utrecht the poſſeſſors of fiefs held of the prince ſtadtholder. He was ſupreme curator of the univerſities of Guelder, Frieſland, and Groningen; grand foreſter and grand veneur in Guelder, in Holland, and other places. In the province of Utrecht, his highneſs, by virtue of the regulation of 1674, diſpoſed of the provoſtſhips and other benefices which remained to the chapters, as alſo of the canonical prebends that fell in the months which were formerly the papal months.

By the firſt article of the council of ſtate of the United Provinces, the ſtadtholder was the firſt member of it, and had a right of voting there, with an appointment of 25,000 guilders a year. He aſſiſted alſo, as often as he thought it for the ſervice of the ſtate, at the deliberations of the ſtates-general, to make propoſitions to them, and ſometimes alſo at the conferences which the deputies of their high mightineſſes held in their different committees, in conſequence of their ſtanding orders. He likewiſe aſſiſted at the aſſemblies of the ſtates of each particular province, and at that of the counſellors committees. In Guelder, Holland, and Utrecht, his highneſs had a ſhare of the ſovereignty, as chief or preſident of the body of nobles; and in Zealand, where he poſſeſſed the marquiſate of Veer and Fluſhing, as firſt noble, and repreſenting the whole nobility. In his abſence he had

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(A) In times of war, however, the ſtates had always named deputies for the army, to accompany the ſtadtholders in the field, and to ſerve them as counſellors in all their enterpriſes, particularly in the moſt important affairs, ſuch as giving battle, or undertaking a ſiege, &c. This was always practiſed till the acceſſion of King William the Third to the crown of Great Britain, and after his death was continued with regard to the general in chief of the army of the republic. In 1747 and 1748 there were likewiſe deputies with the army, but with more limited power.

had in Zealand his repreſentatives, who had the firſt place and the firſt voice in all the councils, and the firſt of whom was always firſt deputy from the province to the aſſembly of their high mightineſſes.

In 1749 the prince ſtadtholder was created by the ſtates-general, governor-general and ſupreme director of the Eaſt and Weſt India companies; dignities which gave him a great deal of authority and power, and which had never been conferred upon any of his predeceſſors, nor had they hitherto been made hereditary. He had his repreſentatives in the ſeveral chambers of the company, and choſe their directors out of a nomination of three qualified perſons. The prince enjoyed this prerogative in Zealand from the time of his elevation to the ſtadtholderate.

The revenues of the ſtadtholderate of the ſeven United Provinces were reckoned (including the 25,000 guilders which the prince enjoyed annually as the firſt member of the council of ſtate, and what he had from the India company's dividends) to amount to 300,000 guilders a-year. As captain-general of the union, his ſerene highneſs had 120,000 guilders per annum; beſides 24,000 from Frieſland, and 12,000 from Groningen, in quality of captain-general of thoſe provinces. In times of war the ſtate allowed extraordinary ſums to the captain-general for the expence of every campaign.

All theſe powers and privileges were held by the prince of Orange previous to the revolutionary war of France. The influence of the uſurper of that kingdom has extended to the ſtates of Holland, and attached them as a province to France under the name of a kingdom, at the head of which is a brother of Bonaparte.

STÆHELINA, a genus of plants belonging to the claſs of ſyngeneſia, and order of polygamia æqualis: and in the natural ſyſtem arranged under the 49th order, *Compoſitæ*. See BOTANY *Index*.

STAFF, an inſtrument ordinarily uſed to reſt on in walking. The ſtaff is alſo frequently uſed as a kind of natural weapon both of offence and defence; and for ſeveral other purpoſes.

STAFF, a light pole erected in different parts of a ſhip, whereon to hoiſt and diſplay the colours.

The principal of theſe is reared immediately over the ſtern, to diſplay the enſign; another is fixed on the bowſprit, to extend the jack; three more are erected at the three maſt heads, or formed by their upper ends, to ſhow the flag or pendant of the reſpective ſquadron or diviſion to which the ſhip is appropriated. See ENSIGN, MAST, JACK, and PENDANT.

STAFF, in military matters, conſiſts of a quarter-maſter-general, adjutant-general, and majors of brigade. The ſtaff properly exiſts only in time of war. See *QUARTER-Maſter General*, &c.

Regimental STAFF, conſiſts in the adjutant, quarter-maſter, chaplain, ſurgeon, &c.

STAFF, in *Muſic*, five lines, on which, with the intermediate ſpaces, the notes of a ſong or piece of muſic are marked.

Fore-STAFF. See *FORE-Staff*.

STAFFA, one of the Hebrides or Weſtern Iſlands of Scotland, remarkable for its baſaltic pillars. It was viſited by Sir Joſeph Banks, who communicated the following account of it to Mr Pennant.

"The little iſland of Staffa lies on the weſt coaſt of Mull, about three leagues north-eaſt from Iona, or Icolumbkill: its greateſt length is about an Engliſh mile, and its breadth about half a one. On the eaſt ſide of the iſland is a ſmall bay where boats generally land; a little to the ſouthward of which the firſt appearance of pillars is to be obſerved; they are ſmall; and inſtead of being placed upright, lie down on their ſide, each forming a ſegment of a circle. From thence you paſs a ſmall cave, above which the pillars, now grown a little larger, are inclining in all directions: in one place in particular, a ſmall maſs of them very much reſembles the ribs of a ſhip. From hence having paſſed the cave, which, if it is not low-water, you muſt do in a boat, you come to the firſt ranges of pillars, which are ſtill not above half as large as thoſe a little beyond. Over againſt this place is a ſmall iſland, called in Erſe *Boo-ſha-la*, ſeparated from the main by a channel not many fathoms wide. This whole iſland is compoſed of pillars without any ſtratum above them; they are ſtill ſmall, but by much the neateſt formed of any about the place.

"The firſt diviſion of the iſland, for at high water it is divided into two, makes a kind of a cone, the pillars converging together towards the centre: on the other they are in general laid down flat: and in the front next to the main, you ſee how beautifully they are packed together, their ends coming out ſquare with the bank which they form. All theſe have their tranſverſe ſections exact, and their ſurfaces ſmooth; which is by no means the caſe with the large ones, which are cracked in all directions. I muſt queſtion, however, if any part of this whole iſland of Boo-ſha-la is two feet in diameter.

"The main iſland oppoſite to Boo-ſha-la, and farther towards the north-weſt, is ſupported by ranges of pillars pretty erect, and, though not tall (as they are not uncovered to the baſe), of large diameters; and at their feet is an irregular pavement, made by the upper ſides of ſuch as have been broken off, which extends as far under water as the eye can reach. Here the forms of the pillars are apparent; theſe are of three, four, five, ſix, and ſeven ſides; but the numbers of five and ſix are by much the moſt prevalent. The largeſt I meaſured was of ſeven; it was four feet five inches in diameter.

"The ſurfaces of theſe large pillars, in general, are rough and uneven, full of cracks in all directions; the tranſverſe figures in the upright ones never fail to run in their true directions. The ſurfaces upon which we walked were often flat, having neither concavity nor convexity; the larger number, however, was concave, though ſome were very evidently convex. In ſome places, the interſtices within the perpendicular figures were filled up with a yellow ſpar: in one place, a vein paſſed in among the maſs of pillars, carrying here and there ſmall threads of ſpar. Though they were broken and cracked through in all directions, yet their perpendicular figures might eaſily be traced: from whence it is eaſy to infer, that whatever the accident might have been that cauſed the diſlocation, it happened after the formation of the pillars.

"From hence proceeding along ſhore, you arrive at Fingal's cave. Its dimenſions I have given in the form of a table:

	Feet.	In.
Length of the cave from the rock without,	371	6
From the pitch of the arch, -	250	0

Staffa.

Breadth of ditto at the mouth, -	53	7
At the farther end, - - -	20	0
Height of the arch at the mouth, -	117	6
At the end, - - -	70	0
Height of an outſide pillar, -	39	6
Of one at the north-weſt corner, -	54	0
Depth of water at the mouth, -	18	0
At the bottom, - - - -	9	0

"The cave runs into the rock in the direction of north-eaſt by eaſt by the compaſs.

"Proceeding farther to the north-weſt, you meet with the higheſt ranges of pillars; the magnificent appearance of which is paſt all deſcription. Here they are bare to their very baſis, and the ſtratum below them is alſo viſible: in a ſhort time, it riſes many feet above the water, and gives an opportunity of examining its quality. Its ſurface is rough, and has often large lumps of ſtone ſticking in it as if half immerſed: itſelf, when broken, is compoſed of a thouſand heterogeneous parts, which together have very much the appearance of a lava; and the more ſo, as many of the lumps appear to be of the very ſame ſtone of which the pillars are formed. This whole ſtratum lies in an inclined poſition, dipping gradually towards the ſouth-eaſt. As hereabouts is the ſituation of the higheſt pillars, I ſhall mention my meaſurements of them, and the different ſtrata in this place, premiſing, that the meaſurements were made with a line held in the hand of a perſon who ſtood at the top of the cliff, and reaching to the bottom; to the lower end of which was tied a white mark, which was obſerved by one who ſtaid below for the purpoſe: when this mark was ſet off from the water, the perſon below noted it down, and made ſignal to him above, who made then a mark in his rope: whenever this mark paſſed a notable place, the ſame ſignal was made, and the name of the place noted down as before: the line being all hauled up, and the diſtances between the marks meaſured and noted down, gave, when compared with the book kept below, the diſtances, as for inſtance in the cave:

"N° 1. in the book below, was called from the water to the foot of the firſt pillar in the book above; N° 1. gave 36 feet eight inches, the higheſt of that aſcent, which was compoſed of broken pillars.

"N° 1. Pillar at the weſt corner of Fingal's cave.

	Feet.	In.
1 From the water to the foot of the pillar,	12	10
2 Height of the pillar, - -	37	3
3 Stratum above the pillar, - -	66	9

"N° 2. Fingal's cave.

1 From the water to the foot of the pillar,	36	8
2 Height of the pillar - -	39	6
3 From the top of the pillar to the top of the arch, , - - - -	31	4
4 Thickneſs of the ſtratum above, -	34	4
By adding together the three firſt meaſurements, we got the height of the arch from the water, - - -	117	6

"N° 3. Corner pillar to the weſtward of Fingal's cave.

Staffa
‖
Staffordſhire.

Stratum below the pillar of lava-like matter,	11	0
Length of pillar, - -	54	0
Stratum above the pillar, - -	61	6

"N° 5. Another part to the weſtward.

Stratum below the pillar, - -	17	1
Height of the pillar, - -	50	0
Stratum above, - - -	51	1

"N° 5. Another pillar farther to the weſtward.

Stratum below the pillar, - -	19	8
Height of the pillar, - -	55	1
Stratum above, - - -	54	7

"The ſtratum above the pillars, which is here mentioned, is uniformly the ſame, conſiſting of numberleſs ſmall pillars, bending and inclining in all directions, ſometimes ſo irregular that the ſtones can only be ſaid to have an inclination to aſſume a columnar form; in others more regular, but never breaking into or diſturbing the ſtratum of large pillars, whoſe tops everywhere keep an uniform and regular line.

"Proceeding now along the ſhore round the north end of the iſland, you arrive at *Oua na ſcarve*, or the Corvorant's Cave. Here the ſtratum under the pillars is lifted up very high; the pillars above it are conſiderably leſs than thoſe at the north-weſt end of the iſland, but ſtill very conſiderable. Beyond is a bay, which cuts deep into the iſland, rendering it in that place not more than a quarter of a mile over. On the ſides of this bay, eſpecially beyond a little valley, which almoſt cuts the iſland into two, are two ſtages of pillars, but ſmall; however, having a ſtratum between them exactly the ſame as that above them, formed of innumerable little pillars, ſhaken out of their places, and leaning in all directions.

"Having paſſed this bay, the pillars totally ceaſe; the rock is of a dark brown ſtone, and no ſigns of regularity occur till you have paſſed round the ſouth-eaſt end of the iſland (a ſpace almoſt as large as that occupied by the pillars), which you meet again on the weſt ſide, beginning to form themſelves irregularly, as if the ſtratum had an inclination to that form, and ſoon arrive at the bending pillars where I began.

"The ſtone of which the pillars are formed, is a coarſe kind of baſaltes, very much reſembling the Giant's Cauſeway in Ireland, though none of them are near ſo neat as the ſpecimens of the latter which I have ſeen at the Britiſh Muſeum; owing chiefly to the colour, which in ours is a dirty brown, in the Iriſh a fine black; indeed the whole production ſeems very much to reſemble the Giant's Cauſeway."

STAFFORD, the county town of Staffordſhire, in W. Long. 2. 8. N. Lat. 53. 0. It ſtands on the river Sow, has two pariſh-churches, a fine ſquare market-place, and a flouriſhing cloth-manufacture. It ſends two members to parliament, and is 135 miles from London. The population is nearly 4000.

STAFFORDSHIRE, a county of England, bounded on the ſouth by Worceſterſhire, by Cheſhire and Derbyſhire on the north, by Warwickſhire and Derbyſhire on the eaſt, and Shropſhire and Cheſhire on the weſt. The length is reckoned 62 miles, the breadth 33, and the circumference 180. It contains five hundreds, 150 pariſhes, 810,000 acres, 18 market-towns, and

239,153 inhabitants. The air, except in thoſe parts that are called the Moorlands and Woodlands, and about the mines, is good, eſpecially upon the hills, where it is accounted very fine. The ſoil in the northern mountainous parts is not fertile; but in the middle, where it is watered by the Trent, the third river in England, it is both fruitful and pleaſant, being a mixture of arable and meadow grounds. In the ſouth, it abounds not only with corn, but with mines of iron and pits of coal. The principal rivers of this county, beſides the Trent, which runs almoſt through the middle of it, and abounds with ſalmon, are the Dove and Tame, both of which are well ſtored with fiſh. In this county are alſo a great many lakes, and meres or pools, as they are called; which, having ſtreams either running into them or from them, cannot be ſuppoſed to be of any great prejudice to the air; they yield plenty of fiſh. In divers parts of the county are medicinal waters, impregnated with different ſorts of minerals, and conſequently of different qualities and virtues; as thoſe at Hints and Breſsford-houſe, which are mixed with bitumen; thoſe at Ingeſtre, Codſalwood, and Willoughbridge park, which are ſulphureous. Of the ſaline kind are the Brine-pits at Chertley, Epſom, Penſnet-cloſe, of which very good ſalt is made. There is a well at Newcaſtle-under-Line that is ſaid to cure the king's evil; another called *Elder-well* near Blemhill, ſaid to be good for ſore eyes; and a third called the *Spa*, near Wolverhampton.

Great flocks of ſheep are bred in this county, eſpecially in the moorlands, or mountains of the northern part of it; but the wool is ſaid to be ſomewhat coarſer than that of many other counties. Of this wool, however, they make a variety of manufactures, particularly felts. In the low grounds along the rivers are rich paſtures for black cattle; and vaſt quantities of butter and cheeſe are made. In the middle and ſouthern parts not only grain of all kinds, but a great deal of hemp and flax, are raiſed. This county produces alſo lead, copper, iron; marble, alabaſter, millſtones, limeſtone; coal, ſalt, and marles of ſeveral ſorts and colours; brick-earth, fullers earth, and potters clay, particularly a ſort uſed in the glaſs manufacture at Amblecot, and ſold at ſeven-pence a buſhel; tobacco pipe clay; a ſort of reddiſh earth called *ſlip*, uſed in painting divers veſſels; red and yellow ochres; fire-ſtones for hearths of iron furnaces, ovens, &c.; iron-ſtones of ſeveral ſorts; blood-ſtones, or hæmatites, found in the brook Tent, which, when wet a little, will draw red lines like ruddle; quarry-ſtones, and grind-ſtones. For fuel the country is well ſupplied with turf, peat, and coal of ſeveral ſorts, as cannel-coal, peacock-coal, and pit-coal. The peacock-coal is ſo called, becauſe, when turned to the light, it diſplays all the colours of the peacock's tail; but it is fitter for the forge than the kitchen. Of the pit-coal there is an inexhauſtible ſtore: it burns into white aſhes, and leaves no ſuch cinder as that of the Newcaſtle coal. It is not uſed for malting till it is charred, and in that ſtate it makes admirable winter-fuel for a chamber.

This county is in the dioceſe of Litchfield and Coventry, and the Oxford circuit. It ſends ten members to parliament; namely, two for the county, two for the city of Litchfield, two for Stafford, two for Newcaſtle-under-Line, and two for Tamworth.

STAG. See CERVUS, MAMMALIA *Index*.

STAG-Beetle. See LUCANUS, ENTOMOLOGY *Index*.

STAGE, in the modern drama, the place of action and repreſentation, included between the pit and the ſcenes, and anſwering to the proſcenium or pulpitum of the ancients. See PLAYHOUSE and THEATRE.

STAGGERS. See FARRIERY *Index*.

STAHL, GEORGE ERNEST, an eminent German chemiſt, was born at Onold in Franconia in 1660, and choſen profeſſor of medicine at Hall, when a univerſity was founded in that city in 1694. The excellency of his lectures whilſt he filled that chair, the importance of his various publications, and his extenſive practice, ſoon raiſed his reputation to a very great height. He received an invitation to Berlin in 1716, which having accepted, he was made counſellor of ſtate and phyſician to the king. He died in 1734, in the 75th year of his age. Stahl is without doubt one of the greateſt men of which the annals of medicine can boaſt: his name marks the commencement of a new and more illuſtrious era in chemiſtry. He was the author of the doctrine of phlogiſton, which, though now completely overturned by the diſcoveries of Lavoiſier and others, was not without its uſe; as it ſerved to combine the ſcattered fragments of former chemiſts into a ſyſtem, and as it gave riſe to more accurate experiments and a more ſcientific view of the ſubject, to which many of the ſubſequent diſcoveries were owing. This theory maintained its ground for more than half a century, and was received and ſupported by ſome of the moſt eminent men which Europe has produced; a ſufficient proof of the ingenuity and the abilities of its author. He was the author alſo of A Theory of Medicine, founded upon the notions which he entertained of the abſolute dominion of mind over body; in conſequence of which, he affirmed, that every muſcular action is a voluntary act of the mind, whether attended with conſciouſneſs or not. This theory he and his followers carried a great deal too far, but the advices at leaſt which he gives to attend to the ſtate of the mind of the patient are worthy of the attention of phyſicians.

His principal works are, 1. *Experimenta et Obſervationes Chemicæ et Phyſicæ*, Berlin, 1731, 8vo. 2. *Diſſertationes Medicæ*, Hall, 2 vols 4to. This is a collection of theſes. 3. *Theoria Medica vera*, 1737, 4to. 4. *Opuſculum Chymico-phyſico-medicum*, 1740, 4to. 5. A Treatiſe on Sulphur, both Inflammable and Fixed, written in German. 6. *Negotium Otioſum*, Hall, 1720, 4to. It is in this treatiſe chiefly that he eſtabliſhes his ſyſtem concerning the action of the ſoul upon the body. 7. *Fundamenta Chymiæ Dogmaticæ et Experimentalis*, Nuremberg, 1747, 3 vols 4to. 8. A Treatiſe on Salts, written in German. 9. *Commentarium in Metallurgiam Beccheri*, 1723.

STAINING *or* COLOURING *of* BONE, HORN, MARBLE, PAPER, WOOD, &c. See theſe articles.

STAIRCASE, in *Architecture*, an aſcent incloſed between walls, or a baluſtrade conſiſting of ſtairs or ſteps, with landing places and rails, ſerving to make a communication between the ſeveral ſtories of a houſe. See ARCHITECTURE, Nº 89, &c.

STALACTITES, in *Mineralogy*, cryſtalline ſpars formed into oblong, conical, round, or irregular bodies, compoſed of various cruſts, and uſually found hanging in form of iſicles from the roofs of grottoes, &c.

STALAGMITIS, a genus of the monœcia order, belonging

belonging to the polygamia claſs of plants; and in the natural method ranking under the 38th order, *Tricoccæ*. See Botany and Materia Medica *Index*.

STALE, among ſportſmen, a living fowl put in a place to allure and bring others where they may be taken. For want of theſe, a bird ſhot, his entrails taken out, and dried in an oven in his feathers, with a ſtick thruſt through to keep it in a convenient poſture, may ſerve as well as a live one.

Stale is alſo a name for the urine of cattle.

Animated **STALK**. This remarkable animal was found by Mr Ives at Cuddalore: and he mentions ſeveral kinds of it; ſome appearing like dry ſtraws tied together, others like graſs; ſome have bodies much larger than others, with the addition of two ſcaly imperfect wings; their neck is no bigger than a pin, but twice as long as their bodies; their heads are like thoſe of an hare, and their eyes vertical and very briſk. They live upon flies, and catch theſe inſects very dexterouſly with the two fore-feet, which they keep doubled up in three parts cloſe to their head, and dart out very quick on the approach of their prey; and when they have caught it, they eat it very voraciouſly, holding it in the ſame manner as a ſquirrel does its food. On the outer joints of the fore-feet are ſeveral very ſharp hooks for the eaſier catching and holding of their prey; while, with the other feet, which are four in number, they take hold of trees or any other thing, the better to ſurpriſe whatever they lie in wait for. They drink like a horſe, putting their mouths into the water. Their excrements, which are very white, are almoſt as large as the body of the animal, and as the natives ſay, dangerous to the eyes.

STALLION, or Stone-horse, in the manege, a horſe deſigned for the covering of mares, in order to propagate the ſpecies. See Equus, Mammalia *Index*.

STAMFORD, an ancient town of Lincolnſhire in England; ſeated on the river Welland, on the edge of Northamptonſhire. It contains ſix pariſh-churches, ſeveral good ſtreets, and fine buildings. It had formerly a college, the ſtudents of which removed to Brazen Noſe college in Oxford. The population in 1801 exceeded 4000. It has no conſiderable manufactories, but deals chiefly in malt. W. Long. 1. 27. N. Lat. 52. 40.

STAMINA, in *Botany*, are thoſe upright filaments which, on opening a flower, we find within the corolla ſurrounding the piſtillum. According to Linnæus, they are the male organs of generation, whoſe office it is to prepare the pollen. Each ſtamen conſiſts of two diſtinct parts, viz. the filamentum and the anthera.

Stamina, in the animal body, are defined to be thoſe ſimple original parts which exiſted firſt in the embryo or even in the ſeed; and by whoſe diſtinction, augmentation, and accretion by additional juices, the animal body at its utmoſt bulk is ſuppoſed to be formed.

STAMP-duties, a branch of the perpetual revenue. See Revenue.

In Great Britain there is a tax impoſed upon all parchment and paper, whereon any legal proceedings or private inſtruments of almoſt any nature whatſoever are written; and alſo upon licenſes for retailing wines, of all denominations; upon all almanacs, newſpapers, advertiſements, cards, dice, &c. Theſe impoſts are very various; being higher or lower, not ſo much according to the value of the property transferred, as according to the nature of the deed. The higheſt do not exceed ſix pounds upon every ſheet of paper or ſkin of parchment; and theſe high duties fall chiefly upon grants from the crown, and upon certain law proceedings, without any regard to the value of the ſubject. There are in Great Britain no duties on the regiſtration of deeds or writings, except the fees of the officers who keep the regiſter; and theſe are ſeldom more than a reaſonable recompenſe for their labour. The crown derives no revenue from them.

Smith's Wealth of Nations, vol. iii.

The ſtamp-duties conſtitute a tax which, though in ſome inſtances it may be heavily felt, by greatly increaſing the expence of all mercantile as well as legal proceedings, yet (if moderately impoſed) is of ſervice to the public in general, by authenticating inſtruments, and rendering it much more difficult than formerly to forge deeds of any ſtanding; ſince, as the officers of this branch of the revenue vary their ſtamps frequently, by marks perceptible to none but themſelves, a man that would forge a deed of King William's time, muſt know and be able to counterfeit the ſtamp of that date alſo. In France and ſome other countries the duty is laid on the contract itſelf, not on the inſtrument in which it is contained; as, with us too in England (beſides the ſtamps on the indentures), a tax is laid, by ſtatute 8 Ann. c. 9. on every apprentice-fee; of 6d. in the pound if it be 50l. or under, and 1s. in the pound if a greater ſum: but this tends to draw the ſubject into a thouſand nice diſquiſitions and diſputes concerning the nature of his contract, and whether taxable or not; in which the farmers of the revenue are ſure to have the advantage. Our general method anſwers the purpoſes of the ſtate as well, and conſults the eaſe of the ſubject much better. The firſt inſtitution of the ſtamp-duties was by ſtatute 5 and 6 W. and M. c. 21. and they have ſince, in many inſtances, been increaſed to five times their original amount.

STANCHION, or Stanchions, a ſort of ſmall pillars of wood or iron uſed for various purpoſes in a ſhip; as to ſupport the decks, the quarter-rails, the nettings, the awnings, &c. The firſt of thoſe are two ranges of ſmall columns fixed under the beams, throughout the ſhip's length between decks; one range being on the ſtarboard and the other on the larboard ſide of the hatchways. They are chiefly intended to ſupport the weight of the artillery.

STAND, in commerce, a weight from two hundred and an half to three hundred of pitch.

STANDARD, in *War*, a ſort of banner or flag borne as a ſignal for the joining together of the ſeveral troops belonging to the ſame body.

Standard, in commerce, the original of a weight, meaſure, or coin, committed to the keeping of a magiſtrate, or depoſited in ſome public place, to regulate, adjuſt, and try the weights uſed by particular perſons in traffic. See Money.

STANHOPE, Philip Dormer, earl of Chesterfield, was born in 1695, and educated in Trinity-hall, Cambridge; which place he left in 1714, when, by his own account, he was an abſolute pedant. In this character he went abroad, where a familiarity with good company ſoon convinced him he was totally miſtaken in almoſt all his notions: and an attentive ſtudy of the air, manner, and addreſs of people of faſhion, ſoon poliſhed a man whoſe predominant deſire was to pleaſe; and who, as it afterwards appeared, valued exterior accompliſhments beyond any other human acquirement. While Lord Stanhope, he got an early ſeat in parliament; and in 1722, ſucceeded to his father's eſtate and titles. In 1728, and in 1745, he was appointed ambaſſador extraordinary and plenipotentiary to Holland: which high character he ſupported with the greateſt dignity; ſerving his own country, and gaining the eſteem of the ſtates-general. Upon his return from Holland, he was ſent lord-lieutenant of Ireland; and during his adminiſtration there, gave general ſatisfaction to all parties. He left Dublin in 1746, and in October ſucceeded the earl of Harrington as ſecretary of ſtate, in which poſt he officiated until February 6th 1748. Being ſeized with a deafneſs in 1752 that incapacitated him for the pleaſures of ſociety, he from that time led a private and retired life, amuſing himſelf with books and his pen; in particular, he engaged largely as a volunteer in a periodical miſcellaneous paper called *The World*, in which his contributions have a diſtinguiſhed degree of excellence. He died in 1773, leaving a character for wit and abilities that had few equals. He diſtinguiſhed himſelf by his eloquence in parliament on many important occaſions; of which we have a characteriſtic inſtance, of his own relating. He was an active promoter of the bill for altering the ſtyle; on which occaſion, as he himſelf writes in one of his letters to his ſon, he made ſo eloquent a ſpeech in the houſe, that every one was pleaſed, and ſaid he had made the whole very clear to them; "when (ſays he), God knows, I had not even attempted it. I could juſt as ſoon have talked Celtic or Sclavonian to them, as aſtronomy; and they would have underſtood me full as well." Lord Macclesfield, one of the greateſt mathematicians in Europe, and who had a principal hand in framing the bill, ſpoke afterwards, with all the clearneſs that a thorough knowledge of the ſubject could dictate; but not having a flow of words equal to Lord Cheſterfield, the latter gained the applauſe from the former, to the equal credit of the ſpeaker and the auditors. The high character Lord Cheſterfield ſupported during life, received no ſmall injury ſoon after his death, from a fuller diſplay of it by his own hand. He left no iſſue by his lady, but had a natural ſon, Philip Stanhope, Eſq. whoſe education was for many years a cloſe object of his attention, and who was afterward envoy extraordinary at the court of Dreſden, but died before him. When Lord Cheſterfield died, Mr Stanhope's widow publiſhed a courſe of letters, writen by the father to the ſon, filled with inſtructions ſuitable to the different gradations of the young man's life to whom they were addreſſed. Theſe letters contain many fine obſervations on mankind, and rules of conduct: but it is obſervable that he lays a greater ſtreſs on exterior accompliſhments and addreſs, than on intellectual qualifications and ſincerity; and allows greater latitude to faſhionable pleaſures than good morals will juſtify, eſpecially in paternal inſtructions. Hence it is that a celebrated writer *, and of manners ſomewhat different from thoſe of the polite earl of Cheſterfield, is ſaid to have obſerved of theſe letters, that "they inculcate only the morals of a whore, with the manners of a dancing-maſter."

STANHOPE, *Dr George*, an eminent divine, was born at Hertiſhorn in Derbyſhire, in the year 1660. His father was rector of that place, vicar of St Margaret's church in Leiceſter, and chaplain to the earls of Cheſterfield and Clare. His grandfather, Dr George Stanhope, was chaplain to James I. and Charles I.; had the chancellorſhip of York, where he was alſo a canon-reſidentiary, held a prebend, and was rector of Weldrake in that county. He was for his loyalty driven from his home with eleven children; and died in 1644. Our author was ſent to ſchool, firſt at Uppingham in Rutland, then at Leiceſter; afterwards removed to Eaton; and thence choſen to King's college in Cambridge, in the place of W. Cleaver. He took the degree of B. A. in 1681; M. A. 1685; was elected one of the ſyndics for the univerſity of Cambridge, in the buſineſs of Alban Francis, 1687; miniſter of Quoi near Cambridge, and vice-proctor, 1688; was that year preferred to the rectory of Tring in Hertfordſhire, which after ſome time he quitted. He was in 1689 preſented to the vicarage of Lewiſham in Kent by Lord Dartmouth, to whom he had been chaplain, and tutor to his ſon. He was alſo appointed chaplain to King William and Queen Mary, and continued to enjoy that honour under Queen Anne. He commenced D. D. July 5th 1697, performing all the offices required to that degree publicly and with great applauſe. He was made vicar of Deptford in 1703; ſucceeded Dr Hooper as dean of Canterbury the ſame year; and was thrice choſen prolocutor of the lower houſe of convocation. His uncommon diligence and induſtry, aſſiſted by his excellent parts, enriched him with a large ſtock of polite, ſolid, and uſeful learning. His diſcourſes from the pulpit were equally pleaſing and profitable; a beautiful intermixture of the cleareſt reaſoning with the pureſt diction, attended with all the graces of a juſt elocution. The good Chriſtian, the ſolid divine, and the fine gentleman, in him were happily united. His converſation was polite and delicate, grave without preciſeneſs, facetious without levity. His piety was real and rational, his charity great and univerſal, fruitful in acts of mercy, and in all good works. He died March 18th 1728, aged 68 years; and was buried in the chancel of the church at Lewiſham. The dean was twice married: firſt to Olivia Cotton, by whom he had one ſon and four daughters. His ſecond lady, who was ſiſter to Sir Charles Wager, ſurvived him, dying October 1ſt 1730, aged about 54. One of the dean's daughters was married to a ſon of Biſhop Burnet. Biſhop Moore of Ely died the day before Queen Anne; who, it has been ſaid, deſigned our dean for that ſee when it ſhould become vacant. Dr Felton ſays, "The late dean of Canterbury is excellent in the whole. His thoughts and reaſoning are bright and ſolid. His ſtyle is juſt, both for the purity of the language and for the ſtrength and beauty of expreſſion; but the periods are formed in ſo peculiar an order of the words, that it was an obſervation, nobody could pronounce them with the ſame grace and advantage as himſelf." His writings, which are an ineſtimable treaſure of piety and devotion are, A Paraphraſe and Comment upon the Epiſtles and Goſpels, 4 vols, 1705, 8vo. Sermons at Boyle's Lectures. 1706. 4to. Fifteen Sermons, 1700, 8vo. Twelve Sermons on Several Occaſions, 1727, 8vo. Thomas à Kempis, 1696, 8vo. Epictetus's Morals, with Simplicius's Comment, and the Life of Epictetus, 1700, 8vo. Parſon's Chriſtian Directory, 1716, 8vo. Rochefoucault's Maxims, 1706, 8vo. A Funeral Sermon on Mr Richard Sare bookſeller, 1724; two editions 4to. Twenty Sermons, publiſhed ſingly between

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* Dr Johnſon.

between the years 1692 and 1724. Private Prayers for every Day in the Week, and for the ſeveral Parts of each Day; tranſlated from the Greek Devotions of Biſhop Andrews, with Additions, 1730. In his tranſlations, it is well known, Dr Stanhope did not confine himſelf to a ſtrict and literal verſion: he took the liberty of paraphraſing, explaining, and improving upon his author; as will evidently appear (not to mention any other work) by the ſlighteſt peruſal of St Auguſtine's Meditations, and the Devotions of Biſhop Andrews.

STANISLAUS Leczinski, king of Poland, was born at Leopold the 20th of October 1677. His father was a Poliſh nobleman, diſtinguiſhed by his rank and the important offices which he held, but ſtill more by his firmneſs and courage. Staniſlaus was ſent ambaſſador in 1704 by the aſſembly of Warſaw to Charles XII. of Sweden, who had conquered Poland. He was at that time 27 years old, was general of Great Poland, and had been ambaſſador extraordinary to the Grand Signior in 1699. Charles was ſo delighted with the frankneſs and ſincerity of his deportment, and with the firmneſs and ſweetneſs which appeared in his countenance, that he offered him the crown of Poland, and ordered him to be crowned at Warſaw in 1705. He accompanied Charles XII. into Saxony, where a treaty was concluded with King Auguſtus in 1705, by which that prince reſigned the crown, and acknowledged Staniſlaus king of Poland. The new monarch remained in Saxony with Charles till 1707, when they returned into Poland and attacked the Ruſſians, who were obliged to evacuate that kingdom in 1708. But Charles being defeated by Peter the Great in 1709, Auguſtus returned into Poland, and being aſſiſted by a Ruſſian army, obliged Staniſlaus to retire firſt into Sweden, and afterwards into Turkey. Soon after he took up his reſidence at Weiſſenburg, a town in Alſace. Auguſtus diſpatched Sum his envoy to France to complain of this; but the duke of Orleans, who was then regent, returned this anſwer: "Tell your king, that France has always been the aſylum of unhappy princes." Staniſlaus lived in obſcurity till 1725, when Louis XV. eſpouſed the princeſs Mary his daughter. Upon the death of King Auguſtus in 1733, he returned to Poland in hopes of remounting the throne of that kingdom. A large party declared for him; but his competitor the young elector of Saxony, being ſupported by the emperor Charles VI. and the empreſs of Ruſſia, was choſen king, though the majority was againſt him. Dantzic, to which Staniſlaus had retired, was quickly taken, and the unfortunate prince made his eſcape in diſguiſe with great difficulty, after hearing that a price was ſet upon his head by the Ruſſians. When peace was concluded in 1736 between the emperor and France, it was agreed that Staniſlaus ſhould abdicate the throne, but that he ſhould be acknowledged king of Poland and grand duke of Lithuania, and continue to bear theſe titles during life; that all his effects and thoſe of the queen his ſpouſe ſhould be reſtored; that an amneſty ſhould be declared in Poland for all that was paſt, and that every perſon ſhould be reſtored to his poſſeſſions, rights, and privileges: that the elector of Saxony ſhould be acknowledged king of Poland by all the powers who acceded to the treaty: that Staniſlaus ſhould be put in peaceable poſſeſſion of the duchies of Lorraine and Bar; but that immediately after his death theſe duchies ſhould be united for ever to the crown of France. Staniſlaus ſucceeded a race of princes in Lorraine, who were beloved and regretted: and his ſubjects found their ancient ſovereigns revived in him. He taſted then the pleaſure which he had ſo long deſired, the pleaſure of making men happy. He aſſiſted his new ſubjects; he embelliſhed Nancy and Lunéville; he made uſeful eſtabliſhments; he founded colleges and built hoſpitals. He was engaged in theſe noble employments, when an accident occaſioned his death. His night-gown caught fire, and burnt him ſo ſeverely before it could be extinguiſhed, that he was ſeized with a fever, and died the 23d of February 1766. His death occaſioned a public mourning: the tears of his ſubjects indeed are the beſt eulogium upon this prince. In his youth he had accuſtomed himſelf to fatigue, and had thereby ſtrengthened his mind as well as his conſtitution. He lay always upon a kind of mattreſs, and ſeldom required any ſervice from his domeſtics. He was temperate, liberal, adored by his vaſſals, and perhaps the only nobleman in Poland who had any friends. He was in Lorraine what he had been in his own country, gentle, affable, compaſſionate, treating his ſubjects like equals, participating their ſorrows and alleviating their misfortunes. He reſembled completely the picture of a philoſopher which he himſelf has drawn. "The true philoſopher (ſaid he) ought to be free from prejudices, and to know the value of reaſon: he ought neither to think the higher ranks of life of more value than they are, nor to treat the lower orders of mankind with greater contempt than they deſerve: he ought to enjoy pleaſures without being a ſlave to them, riches without being attached to them, honours without pride or vanity: he ought to ſupport diſgraces without either fearing or courting them: he ought to reckon what he poſſeſſes ſufficient for him, and to regard what he has not as uſeleſs: he ought to be equal in every fortune, always tranquil, always gay: he ought to love order, and to obſerve it in all his actions: he ought to be ſevere to himſelf, but indulgent to others: he ought to be frank and ingenuous without rudeneſs, polite without falſehood, complaiſant without baſeneſs: he ought to have the courage to diſregard every kind of glory, and to reckon as nothing even philoſophy itſelf." Such was Staniſlaus in every ſituation. His temper was affectionate. He told his treaſurer one day to put a certain officer on his liſt, to whom he was very much attached: "In what quality (ſaid the treaſurer) ſhall I mark him down?" "As my friend" (replied the monarch). A young painter conceiving hopes of making his fortune if his talents were made known to Staniſlaus, preſented him with a picture, which the courtiers criticiſed ſeverely. The prince praiſed the performance, and paid the painter very generouſly: then turning to his courtiers, he ſaid, "Do ye not ſee, gentlemen, that this poor man muſt provide for his family by his abilities? if you diſcourage him by your cenſures, he is undone. We ought always to aſſiſt men; we never gain any thing by hurting them." His revenues were ſmall; but were we to judge of him by what he did, we ſhould probably reckon him the richeſt potentate in Europe. A ſingle inſtance will be ſufficient to ſhow the well-judged economy with which his benevolent plans were conducted. He gave 18.000 crowns to the magiſtrates of Bar to be employed in purchaſing grain, when at a low price, to be ſold out again to the poor at a moderate rate when the

the price ſhould riſe above a certain ſum. By this arrangement (ſay the authors of *Dictionaire Hiſtorique*), the money increaſes continually, and its good effects may in a ſhort time be extended over the whole province.

He was a protector of the arts and ſciences: he wrote ſeveral works of philoſophy, politics, and morality, which were collected and publiſhed in France in 1765, in 4 vols, 8vo, under the title of *Oeuvres de Philoſophe Bienfaiſant*, " the works of the Benevolent Philoſopher."

STANITZAS, villages or ſmall diſtricts of the banks of the Don, inhabited by Coſſacs.

STANLEY, Thomas, a learned Engliſh writer in the 17th century, was the ſon of Sir Thomas Stanley of Cumberlow-Green in Herefordſhire, knight. He was born at Cumberlow about 1644, and educated in his father's houſe, whence he removed to the univerſity of Cambridge. He afterwards travelled; and, upon his return to England, proſecuted his ſtudies in the Middle Temple. He married, when young, Dorothy, the eldeſt daughter of Sir James Engan of Flower, in Northamptonſhire. He wrote, 1. A volume of Poems. 2. Hiſtory of Philoſophy, and Lives of the Philoſophers. 3. A Tranſlation of Eſchylus, with a Commentary; and ſeveral other works. He died in 1678.

STANNARIES, the mines and works where tin is dug and purified; as in Cornwall, Devonſhire, &c.

STANNARY courts, in Devonſhire and Cornwall, for the adminiſtration of juſtice among the tinners therein. They are held before the lord-warden and his ſubſtitutes, in virtue of a privilege granted to the workers in the tin-mines there, to ſue and be ſued only in their own courts, that they may not be drawn from their buſineſs, which is highly profitable to the public, by attending their law-ſuits in other courts. The privileges of the tinners are confirmed by a charter, 33 Edw. I. and fully expounded by a private ſtatute, 50 Edw. III. which has ſince been explained by a public act, 16 Car. I. c. 15. What relates to our preſent purpoſe is only this: That all tinners and labourers in and about the ſtannaries ſhall, during the time of their working therein, *bona fide*, be privileged from ſuits of other courts, and be only pleaded in the ſtannary court in all matters, excepting pleas of land, life, and member. No writ of error lies from hence to any court in Weſtminſter hall; as was agreed by all the judges, in 4 Jac. I. But an appeal lies from the ſteward of the court to the under warden; and from him to the lord warden; and thence to the privy-council of the prince of Wales, as duke of Cornwall, when he hath had livery or inveſtiture of the ſame. And from thence the appeal lies to the king himſelf, in the laſt reſort.

Blackſt. Comment. vol. iii. p. 79. and 80.

STANNUM, Tin. See Tin, Chemistry and Mineralogy *Index*.

STANZA, in *Poetry*, a number of lines regularly adjuſted to each other; ſo much of a poem as contains every variation of meaſure or relation of rhime uſed in that poem.

STAPELIA, a genus of plants belonging to the claſs pentandria and order digynia, and in the natural orders arranged under the *Succulentæ*. See Botany *Index*.—This ſingular tribe of plants is peculiar to the ſandy deſerts of Africa and Arabia. They are extremely ſucculent. From this peculiarity of ſtructure, the power of retaining water to ſupport and nouriſh them, they are enabled to live during the prevalent droughts of thoſe arid regions. On this account the ſtapelia has been compared to the camel; and we are told that, by a very apt ſimilitude, it has been denominated " the *camel* of the vegetable kingdom." We muſt confeſs ourſelves quite at a loſs to ſee the propriety or aptitude of this compariſon. In many parts of the animal and vegetable economy there is doubtleſs a very obvious and ſtriking analogy: but this analogy has been often carried too far; much farther than fair experiment and accurate obſervation will in any degree ſupport. It is perhaps owing to this inaccuracy in obſerving the peculiarity of ſtructure and diverſity of functions, that a reſemblance is ſuppoſed to exiſt, as in the preſent caſe, where in reality there is none. The camel is provided with a bag or fifth ſtomach, in addition to the four with which ruminant animals are furniſhed. This fifth ſtomach is deſtined as a reſervoir to contain water; and it is ſufficiently capacious to receive a quantity of that neceſſary fluid, equal to the wants of the animal, for many days: and this water, as long as it remains in the fifth ſtomach, is ſaid to be perfectly pure and unchanged. The *ſtapelia*, and other ſucculent plants, have no ſuch reſervoir. The water is equally, or nearly ſo, diffuſed through the whole plant. Every veſſel and every cell is fully diſtended. But beſides, this water, whether it be received by the roots, or abſorbed from the atmoſphere, has probably undergone a complete change, and become, after it has been a ſhort time within the plant, a fluid poſſeſſed of very different qualities.

The peculiar economy in the ſtapelia, and other ſucculent plants, ſeems to exiſt in the abſorbent and exhalant ſyſtems. The power of abſorption is as much increaſed as the power of the exhalant or perſpiratory veſſels is diminiſhed. In theſe plants, a ſmall quantity of nouriſhment is required. There is no ſolid part to be formed, no large fruit to be produced. They generally have very ſmall leaves, often are entirely naked; ſo that taking the whole plant, a ſmall ſurface only is expoſed to the action of light and heat, and conſequently a much ſmaller proportion of water is decompoſed than in plants which are much branched and furniſhed with leaves.

Two ſpecies of ſtapelia only were known at the beginning of the century. The unfortunate Forſkal, the companion of Niebuhr, who was ſent out by the king of Denmark to explore the interior of Arabia, and who fell a ſacrifice to the peſtilential diſeaſes of thoſe inhoſpitable regions, diſcovered two new ſpecies. Thunberg, in his *Prodromus*, has mentioned five more. Forty new ſpecies have been diſcovered by Mr Maſſon of Kew Gardens, who was ſent out by his preſent Majeſty for the purpoſe of collecting plants round the Cape of Good Hope. Deſcriptions of theſe, with elegant and highly finiſhed coloured engravings, have lately been publiſhed. They are chiefly natives of the extenſive deſerts called *Karro*, on the weſtern ſide of the Cape.

STAPHYLEA, Bladder-nut, a genus of plants belonging to the claſs of pentandria and order of trigynia; and in the natural ſyſtem arranged under the 23d order, *Trihilatæ*. See Botany *Index*.

STAPHYLINUS, a genus of inſects belonging to the order of coleoptera. See Entomology *Index*.

STAPLE, primarily ſignifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people; as the Greve, or the places along the Seine, for ſale of wines and corn, at Paris, whither the merchants of other parts are obliged to bring thoſe commodities.

Formerly, the merchants of England were obliged to carry their wool, cloth, lead, and other like ſtaple commodities of this realm, in order to expoſe them by wholeſale; and theſe ſtaples were appointed to be conſtantly kept at York, Lincoln, Newcaſtle-upon-Tyne, Norwich, Weſtminſter, Canterbury, Chicheſter, Wincheſter, Exeter, and Briſtol; in each whereof a public mart was appointed to be kept, and each of them had a court of the mayor of the ſtaple, for deciding differences, held according to the law-merchant, in a ſummary way.

STAR, in *Aſtronomy*, a general name for all the heavenly bodies, which, like ſo many brilliant ſtuds, are diſperſed throughout the whole heavens. The ſtars are diſtinguiſhed, from the phenomena of their motion, &c. into fixed, and erratic or wandering ſtars: theſe laſt are again diſtinguiſhed into the greater luminaries, viz. the ſun and moon; the planets, or wandering ſtars, properly ſo called, and the comets; which have been all fully conſidered and explained under the article ASTRONOMY. As to the fixed ſtars, they are ſo called, becauſe they ſeem to be fixed, or perfectly at reſt, and conſequently appear always at the ſame diſtance from each other.

Falling STARS, in *Meteorology*, fiery meteors which dart through the ſky in form of a ſtar. See METEOR.

Twinkling of the STARS. See OPTICS.

STAR, is alſo a badge of honour, worn by the knights of the Garter, Bath, and Thiſtle. See GARTER.

STAR *of Bethlehem*. See ORNITHOGALUM, BOTANY *Index*.

STAR, in *Fortification*, denotes a ſmall fort, having five or more points, or ſaliant and re-entering angles, flanking one another, and their faces 90 or 100 feet long.

Court of STAR-CHAMBER, (*camera ſtellata*), a famous, or rather infamous, Engliſh tribunal, ſaid to have been ſo called either from a Saxon word ſignifying to *ſteer* or govern; or from its puniſhing the *crimen ſtellionatus*, or coſenage; or becauſe the room wherein it ſat, the old council-chamber of the palace of Weſtminſter, (Lamb. 148.) which is now converted into the lottery-office, and forms the eaſtern ſide of New-Palace yard, was full of windows; or, (to which Sir Edward Coke, 4 Inſt. 66. accedes), becauſe *haply* the roof thereof was at the firſt garniſhed with gilded *ſtars*. As all theſe are merely conjectures, (for no ſtars are now in the roof, nor are any ſaid to have remained there ſo late as the reign of Queen Elizabeth), it may be allowable to propoſe another conjectural etymology, as plauſible perhaps as any of them. It is well known, that, before the baniſhment of the Jews under Edward I. their contracts and obligations were denominated in our ancient records *ſtarra* or *ſtarrs*, from a corruption of the Hebrew word, *ſhetar*, a covenant. (Tovey's *Angl. Judaic.* 32. Selden. tit. of hon. ii. 34. *Uxor Ebraic*, i. 14.). Theſe ſtarrs, by an ordinance of Richard I. preſerved by Hoveden, were commanded to be enrolled and depoſited in cheſts under three keys in certain places; one, and the moſt conſiderable, of which was in the king's exchequer at Weſtminſter: and no ſtarr was allowed to be valid, unleſs it were found in ſome of the ſaid repoſitories. (*Memorand. in Scac'* P. 6. *Edw. I.* prefixed to Maynard's year-book of Edw. II. fol. 8. Madox hiſt. exch. c. vii. § 4, 5, 6.). The room at the exchequer, where the cheſts containing theſe ſtarrs were kept, was probably called the *ſtar-chamber*; and, when the Jews were expelled the kingdom, was applied to the uſe of the king's council, ſitting in their judicial capacity. To confirm this, the firſt time the ſtar-chamber is mentioned in any record, it is ſaid to have been ſituated near the receipt of the exchequer at Weſtminſter: (the king's council, his chancellor, treaſurer, juſtices, and other ſages, were aſſembled *en la chaumbre des eſteilles pres la receipt al Weſtminſter. Clauſ.* 41 Edw. III. *m.* 13.). For in proceſs of time, when the meaning of the Jewiſh *ſtarrs* was forgotten, the word *ſtar-chamber* was naturally rendered in law French, *la chaumbre des eſteilles*, and in law Latin *camera ſtellata*; which continued to be the ſtyle in Latin till the diſſolution of that court.

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vo v.
p. 5.

This was a court of very ancient original; but new-modelled by ſtatutes 3 Hen. VII. c. 1. and 21 Henry VIII. c. 20. conſiſting of divers lords ſpiritual and temporal, being privy-counſellors, together with two judges of the courts of common law, without the intervention of any jury. Their juriſdiction extended legally over riots, perjury, miſbehaviour of ſheriffs, and other notorious miſdemeanors, contrary to the laws of the land. Yet this was afterwards (as Lord Clarendon informs us) ſtretched "to the aſſerting of all proclamations and orders of ſtate; to the vindicating of illegal commiſſions and grants of monopolies; holding for honourable that which pleaſed, and for juſt that which profited; and becoming both a court of law to determine civil rights, and a court of revenue to enrich the treaſury: the council-table by proclamations enjoining to the people that which was not enjoined by the laws, and prohibiting that which was not prohibited; and the ſtar-chamber, which conſiſted of the ſame perſons in different rooms, cenſuring the breach and diſobedience to thoſe proclamations by very great fines, impriſonments, and corporal ſeverities: ſo that any diſreſpect to any acts of ſtate, or to the perſons of ſtateſmen, was in no time more penal, and the foundations of right never more in danger to be deſtroyed." For which reaſons, it was finally aboliſhed by ſtatute 16 Car. I. c. 10. to the general joy of the whole nation. See KING'S-*Bench*. There is in the Britiſh Muſeum (Harl. MSS. vol. i. N° 126.) a very full, methodical, and accurate account of the conſtitution and courſe of this court, compiled by William Hudſon of Gray's Inn, an eminent practitioner therein. A ſhort account of the ſame, with copies of all its proceſs, may alſo be found in 18 Rym. Foed. 192, &c.

STAR-*Board*, the right ſide of the ſhip when the eye of the ſpectator is directed forward.

STAR-*Fiſh*. See ASTERIAS, HELMINTHOLOGY *Index*.

STAR-*ſhot*, a gelatinous ſubſtance frequently found in fields, and ſuppoſed by the vulgar to have been produced from the meteor called a *falling-ſtar*: but, in reality, is the half-digeſted food of herons, ſea-mews, and the like birds; for theſe birds have been found when newly ſhot, to diſgorge a ſubſtance of the ſame kind.

STAR-Stone, in *Natural Hiſtory*, a name given to certain extraneous foſſil ſtones, in form of ſhort, and commonly ſomewhat crooked columns, compoſed of ſeveral joints, each reſembling the figure of a radiated ſtar, with a greater or ſmaller number of rays in the different ſpecies: they are uſually found of about an inch in length, and of the thickneſs of a gooſe-quill. Some of them have five angles or rays, and others only four; and in ſome the angles are equidiſtant, while in others they are irregularly ſo: in ſome alſo they are ſhort and blunt, while in others they are long, narrow, and pointed; and ſome have their angles very ſhort and obtuſe. The ſeveral joints in the ſame ſpecimen are uſually all of the ſame thickneſs; this, however, is not always the caſe: but in ſome they are larger at one end, and in others at the middle, than in any other part of the body; and ſome ſpecies have one of the rays bifid, ſo as to emulate the appearance of a ſix-rayed kind.

STAR-Thiſtle. See CENTAUREA, } BOTANY *Index.*
STAR-Wort See ASTER, }

STARCH, a fecula or ſediment, found at the bottom of veſſels wherein wheat has been ſteeped in water, of which fecula, after ſeparating the bran from it, by paſſing it through ſieves, they form a kind of loaves, which being dried in the ſun or an oven, is afterwards cut into little pieces, and ſo ſold. The beſt ſtarch is white, ſoft, and friable, and eaſily broken into powder. Such as require fine ſtarch, do not content themſelves, like the ſtarchmen, with refuſe wheat, but uſe the fineſt grain. The proceſs is as follows: The grain, being well cleaned, is put to ferment in veſſels full of water, which they expoſe to the ſun while in its greateſt heat; changing the water twice a-day, for the ſpace of eight or twelve days, according to the ſeaſon. When the grain burſts eaſily under the finger, they judge it ſufficiently fermented. The fermentation perfected, and the grain thus ſoftened, it is put, handful by handful, into a canvas-bag, to ſeparate the flour from the huſks; which is done by rubbing and beating it on a plank laid acroſs the mouth of an empty veſſel that is to receive the flour.

As the veſſels are filled with this liquid flour, there is ſeen ſwimming at top a reddiſh water, which is to be carefully ſcummed off from time to time, and clean water is to be put in its place, which, after ſtirring the whole together, is alſo to be ſtrained through a cloth or ſieve, and what is left behind put into the veſſel with new water, and expoſed to the ſun for ſome time. As the ſediment thickens at the bottom, they drain off the water four or five times, by inclining the veſſel, but without paſſing it through the ſieve. What remains at bottom is the ſtarch, which is cut in pieces to get out, and left to dry in the ſun. When dry, it is laid up for uſe.

The following mill, was invented by M. Baumé for grinding potatoes, with a view to extract ſtarch from them.

Plate D. fig. 1.

He had a grater made of plate iron, in a cylindrical form (fig. 1.) about ſeven inches in diameter, and about eight inches high; the burs made by ſtumping the holes are on the inſide. This grater is ſupported upon three feet AAA, made of flat iron bars, ſeven feet high, ſtrongly rivetted to the grater; the bottom of each foot is bent horizontally, and has a hole in it which receives a ſcrew, as at A, fig. 4. A little below the upper end of the three feet is fixed a croſs piece B (fig. 1. and 4.), divided into three branches, and rivetted to the feet. This croſs piece not only ſerves to keep the feet at a proper diſtance from each other, and to prevent their bending; but the centre of it having a hole cut in it, ſerves to ſupport an axis or ſpindle of iron, to be preſently deſcribed.

The upper end of this cylindrical grater has a diverging border of iron C (fig. 1. 4. and 7.), about 10 inches in diameter at the top, and five inches in height.

Within this cylindrical grater is placed a ſecond grater (fig. 2. and 3.), in the form of a cone, the point of which is cut off. The latter is made of thick plate iron, and the burs of the holes are on the outſide; it is fixed, with the broad end at the bottom, as in fig. 4. At the upper end of the cone is rivetted a ſmall triangle, or croſs piece of iron, conſiſting of three branches D (fig. 2.), in the middle of which is made a ſquare hole, to receive an axis or ſpindle; to give more reſiſtance to this part of the cone, it is ſtrengthened by means of a cap of iron E, which is fixed to the grater by means of rivets, and has alſo a ſquare hole made in it, to let the axis paſs through.

Fig. 3. repreſents the ſame cone ſeen in front; the baſe F has alſo a croſs piece of three branches, rivetted to a hoop of iron, which is fixed to the inner ſurface of the cone; the centre of this croſs piece has alſo a ſquare hole for the paſſage of the axis.

Fig. 5. is a ſpindle or axis itſelf; it is a ſquare bar of iron about 16 inches long, and more than half an inch thick; round at the bottom, and alſo towards the top, where it fits into the croſs piece I, fig. 7. and B, fig. 1. and 4.; in theſe pieces it turns round, and by them it is kept in its place. It muſt be ſquare at its upper extremity, that it may have a handle, about nine inches long, fixed to it, by means of which the conical grater is turned round. At G, (fig. 5.), a ſmall hole is made through the axis, to receive a pin H, by means of which the conical grater is kept at its proper height within the cylindrical one.

Fig. 6. is a bird's-eye view, in which the mill is repreſented placed in an oval tub, like a bathing-tub. I is the fore-mentioned triangular iron croſs, fixed with ſcrews to the ſide of the tub; the centre of it has a round hole, for the axis of the mill to move in when it is uſed.

Fig. 7. repreſents the mill in the oval tub; it is placed at one end of it, that the other end may be left free for any operation to be performed in it which may be neceſſary. A part of the tub is cut off, that the inſide of it, and the manner of fixing the mill, may be ſeen. That the bottom of the tub may not be worn by the ſcrews which paſs through the feet of the mill, a deal board, about an inch thick, and properly ſhaped, is placed under the mill.

When we wiſh to make uſe of this mill, it is to be fixed by the feet, in the manner already deſcribed; it is alſo fixed at the top, by means of the croſs piece I, fig. 6. and 7. The tub is then to have water poured into it as high as K, and the top of the mill is to be filled with potatoes, properly waſhed and cut; the handle L is to be turned round, and the potatoes, after being ground between

Starch.

between the two graters, go out gradually at the lower part, being aſſiſted by the motion produced in the water by the action of the mill.

To prepare ſtarch from potatoes, ſays M. Baumé, any quantity of theſe roots may be taken, and ſoaked in a tub of water for about an hour; they are afterwards to have their fibres and ſhoots taken off, and then to be rubbed with a pretty ſtrong bruſh, that the earth, which is apt to lodge in the inequalities of their ſurface, may be entirely removed; as this is done, they are to be waſhed, and thrown into another tub full of clean water. When the quantity which we mean to make uſe of has been thus treated, thoſe which are too large are to be cut into pieces about the ſize of eggs, and thrown into the mill; that being already fixed in the oval tub, with the proper quantity of water: the handle is then turned round, and as the potatoes are grated they paſs out at the bottom of the mill. The pulp which collects about the mill muſt be taken off from time to time with a wooden ſpoon, and put aſide in water.

When all the potatoes are ground, the whole of the pulp is to be collected in a tub, and mixed up with a great quantity of clean water. At the ſame time, another tub, very clean, is to be prepared, on the brim of which are to be placed two wooden rails, to ſupport a hair ſieve, which muſt not be too fine. The pulp and water are to be thrown into the ſieve; the flour paſſes through with the water, and freſh quantities of water are ſucceſſively to be poured on the remaining pulp, till the water runs through as clear as it is poured in. In this way we are to proceed till all the potatoes that were ground are uſed.

The pulp is commonly thrown away as uſeleſs; but it ſhould be boiled in water, and uſed as food for animals; for it is very nouriſhing, and is about $\frac{7}{8}$ths of the whole quantity of potatoes uſed.

It is farther to be obſerved that the liquor which has paſſed through the ſieve is turbid, and of a browniſh colour, on account of the extractive matter which is diſſolved in it; it depoſits, in the ſpace of five or ſix hours, the flour which was ſuſpended in it. When all the flour is ſettled to the bottom, the liquor is to be poured off and thrown away, being uſeleſs; a great quantity of very clean water is then to be poured upon the flour remaining at the bottom of the tub, which is to be ſtirred up in the water, that it may be waſhed, and the whole is to ſtand quiet till the day following. The flour will then be found to have ſettled at the bottom of the tub; the water is again to be poured off as uſeleſs, the flour waſhed in a freſh quantity of pure water, and the mixture paſſed through a ſilk ſieve pretty fine, which will retain any ſmall quantity of pulp which may have paſſed through the hair ſieve. The whole muſt once more be ſuffered to ſtand quiet till the flour is entirely ſettled; if the water above it is perfectly clear and colourleſs, the flour has been ſufficiently waſhed; but if the water has any ſenſible appearances either of colour or of taſte, the flour muſt be again waſhed, as it is abſolutely neceſſary that none of the extractive matter be ſuffered to remain.

When the flour is ſufficiently waſhed, it may be taken out of the tub with a wooden ſpoon; it is to be placed upon wicker frames covered with paper, and dried, properly defended from duſt. When it is thoroughly dry, it is to be paſſed through a ſilk ſieve, that if any clotted lumps ſhould have been formed they may be divided. It is to be kept in glaſs-veſſels ſtopped with paper only.

Starch, Stark.

A patent was granted in 1796 to Lord William Murray for his diſcovery of a method by which ſtarch may be extracted from horſe-cheſnuts. It is as follows:

Take the horſe-cheſnuts out of the outward green prickly huſks; and either by hand, with a knife, or other tool, or elſe with a mill adapted for that purpoſe, very carefully pare off the brown rind, being particular not to leave the ſmalleſt ſpeck, and to entirely eradicate the ſprout or growth. Next take the nuts, and raſp, grate, or grind them fine into water, either by hand, or by a mill adapted for that purpoſe. Waſh the pulp, which is thereby formed in this water, as clean as poſſible, through a coarſe horſe-hair ſieve; this again waſh through a finer ſieve, and then again through a ſtill finer, conſtantly adding clean water, to prevent any ſtarch from adhering to the pulp. The laſt proceſs is, to put it with a large quantity of water (about four gallons to a pound of ſtarch) through a fine gauze, muſlin, or lawn, ſo as entirely to clear it of all bran or other impurities. As ſoon as it ſettles, pour off the water; then mix it up with clean water, repeating this operation till it no longer imparts any green, yellow, or other colour to the water. Then drain it off till nearly dry, and ſet it to bake, either in the uſual mode of baking ſtarch, or elſe ſpread out before a briſk fire; being very attentive to ſtir it frequently to prevent its horning, that is to ſay, turning to a paſte or jelly, which, on being dried, turns hard like horn. The whole proceſs ſhould be conducted as quickly as poſſible.

Mention is here made of a mill which may be employed to grind the horſe-cheſnuts; but it is not deſcribed; perhaps the one deſcribed above for grinding potatoes might anſwer the purpoſe.

STARK, Dr William, known to the public by a volume containing Clinical and Anatomical Obſervations, with ſome curious Experiments on Diet, was born at Mancheſter in the month of July 1740; but the family from which he ſprang was Scotch, and reſpectable for its antiquity. His grandfather John Stark of Killermont was a covenanter; and having appeared in arms againſt his ſovereign at the battle of Bothwel bridge in the year 1679, became obnoxious to the government, and, to conceal himſelf, withdrew into Ireland. There is reaſon to believe that he had not imbibed either the extravagant zeal or the ſavage manners of the political and religious party to which he adhered; for after reſiding a few years in the country which he had choſen for the ſcene of his baniſhment, he married Elizabeth daughter of Thomas Stewart, Eſq. of Balydrone in the north of Ireland; who, being deſcended of the noble family of Galloway, would not probably have matched his daughter to ſuch an exile as a ruthleſs fanatic of the laſt century. By this lady Mr Stark had ſeveral children; and his ſecond ſon Thomas, who ſettled at Mancheſter as a wholeſale linen-draper, and married Margaret Stirling, daughter of William Stirling, Eſq. of Northwoodſide, in the neighbourhood of Glaſgow, was the father of the ſubject of this article. Another of his ſons, the reverend John Stark, was miniſter of Lecropt in Perthſhire; and it was under the care of this gentleman that our author received the rudiments of his education, which, when we conſider the character of the maſter, and

and reflect on the relation between him and his pupil, we may preſume was calculated to ſtore the mind of Dr Stark with thoſe virtuous principles which influenced his conduct through life.

From Lecropt young Stark was ſent to the univerſity of Glaſgow, where, under the tuition of the doctors Smith and Black, with other eminent maſters, he learned the rudiments of ſcience, and acquired that mathematical accuracy, that logical preciſion, and that contempt of hypotheſes, with which he proſecuted all his future ſtudies. Having choſen phyſic for his profeſſion, he removed from the univerſity of Glaſgow to that of Edinburgh, where he was ſoon diſtinguiſhed, and honoured with the friendſhip of the late Dr Cullen; a man who was not more eminently conſpicuous for the ſuperiority of his own genius, than quick-ſighted in perceiving, and liberal in encouraging, genius in his pupils. Having finiſhed his ſtudies at Edinburgh, though he took there no degree, Mr Stark, in the year 1765, went to London, and devoted himſelf entirely to the ſtudy of phyſic and the elements of ſurgery; and looking upon anatomy as one of the principal pillars of both theſe arts, he endeavoured to complete with Dr Hunter what he had begun with Dr Monro; and under theſe two eminent profeſſors he appears to have acquired a high degree of anatomical knowledge. He likewiſe entered himſelf about this time a pupil at St George's hoſpital; for being diſguſted, as he often confeſſed, with the inaccuracy or want of candour obſervable in the generality of practical writers, he determined to obtain an acquaintance with diſeaſes at a better ſchool and from an abler maſter; and to have from his own experience a ſtandard, by which he might judge of the experience of others. With what induſtry he proſecuted this plan, and with what ſucceſs his labours were crowned, may be ſeen in a ſeries of Clinical and Anatomical Obſervations, which were made by him during his attendance at the hoſpital, and were publiſhed after his death by his friend Dr Carmichael Smyth. Theſe obſervations give the public no cauſe to complain of want of candour in their author; for whatever delicacy he may have obſerved, when relating the caſes of patients treated by other phyſicians, he has related thoſe treated by himſelf with the utmoſt impartiality. Whilſt attending the hoſpital, he likewiſe employed himſelf in making experiments on the blood, and other animal fluids; and alſo in a courſe of experiments in chemical pharmacy; but though accounts of theſe experiments were left behind him, we believe they have not yet been given to the public.

In the year 1767 Mr Stark went abroad, and obtained the degree of M. D. in the univerſity of Leyden, publiſhing an inaugural diſſertation on the dyſentery. On his return to London, he recommenced his ſtudies at the hoſpital; and when Dr Black was called to the chemical chair in Edinburgh, which he has long filled with ſo much honour to himſelf and credit to the univerſity, Dr Stark was ſolicited by ſeveral members of the univerſity of Glaſgow to ſtand a candidate for their profeſſorſhip of the theory and practice of phyſic, rendered vacant by Dr Black's removal to Edinburgh. This however Dr Stark declined, being influenced by the advice of his Engliſh friends, who wiſhed to detain him in London, and having likewiſe ſome proſpects of an appointment in the hoſpital.

In the mean time he had commenced (1769) a ſeries of experiments on diet, which he was encouraged to undertake by Sir John Pringle and Dr Franklin, whoſe friendſhip he enjoyed, and from whom he received many hints reſpecting both the plan and its execution. Theſe experiments, or rather the imprudent zeal with which he proſecuted them, proved, in the opinion of his friends, fatal to himſelf; for he began them on the 12th of July 1769 in perfect health and vigour, and from that day, though his health varied, it was ſeldom if ever good, till the 23d of February 1770, when he died, after ſuffering much uneaſineſs. His friend and biographer Dr Smyth thinks, that other cauſes, particularly chagrin and diſappointment, had no ſmall ſhare in haſtening his death; and as the Doctor was intimately acquainted with his character and diſpoſition, his opinion is probably well-founded, though the pernicious effects of the experiments are viſible in Dr Stark's own journal. When he entered upon them, the weight of his body was 12 ſtone 3 lb. avoirdupois, which in a very few days was reduced to 11 ſtone 10 lb. 8 oz.: and though ſome kinds of food increaſed it, by much the greater part of what he uſed had a contrary effect, and it continued on the whole to decreaſe till the day of his death. This indeed can excite no wonder. Though the profeſſed object of his experiments was to prove that a *pleaſant* and varied diet is equally conducive to health with a more ſtrict and ſimple one, moſt of the diſhes which he ate during theſe experiments were neither pleaſant nor ſimple, but compounds, ſuch as every ſtomach muſt nauſeate. He began with *bread* and *water;* from which he proceeded to *bread, water*, and *ſugar;* then to *bread, water*, and *oil of olives;* then to *bread* and *water* with *milk;* afterwards he tried *bread* and *water* with *roaſted gooſe; bread* and *water* with *boiled beef; ſtewed lean of beef* with the *gravy* and *water* without bread; *ſtewed lean of beef* with the *gravy, oil* of *fat* or *ſuet* and *water; flour, oil of ſuet, water* and *ſalt; flour, water*, and *ſalt;* and a number of others infinitely more diſagreeable to the ſtomach than even theſe, ſuch as *bread, fat of bacon ham, infuſion of tea* with *ſugar;* and *bread* or *flour* with *honey* and the infuſion of *roſemary*. But though we conſider Dr Stark's experiments as whimſical, it cannot be denied that they indicate eccentricity of genius in the perſon who made them; and ſuch of our readers as think genius hereditary, may perhaps be of opinion, that he derived a ray from the celebrated NAPIER the inventor of the logarithms, who was his anceſtor by both parents. At any rate, theſe experiments, of which a full account is given in the ſame volume with his clinical and anatomical obſervations, diſplay an uncommon degree of fortitude, perſeverance, ſelf-denial, and zeal for the promoting of uſeful knowledge in their author; and with reſpect to his moral character, we believe it is with great juſtice that Dr Smyth compares him to Cato, by applying to him what was ſaid of that virtuous Roman by Salluſt.—"Non divitiis cum divite, neque factione cum factioſo; ſed cum ſtrenuo virtute, cum modeſto pudore, cum innocente abſtinentia certabat; eſſe, quam videri, bonus malebat *."

STARLING. See STURNUS, ORNITHOLOGY *Index.*

STARLINGS, or STERLINGS, the name given to the ſtrong pieces of timber which were driven into the bed of the river to protect the piles, on the top of which were laid the flat beams upon which were built the

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* *Bellum Catilinarium.*

the baſes of the ſtone piers that ſupport the arches of London bridge. In general, ſtarlings are large piles placed on the outſide of the foundation of the piers of bridges, to break the force of the water, and to protect the ſtone work from injury by floating ice. They are otherwiſe called *jettes*, and their place is often ſupplied by large ſtones thrown at random round the piers of bridges, as may be ſeen at Stirling bridge when the river is low; and as was done by Mr Smeaton's direction round the piers of the centre arch of London bridge, when it was thought in danger of being undermined by the current.

STATE OF A CONTROVERSY. See ORATORY, Part I. N° 14.

STATES, or ESTATES, a term applied to ſeveral orders or claſſes of people aſſembled to conſult of matters for the public good.

Thus ſtates-generals, in the old government of Holland, is the name of an aſſembly conſiſting of the deputies of the ſeven United Provinces. Theſe were uſually 30 in number, ſome provinces ſending two, others more; and whatever reſolution the ſtates-general took was confirmed by every province, and by every city and republic in that province, before it had the force of a law. The deputies of each province, of what number ſoever they were, had only one voice, and were eſteemed as but one perſon, the votes being given by provinces. Each province preſided in the aſſembly in its turn, according to the order ſettled among them. Guelderland preſided firſt, then Holland, &c.

States of Holland were the deputies of eighteen cities, and one repreſentative of the nobility, conſtituting the ſtates of the province of Holland: the other provinces had likewiſe their ſtates, repreſenting their ſovereignty; deputies from which made what was called the ſtates-general. In an aſſembly of the ſtates of a particular province, one diſſenting voice prevented their coming to any reſolution.

STATICE, THRIFT, a genus of plants belonging to the claſs of pentandria, and order of pentagynia; and in the natural ſyſtem ranging under the 48th order, *Aggregatæ*. See BOTANY *Index*.

STATICS, a term which the modern improvements in knowledge have made it neceſſary to introduce into phyſico-mathematical ſcience. It was found convenient to diſtribute the doctrines of univerſal mechanics into two claſſes, which required both a different mode of conſideration and different principles of reaſoning.

Till the time of Archimedes little ſcience of this kind was poſſeſſed by the ancients, from whom we have received the firſt rudiments. His inveſtigation of the centre of gravity, and his theory of the lever, are the foundations of our knowledge of common mechanics; and his theory of the equilibrium of floating bodies contains the greateſt part of our hydroſtatical knowledge. But it was as yet limited to the ſimpleſt caſes; and there were ſome in which Archimedes was ignorant, or was miſtaken. The marquis Guido Ubaldi, in 1578, publiſhed his theory of mechanics, in which the doctrines of Archimedes were well explained and conſiderably augmented. Stevinus, the celebrated Dutch engineer, publiſhed about 20 years after an excellent ſyſtem of mechanics, containing the chief principles which now form the ſcience of equlibrium among ſolid bodies. In particular, he gave the theory of inclined planes, which was unknown to the ancients, though it is of the very firſt importance in almoſt every machine. He even ſtates in the moſt expreſs terms the principle afterwards made the foundation of the whole of mechanics, and publiſhed as a valuable diſcovery by Varignon, viz. that three forces, whoſe directions and intenſities are as the ſides of a triangle, balance each other. His theory of the preſſure of fluids, or hydroſtatics, is no leſs eſtimable, including every thing that is now received as a leading principle in the ſcience. When we conſider the ignorance, even of the moſt learned, of that age, in mechanical or phyſico-mathematical knowledge, we muſt conſider theſe performances as the works of a great genius; and we regret that they are ſo little known, being loſt in a crowd of good writings on thoſe ſubjects which appeared ſoon after.

Hitherto the attention had been turned entirely to equilibrium, and the circumſtances neceſſary for producing it. Mechanicians indeed ſaw, that the energy of a machine might be ſomehow meaſured by the force which could be oppoſed or overcome by its intervention: but they did not remark, that the force which prevented its motion, but did no more than prevent it, was an *exact* meaſure of its energy, becauſe it was in immediate equilibrio with the preſſure exerted by that part of the machine with which it was connected. If this oppoſed force was leſs, or the force acting at the other extremity of the machine was greater, the mechanicians knew that the machine would move, and that work would be performed; but what would be the rate of its motion or its performance, they hardly pretended to conjecture. They had not ſtudied the action of moving forces, nor conceived what was done when motion was communicated.

The great Galileo opened a new field of ſpeculation in his work on Local Motion. He there conſiders a change of motion as the indication and exact and adequate meaſure of a moving force; and he conſiders every kind of preſſure as competent to the production of ſuch changes.—He contented himſelf with the application of this principle to the motion of bodies by the action of gravity, and gave the theory of projectiles, which remains to this day without change, and only improved by conſidering the changes which are produced in it by the reſiſtance of the air.

Sir Iſaac Newton took up this ſubject nearly as Galileo had left it, For, if we except the theory of the centrifugal forces ariſing from rotation, and the theory of pendulums, publiſhed by Huygens, hardly any thing had been added to the ſcience of motion. Newton conſidered the ſubject in its utmoſt extent; and in his mathematical principles of natural philoſophy he conſiders every conceivable variation of moving force, and determines the motion reſulting from its action.—His firſt application of theſe doctrines was to explain the celeſtial motions; and the magnificence of this ſubject cauſed it to occupy for a while the whole attention of the mathematicians. But the ſame work contained propoſitions equally conducive to the improvement of common mechanics, and to the complete underſtanding of the mechanical actions of bodies. Philoſophers began to make theſe applications alſo. They ſaw that every kind of work which is to be performed by a machine may be conſidered abſtractedly as a retarding force; that the impulſe of water or wind, which are employed as moving powers, Statics.

act by means of preſſures which they exert on the impelled point of the machine; and that the machine itſelf may be conſidered as an aſſemblage of bodies moveable in certain limited circumſtances, with determined directions and proportions of velocity. From all theſe conſiderations reſulted a general abſtract condition of a body acted on by known powers. And they found, that after all conditions of equilibrium were ſatisfied, there remains a ſurplus of moving force. They could now ſtate the motion which will enſue, the new reſiſtance which this will excite, the additional power which this will abſorb; and they at laſt determined a new kind of equilibrium, not thought of by the ancient mechanicians, between the reſiſtance to the machine performing work and the moving power, which exactly balance each other, and is indicated, not by the *reſt*, but by the *uniform motion* of the machine.—In like manner, the mathematician was enabled to calculate that preciſe motion of water which would completely abſorb, or, in the new language, balance the ſuperiority of preſſure by which water is forced through a ſluice, a pipe, or canal, with a conſtant velocity.

Thus the general doctrines of motion came to be conſidered in two points of view, according as they balanced each other in a ſtate of reſt or of uniform motion. Theſe two ways of conſidering the ſame ſubject required both different principles and a different manner of reaſoning. The firſt has been named *ſtatics*, as expreſſing that reſt which is the teſt of this kind of equilibrium. The ſecond has been called DYNAMICS or UNIVERSAL MECHANICS, becauſe the different kinds of motion are characteriſtic of the powers or forces which produce them. A knowledge of both is indiſpenſably neceſſary for acquiring any uſeful practical knowledge of machines; and it was ignorance of the doctrines of accelerated and retarded motions which made the progreſs of practical mechanical knowledge ſo very ſlow and imperfect. The mechanics, even of the moderns, before Galileo, went no further than to ſtate the proportion of the power and reſiſtance which would be balanced by the intervention of a given machine, or the proportion of the parts of a machine by which two known forces may balance each other. This view of the matter introduced a principle, which even Galileo conſidered as a mechanical axiom, viz. that *what is gained in force by means of a machine is exactly compenſated by the additional time which it obliges us to employ*. This is falſe in every inſtance, and not only prevents improvement in the conſtruction of machines, but leads us into erroneous maxims of conſtruction. The true principles of dynamics teach us, that there is a certain proportion of the machine, dependent on the kind and proportion of the power and reſiſtance, which enables the machine to perform the greateſt poſſible work.

It is highly proper therefore to keep ſeparate theſe two ways of conſidering machines, that both may be improved to the utmoſt, and then to blend them together in every practical diſcuſſion.

Statics therefore is preparatory to the proper ſtudy of mechanics; but it does not hence derive all its importance. It is the ſole foundation of many uſeful parts of knowledge. This will be beſt ſeen by a brief enumeration.

1. It comprehends all the doctrines of the excitement and propagation of preſſure through the parts of ſolid bodies, by which the energies of machines are produced. A preſſure is exerted on the impelled point of a machine, ſuch as the float-boards or buckets of a mill-wheel. This excites a preſſure at the pivots of its axle, which act on the points of ſupport. This muſt be underſtood, both as to direction and intenſity, that it may be effectually reſiſted. A preſſure is alſo excited at the acting tooth of the cog-wheel on the ſame axle, by which it urges round another wheel, exciting ſimilar preſſures on its pivots and on the acting tooth perhaps of a third wheel.—Thus a preſſure is ultimately excited in the working point of the machine, perhaps a wiper, which lifts a heavy ſtamper, to let it fall again on ſome matter to be pounded. Now ſtatics teaches us the intenſities and direction of all thoſe preſſures, and therefore how much remains at the working point of the machine unbalanced by reſiſtance.

Statics || Statiſtics.

2. It comprehends every circumſtance which influences the ſtability of heavy bodies; the inveſtigation and properties of the centre of gravity; the theory of the conſtruction of arches, vaults, and domes; the attitudes of animals.

3. The ſtrength of materials, and the principles of conſtruction, ſo as to make the proper adjuſtment of ſtrength and ſtrain in every part of a machine, edifice, or ſtructure of any kind. Statics therefore furniſhes us with what may be called *a theory of carpentry*, and gives us proper inſtructions for framing floors, roofs, centres, &c.

4. Statics comprehends the whole doctrine of the preſſure of fluids, whether liquid or aeriform, whether ariſing from their weight or from any external action. Hence therefore we derive our knowledge of the ſtability of ſhips, or their power of maintaining themſelves in a poſition nearly upright, in oppoſition to the action of the wind on the ſails. We learn on what circumſtances of figure and ſtowage this quality depends, and what will augment or diminiſh it.

Very complete examples will be given in the remaining part of this work of the advantages of this ſeparate conſideration of the condition of a machine at reſt and in working motion; and in what yet remains to be delivered of the hydraulic doctrines in our account of *WATER-Works* in general, will be perceived the propriety of ſtating apart the equilibrium which is indicated by the uniform motion of the fluid. The obſervations too which we have to make on the ſtrength of the materials employed in our edifices or mechanical ſtructures, will be examples of the inveſtigation of thoſe powers, preſſures, or ſtrains, which are excited in all their parts.

STATIONARY, in *Aſtronomy*, the ſtate of a planet when, to an obſerver on the earth, it appears for ſome time to ſtand ſtill, or remain immoveable in the ſame place in the heavens. For as the planets, to ſuch an obſerver, have ſometimes a progreſſive motion, and ſometimes a retrograde one, there muſt be ſome point between the two where they muſt appear ſtationary.

STATISTICS, a word lately introduced to expreſs a view or ſurvey of any kingdom, county, or pariſh.

A Statiſtical view of Germany was publiſhed in 1790 by Mr B. Clarke: giving an account of the imperial and territorial conſtitutions, forms of government, legiſlation, adminiſtration of juſtice, and of the eccleſiaſtical ſtate; with a ſketch of the character and genius of the Germans; a ſhort inquiry into the ſtate of their trade and commerce; and giving a diſtinct view of the dominions, extent, number of inhabitants to a ſquare mile; chief towns, with their ſize and population; revenues, expences, debts, and military ſtrength of each ſtate. In Pruſſia, in Saxony, Sardinia, and Tuſcany, attempts have alſo been made to draw up ſtatiſtical accounts; but they were done rather with a view of aſcertaining the preſent ſtate of theſe countries, than as the means of future improvement.

A grand and extenſive work of this kind, founded on a judicious plan, conducted by the moſt patriotic and enlightened motives, and drawn up from the communications of the whole body of the clergy, was undertaken in Scotland in the year 1790 by Sir John Sinclair of Ulbſter, one of the moſt uſeful members of his country. Many praiſes are heaped upon genius and learning; but to genius and learning no applauſe is due, except when exerted for the benefit of mankind: but gratitude and praiſe is due to him whoſe talents ſhine only in great undertakings, whoſe happineſs ſeems to conſiſt in patriotic exertions, and whoſe judgment is uniformly approved by his ſucceſs. A work of this kind, ſo important in its object, ſo comprehenſive in its range, ſo judicious in its plan, and drawn up by more than 900 men of literary education, many of them men of great genius and learning, muſt be of immenſe value. It was completed about 1799, in 21 volumes 8vo.

The great object of this work is to give an accurate view of the ſtate of the country, its agriculture, its manufactures, and its commerce; the means of improvement, of which they are reſpectively capable; the amount of the population of a ſtate, and the cauſes of its increaſe or decreaſe; the manner in which the territory of a country is poſſeſſed and cultivated; the nature and amount of the various productions of the ſoil; the value of the perſonal wealth or ſtock of the inhabitants, and how it can be augmented; the diſeaſes to which the people are ſubject, their cauſes and their cure; the occupations of the people; where they are entitled to encouragement, and where they ought to be ſuppreſſed; the condition of the poor, the beſt mode of maintaining them, and of giving them employment; the ſtate of ſchools, and other inſtitutions, formed for purpoſes of public utility; the ſtate of the villages and towns, and the regulations beſt calculated for their police and good government; the ſtate of the manners, the morals, and the religious principles of the people, and the means by which their temporal and eternal intereſts can beſt be promoted.

To ſuch of our readers as have not an opportunity of peruſing this national work, or of examining its plan, we will preſent the ſcheme for the ſtatiſtical account of a parochial diſtrict which Sir John Sinclair publiſhed for the conſideration of the clergy, and which has been generally followed by them, though often with great improvements.

The name of the pariſh and its origin; ſituation and extent of the pariſh; number of acres; deſcription of the ſoil and ſurface; nature and extent of the ſea coaſt; lakes, rivers, iſlands, hills, rocks, caves, wood, orchards, &c.; climate and diſeaſes; inſtances of longevity; ſtate of property; number of proprietors; number of reſiding proprietors; mode of cultivation; implements of huſbandry; manures; ſeedtime and harveſt; remarkable inſtances of good and bad ſeaſons; quantity and value of each ſpecies of crop; total value of the whole produce of the diſtrict; total quantity of grain and other articles conſumed in the pariſh; wages and price of labour; ſervices, whether exacted or aboliſhed; commerce; manufactures; manufacture of kelp, its amount, and the number of people employed in it; fiſheries; towns and villages; police; inns and alehouſes; roads and bridges; harbours, ferries, and their ſtate; number of ſhips and veſſels; number of ſeamen; ſtate of the church; ſtipend, manſe, glebe, and patron; number of poor; parochial funds, and the management of them; ſtate of the ſchools, and number of ſcholars; ancient ſtate of population; cauſes of its increaſe or decreaſe; number of families; exact amount of the number of ſouls now living; diviſion of the inhabitants; 1. By the place of their birth; 2. By their ages; 3. By their religious perſuaſions; 4. By their occupations and ſituation in life; 5. By their reſidence; whether in town, village, or in the country; number of houſes; number of uninhabited houſes; number of dove-cots, and to what extent they are deſtructive to the crops; number of horſes, their nature and value; number of cattle, their nature and value; number of ſheep, their nature and value; number of ſwine, their nature and value; minerals in general; mineral ſprings; coal and fuel; eminent men; antiquities; parochial records; miſcellaneous obſervations; character of the people; their manners, cuſtoms, ſtature, &c.; advantages and diſadvantages; means by which their ſituation could be meliorated.

If ſimilar ſurveys (ſays the public-ſpirited editor of this work) were inſtituted in the other kingdoms of Europe, it might be the means of eſtabliſhing, on ſure foundations, the principles of that moſt important of all ſciences, viz. political or ſtatiſtical philoſophy; that is, the ſcience, which, in preference to every other, ought to be held in reverence. No ſcience can furniſh, to any mind capable of receiving uſeful information, ſo much real entertainment; none can yield ſuch important hints for the improvement of agriculture, for the extenſion of commercial induſtry, for regulating the conduct of individuals, or for extending the proſperity of the ſtate; none can tend ſo much to promote the general happineſs of the ſpecies.

STATIUS, Publius Papinius, a celebrated Latin poet of the firſt century, was born at Naples, and was the ſon of Statius, a native of Epirus, who went to Rome to teach poetry and eloquence, and had Domitian for his ſcholar. Statius the poet alſo obtained the favour and friendſhip of that prince; and dedicated to him his Thebais and Achilleis; the firſt in twelve books, and the laſt in two. He died at Naples about the year 100. Beſides the above poems, there are alſo ſtill extant his *Sylvæ*, in five books; the ſtyle of which is purer, more agreeable, and more natural, than that of his Thebais and Achilleis.

STATUARY, a branch of ſculpture, employed in the making of ſtatues. See Sculpture and the next article.

Statuary is one of thoſe arts wherein the ancients ſurpaſſed the moderns; and indeed it was much more popular, and more cultivated, among the former than the latter. It is diſputed between ſtatuary and painting, which of the two is the moſt difficult and the moſt artful.

Statuary, Statue.

Statuary is alſo uſed for the artificer who makes ſtatues. Phidias was the greateſt ſtatuary among the ancients, and Michael Angelo among the moderns.

STATUE, is defined to be a piece of ſculpture in full relievo, repreſenting a human figure. Daviler more ſcientifically defines ſtatue a repreſentation, in high relievo and inſulate, of ſome perſon diſtinguiſhed by his birth, merit, or great actions, placed as an ornament in a fine building, or expoſed in a public place, to preſerve the memory of his worth. In Greece one of the higheſt honours to which a citizen could aſpire was to obtain a ſtatue.

Statues are formed with the chiſel, of ſeveral matters, as ſtone, marble, plaſter, &c. They are alſo caſt of various kinds of metal, particularly gold, ſilver, braſs, and lead. For the method of caſting ſtatues, ſee the article *FOUNDERY of Statues*.

Statues are uſually diſtinguiſhed into four general kinds. The firſt are thoſe leſs than the life; of which kind we have ſeveral ſtatues of great men, of kings, and of gods themſelves. The ſecond are thoſe equal to the life; in which manner it was that the ancients, at the public expence, uſed to make ſtatues of perſons eminent for virtue, learning, or the ſervices they had done. The third are thoſe that exceed the life; among which thoſe that ſurpaſſed the life once and a half were for kings and emperors; and thoſe double the life, for heroes. The fourth kind were thoſe that exceeded the life twice, thrice, and even more, and were called *coloſſuſes*. See COLOSSUS.

Every ſtatue reſembling the perſon whom it is intended to repreſent, is called *ſtatua iconica*. Statues acquire various other denominations. 1. Thus, allegorical ſtatue is that which, under a human figure, or other ſymbol, repreſents ſomething of another kind; as a part of the earth, a ſeaſon, age, element, temperament, hour, &c. 2. Curule ſtatues, are thoſe which are repreſented in chariots drawn by bigæ or quadrigæ, that is, by two or four horſes; of which kind there were ſeveral in the circuſes, hippodromes, &c. or in cars, as we ſee ſome, with triumphal arches on antique medals. 3. Equeſtrian ſtatue, that which repreſents ſome illuſtrious perſon on horſeback, as that famous one of Marcus Aurelius at Rome; that of King Charles I. at Charing-croſs; King George II. in Leiceſter-Square, &c. 4. Greek ſtatue, denotes a figure that is naked and antique; it being in this manner the Greeks repreſented their deities, athletæ of the olympic games, and heroes; the ſtatues of heroes were particularly called *Achillean ſtatues*, by reaſon of the great number of figures of Achilles in moſt of the cities of Greece. 5. Hydraulic ſtatue, is any figure placed as an ornament of a fountain or grotto, or that does the office of a *jet d'eau*, a cock, ſpout, or the like, by any of its parts, or by any attribute it holds: the like is to be underſtood of any animal ſerving for the ſame uſe. 6. Pedeſtrian ſtatue, a ſtatue ſtanding on foot; as that of King Charles II. in the Royal Exchange, and of King James II. in the Privy-Gardens. 7. Roman ſtatue, is an appellation given to ſuch as are clothed, and which receive various names from their various dreſſes. Thoſe of emperors, with long gowns over their armour, were called *ſtatuæ paludatæ*: thoſe of captains and cavaliers, with coats of arms, *thoracatæ*; thoſe of ſoldiers with cuiraſſes, *loricatæ*; thoſe of ſenators and augurs, *trabeatæ*; thoſe of magiſtrates with long robes, *togatæ*; thoſe of the people with a plain tunica, *tunicatæ*; and, laſtly, thoſe of women with long trains, *ſtolatæ*.

Statue ‖ Steam

In repairing a ſtatue caſt in a mould, they touch it up with a chiſel, graver, or other inſtrument, to finiſh the places which have not come well off: they alſo clear off the barb, and what is redundant in the joints and projectures.

STATURE. See DWARF and GIANT.

STATUTE, in its general ſenſe, ſignifies a law, ordinance, decree, &c. See LAW, &c.

STATUTE, in our laws and cuſtoms, more immediately ſignifies an act of parliament made by the three eſtates of the realm; and ſuch ſtatutes are either general, of which the courts at Weſtminſter muſt take notice without pleading them; or they are ſpecial and private, which laſt muſt be pleaded.

STAVESACRE, a ſpecies of DELPHINIUM, which ſee, BOTANY *Index*.

STAY, a large ſtrong rope employed to ſupport the maſt on the fore part, by extending from its upper end towards the fore part of the ſhip, as the ſhrouds are extended to the right and left, and behind it. See MAST, RIGGING, and SHROUD.

The ſtay of the fore-maſt, which is called the *fore-ſtay*, reaches from the maſt-head towards the bowſprit end: the main ſtay extends over the forecaſtle to the ſhip's ſtem; and the mizen-ſtay is ſtretched down to that part of the main-maſt which lies immediately above the quarter-deck: the fore-top-maſt-ſtay comes alſo to the end of the bowſprit, a little beyond the fore-ſtay: the main-top-maſt ſtay is attached to the head or hounds of the fore-maſt; and the mizen-top-maſt ſtay comes alſo to the hounds of the main-maſt: the fore-top-gallant ſtay comes to the outer end of the jib-boom; and the main-top-gallant ſtay is extended to the head of the fore-top-maſt.

STAY-Sail, a ſort of triangular ſail extended upon a ſtay. See SAIL.

1 Definition.

STEAM, is the name given in our language to the viſible moiſt vapour which ariſes from all bodies which contain juices eaſily expelled from them by heats not ſufficient for their combuſtion. Thus we ſay, the ſteam of boiling water, of malt, of a tan-bed, &c. It is diſtinguiſhed from ſmoke by its not having been produced by combuſtion, by not containing any ſoot, and by its being condenſible by cold into water, oil, inflammable ſpirits, or liquids compoſed of theſe.

2 Appears like a white cloud

We ſee it riſe in great abundance from bodies when they are heated, forming a white cloud, which diffuſes itſelf and diſappears at no very great diſtance from the body from which it was produced. In this caſe the ſurrounding air is found loaded with the water or other juices which ſeem to have produced it, and the ſteam ſeems to be completely ſoluble in air, as ſalt is in water, compoſing while thus united a tranſparent elaſtic fluid.

3 when diſſeminated in air.

But in order to its appearance in the form of an opaque white cloud, the mixture with or diſſemination in air ſeems abſolutely neceſſary. If a tea-kettle boils violently, ſo that the ſteam is formed at the ſpout in great abundance, it may be obſerved, that the viſible cloud is not formed at the very mouth of the ſpout, but at a ſmall diſtance before it, and that the vapour is perfectly tranſparent at its firſt emiſſion. This is rendered ſtill more evident by fitting to the ſpout of the tea-kettle tea-kettle a glaſs pipe of any length, and of as large a diameter as we pleaſe. The ſteam is produced as copiouſly as without this pipe, but the vapour is tranſparent through the whole length of the pipe. Nay, if this pipe communicate with a glaſs veſſel terminating in another pipe, and if the veſſel be kept ſufficiently hot, the ſteam will be as abundantly produced at the mouth of this ſecond pipe as before, and the veſſel will be quite tranſparent. The viſibility therefore of the matter which conſtitutes the ſteam is an accidental or extraneous circumſtance, and requires the admixture with air; yet this quality again leaves it when united with air by ſolution. It appears therefore to require a *diſſemination* in the air. The appearances are quite agreeable to this notion: for we know that one perfectly tranſparent body, when minutely divided and diffuſed among the parts of another tranſparent body, but not diſſolved in it, makes a maſs which is viſible. Thus oil beaten up with water makes a white opaque maſs.

4
again
onverted
to water
cold.

In the mean time, as ſteam is produced, the water gradually waſtes in the tea-kettle, and will ſoon be totally expended, if we continue it on the fire. It is reaſonable therefore to ſuppoſe, that this ſteam is nothing but water changed by heat into an aerial or elaſtic form. If ſo, we ſhould expect that the privation of this heat would leave it in the form of water again. Accordingly this is fully verified by experiment; for if the pipe fitted to the ſpout of the tea-kettle be ſurrounded with cold water, no ſteam will iſſue, but water will continually trickle from it in drops: and if the proceſs be conducted with the proper precautions, the water which we thus obtain from the pipe will be found equal in quantity to that which diſappears from the tea-kettle.

5
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ined,

This is evidently the common proceſs for diſtilling; and the whole appearances may be explained by ſaying, that the water is converted by heat into an elaſtic vapour, and that this, meeting with colder air, imparts to it the heat which it carried off as it aroſe from the heated water, and being deprived of its heat it is again water. The particles of this water being vaſtly more remote from each other than when they were in the tea-kettle, and thus being diſſeminated in the air, become viſible, by reflecting light from their anterior and poſterior ſurfaces, in the ſame manner as a tranſparent ſalt becomes viſible when reduced to a fine powder. This diſſeminated water being preſented to the air in a very extended ſurface, is quickly diſſolved by it, as pounded ſalt is in water, and again becomes a tranſparent fluid, but of a different nature from what it was before, being no longer convertible into water by depriving it of its heat.

6
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ent heat.

Accordingly this opinion, or ſomething very like it, has been long entertained. Muſchenbroeck expreſsly ſays, that the water in the form of vapour carries off with it all the heat which is continually thrown in by the fuel. But Dr Black was the firſt who attended minutely to the whole phenomena, and enabled us to form diſtinct notions of the ſubject. He had diſcovered that it was not ſufficient for converting ice into water that it be raiſed to that temperature in which it can no longer remain in the form of ice. A piece of ice of the temperature 32° of Fahrenheit's thermometer will remain a very long while in air of the temperature 50° before it be all melted, remaining all the while of the temperature 32°, and therefore continually abſorbing heat from the ſurrounding air. By comparing the time in which the ice had its temperature changed from 28° to 32° with the ſubſequent time of its complete liquefaction, he found that it abſorbed about 130 or 140 times as much heat as would raiſe its temperature one degree; and he found that one pound of ice, when mixed with one pound of water 140 degrees warmer, was juſt melted, but without riſing in its temperature above 32°. Hence he juſtly concluded, that water differed from ice of the ſame temperature by containing, as a conſtituent ingredient, a great quantity of fire, or of the cauſe of heat, united with it in ſuch a way as not to quit it for another colder body, and therefore ſo as not to go into the liquor of the thermometer and expand it. Conſidered therefore as the poſſible cauſe of heat, it was latent, which Dr Black expreſſed by the abbreviated term LATENT HEAT. If any more heat was added to the water it was not latent, but would readily quit it for the thermometer, and, by expanding the thermometer, would ſhow what is the degree of this *redundant* heat, while fluidity alone is the indication of the *combined* and latent heat.

Dr Black, in like manner, concluded, that in order to convert water into an elaſtic vapour, it was neceſſary, not only to increaſe its uncombined heat till its temperature is 212°, in which ſtate it is juſt ready to become elaſtic; but alſo to pour into it a great quantity of fire, or the cauſe of heat, which combines with every particle of it, ſo as to make it repel, or to recede from, its adjoining particles, and thus to make it a particle of an elaſtic fluid. He ſuppoſed that this additional heat might be combined with it ſo as not to quit it for the thermometer; and therefore ſo as to be in a latent ſtate, having elaſtic fluidity for its ſole indication.

7
The temperature at which it is produced, and the quantity of heat which it abſorbs.

This opinion was very conſiſtent with the phenomenon of boiling off a quantity of water. The application of heat to it cauſes it gradually to riſe in its temperature till it reaches the temperature 212°. It then begins to ſend off elaſtic vapour, and is ſlowly expended in this way, continuing all the while of the ſame temperature. The ſteam alſo is of no higher temperature, as appears by holding a thermometer in it. We muſt conclude that this ſteam contains all the heat which is expended in its formation. Accordingly the ſcalding power of ſteam is well known; but it is extremely difficult to obtain preciſe meaſures of the quantity of heat abſorbed by water during its converſion into ſteam. Dr Black endeavoured to aſcertain this point, by comparing the time of raiſing its temperature a certain number of degrees with the time of boiling it off by the ſame external heat; and he found that the heat latent in ſteam, which balanced the preſſure of the atmoſphere, was not leſs than 800 degrees. He alſo directed Dr Irvine of Glaſgow to the form of an experiment for meaſuring the heat actually extricated from ſuch ſteam during its condenſation in the refrigeratory of a ſtill, which was found to be not leſs than 774 degrees. Dr Black was afterwards informed by Mr Watt, that a courſe of experiments, which he had made in each of theſe ways with great preciſion, determined the latent heat of ſteam under the ordinary preſſure of the atmoſphere to be about 948 or 950 degrees. Mr Watt alſo found that water would diſtil with great eaſe *in vacuo* when of the temperature 70°; and that in this caſe the latent heat of the ſteam is not leſs than 1200 or 1300 degrees; and a train of experiments, which he had made by diſtilling in different temperatures, made him conclude that the ſum of the ſenſible and latent heats is a conſtant quantity. This is a curious and not an improbable circumſtance; but we have no information of the particulars of theſe experiments. The concluſion evidently preſuppoſes a knowledge of that particular temperature in which the water has no heat; but this is a point which is ſtill *ſub judice*.

8
Steam, by being combined with heat, becomes elaſtic and light,

This converſion of liquids (for it is not confined to water, but obtains alſo in ardent ſpirits, oils, mercury, &c.) is the cauſe of their boiling. The heat is applied to the bottom and ſides of the veſſel, and gradually accumulates in the fluid, in a ſenſible ſtate, uncombined, and ready to quit it and to enter into any body that is colder, and to diffuſe itſelf between them. Thus it enters into the fluid of a thermometer, expands it, and thus gives us the indication of the degree in which it has been accumulated in the water; for the thermometer ſwells as long as it continues to abſorb ſenſible heat from the water: and when the ſenſible heat in both is in equilibrio, in a proportion depending on the nature of the two fluids, the thermometer riſes no more, becauſe it abſorbs no more heat or fire from the water; for the particles of water which are in immediate contact with the bottom, are now (by this gradual expanſion of liquidity) at ſuch diſtance from each other, that their laws of attraction for each other and for heat are totally changed. Each particle either no longer attracts, or perhaps it repels its adjoining particle, and now accumulates round itſelf a great number of the particles of heat, and forms a particle of elaſtic fluid, ſo related to the adjoining new formed particles, as to repel them to a diſtance at leaſt a hundred times greater than their diſtances in the ſtate of water. Thus a maſs of elaſtic vapour of ſenſible magnitude is formed. Being at leaſt ten thouſand times lighter than an equal bulk of water, it muſt riſe up through it, as a cork would do, in form of a tranſparent ball or bubble, and getting to the top, it diſſipates, filling the upper part of the veſſel with vapour or ſteam. Thus, by toſſing the liquid into bubbles, which are produced all over the bottom and ſides of the veſſel, it produces the phenomenon of ebullition or boiling. Obſerve, that during its paſſage up through the water, it is not changed or condenſed; for the ſurrounding water is already ſo hot that the ſenſible or uncombined heat in it, is in equilibrio with that in the vapour, and therefore it is not diſpoſed to abſorb any of that heat which is combined as an ingredient of this vapour, and gives it its elaſticity. For this reaſon, it happens that water will not boil till its whole maſs be heated up to 212°; for if the upper part be colder, it robs the riſing bubble of that heat which is neceſſary for its elaſticity, ſo that it immediately collapſes again, and the ſurface of the water remains ſtill. This may be perceived by holding water in a Florence flaſk over a lamp or choffer. It will be obſerved, ſome time before the real ebullition, that ſome bubbles are formed at the bottom, and get up a very little way, and then diſappear. The diſtances which they reach before collapſing increaſe as the water continues to warm farther up the maſs, till at laſt it breaks out into boiling. If the handle of a tea-kettle be graſped with the hand, a tremor will be felt for ſome little time before boiling, ariſing from the little ſucceſſions which are produced by the collapſing of the bubbles of vapour. This is much more violent, and is really a remarkable phenomenon, if we ſuddenly plunge a lump of red hot iron into a veſſel of cold water, taking care that no red part be near the ſurface. If the hand be now applied to the ſide of the veſſel, a moſt violent tremor is felt, and ſometimes ſtrong thumps: theſe ariſe from the collapſing of very large bubbles. If the upper part of the iron be too hot, it warms the ſurrounding water ſo much, that the bubbles from below come up through it uncondenſed, and produce ebullition without this ſucceſſion. The great reſemblance of this tremor to the feeling which we have during the ſhock of an earthquake has led many to ſuppoſe that theſe laſt are produced in the ſame way, and their hypotheſis, notwithſtanding the objections which we have elſewhere ſtated to it, is by no means unfeaſible.

9
and produces the phenomenon of boiling.

10
The noiſe obſerved i the boilin of a tea-kettle explained.

It is owing to a ſimilar cauſe that violent thumps are ſometimes felt on the bottom of a tea-kettle, eſpecially one which has been long in uſe. Such are frequently cruſted on the bottom with a ſtony concretion. This ſometimes is detached in little ſcales. When one of theſe is adhering by one end to the bottom, the water gets between them in a thin film. Hence it may be heated conſiderably above the boiling temperature, and it ſuddenly riſes up in a large bubble, which collapſes immediately. A ſmooth ſhilling lying on the bottom will produce this appearance very violently, or a thimble with the mouth down.

11
Water wil not boil un leſs the fi be applied to the bottom or ſid of the veſſel.

In order to make water boil, the fire muſt be applied to the bottom or ſides of the veſſel. If the heat be applied at the top of the water, it will waſte away without boiling; for the very ſuperficial particles are firſt ſupplied with the heat neceſſary for rendering them elaſtic, and they fly off without agitating the reſt (A).

Since this diſengagement of vapour is the effect of its

(A) We explained the opaque and cloudy appearance of ſteam, by ſaying that the vapour is condenſed by coming into contact with the cooler air. There is ſomething in the form of this cloud which is very inexplicable. The particles of it are ſometimes very diſtinguiſhable by the eye; but they have not the ſmart ſtar-like brilliancy of very ſmall drops of water, but give the fainter reflection of a very thin film or veſicle like a ſoap bubble. If we attend alſo to their motion, we ſee them deſcending very ſlowly in compariſon with the deſcent of a ſolid drop; and this veſicular conſtitution is eſtabliſhed beyond a doubt by looking at a candle through a cloud of ſteam. It is ſeen ſurrounded by a faint halo with priſmatical colours, preciſely ſuch as we can demonſtrate by optical laws to belong to a collection of veſicles, but totally different from the halo which would be produced by a collection of ſolid drops. It is very difficult to conceive how theſe veſicles can be formed of watery particles, each of which was ſurrounded its elaſticity, and ſince this elaſticity is a determined force when the temperature is given, it follows, that fluids cannot boil till the elaſticity of the vapour overcomes the preſſure of the incumbent fluid and of the atmoſphere. Therefore, when this preſſure is removed or diminiſhed, the fluids muſt ſooner overcome what remains, and boil at a lower temperature. Accordingly it is obſerved that water will boil in an exhauſted receiver when of the heat of the human body. If two glaſs balls A and B (fig. 1.) be connected by a ſlender tube, and one of them A be filled with water (a ſmall opening or pipe *b* being left at top of the other), and this be made to boil, the vapour produced from it will drive all the air out of the other, and will at laſt come out itſelf, producing ſteam at the mouth of the pipe. When the ball B is obſerved to be occupied by tranſparent vapour, we may conclude that the air is completely expelled. Now ſhut the pipe by ſticking it into a piece of tallow or bees-wax; the vapour in B will ſoon condenſe, and there will be a vacuum. The flame of a lamp and blow-pipe being directed to the little pipe, will cauſe it immediately to cloſe and ſeal hermetically. We now have a pretty inſtrument or toy called a Pulse Glass. Graſp the ball A in the hollow of the hand; the heat of the hand will immediately expand the bubble of vapour which may be in it, and this vapour will drive the water into B, and then will blow up through it for a long while, keeping it in a ſtate of violent ebullition, as long as there remains a drop or film of water in A. But care muſt be taken that B is all the while kept cold, that it may condenſe the vapour as faſt as it riſes through the water. Touching B with the hand, or breathing warm on it, will immediately ſtop the ebullition in it. When the water in A has thus been diſſipated, graſp B in the hand; the water will be driven into A, and the ebullition will take place there as it did in B. Putting one of the balls into the mouth will make the ebullition more violent in the other, and the one in the mouth will feel very cold. This is a pretty illuſtration of the rapid abſorption of the heat by the particles of water which are thus converted into elaſtic vapour. We have ſeen this little toy ſuſpended by the middle of the tube like a balance, and thus placed in the inſide of a window, having two holes *a* and *b* cut in the pane, in ſuch a ſituation that when A is full of water and preponderates, B is oppoſite to the hole *b*. Whenever the room became ſufficiently warm, the vapour was formed in A, and immediately drove the water into B, which was kept cool by the air coming into the room through the hole *b*. By this means B was made to preponderate in its turn, and A was then oppoſite to the hole *a*, and the proceſs was now repeated in the oppoſite direction; and this amuſement continued as long as the room was warm enough.

12 No fluid can boil till the elaſticity of the vapour overcome the preſſure of the incumbent bodies. Plate DI. fig. 1.

13 quors differ much in e temperature neceſſary for eir ebullition.

We know that liquors differ exceedingly in the temperatures neceſſary for their ebullition. This forms the great chemical diſtinction between volatile and fixed bodies. But the difference of temperature in which they boil, or are converted into permanently elaſtic vapour, under the preſſure of the atmoſphere, is not a certain meaſure of their differences of volatility. The natural boiling point of a body is that in which it will be converted into elaſtic vapour under no preſſure, or *in vacuo*. The boiling point in the open air depends on the law of the elaſticity of the vapour in relation to its heat. A fluid A may be leſs volatile, that is, may require more heat to make it boil *in vacuo*, than a fluid B: But if the elaſticity of the vapour of A be more increaſed by an increaſe of temperature than that of the vapour of B, A may boil at as low, or even at a lower temperature, in the open air, than B does; for the increaſed elaſticity of the vapour of A may ſooner overcome the preſſure of the atmoſphere. Few experiments have been made on the relation between the temperature and the elaſticity of different vapours. So long ago as the year 1765, we had occaſion to examine the boiling points of all ſuch liquors as we could manage in an air pump; that is, ſuch as did not produce vapours which deſtroyed the valves and the leathers of the piſtons: and we thought that the experiments gave us reaſon to conclude, that the elaſticity of all the vapours was affected by heat nearly in the ſame degree. For we found that the difference between their boiling points in the air and *in vacuo* was nearly the ſame in all, namely, about 120 degrees of Fahrenheit's thermometer. It is exceedingly difficult to make experiments of this kind: The vapours are ſo condenſible, and change their elaſticity ſo prodigiouſly by a trifling change of temperature, that it is almoſt impoſſible to examine this point with preciſion. It is, however, as we ſhall ſee by and bye, a ſubject of conſiderable practical importance in the mechanic arts; and an accurate knowledge of the relation would be of great uſe alſo to the diſtiller: and it would be no leſs important to diſcover the relation of their elaſticity and denſity, by examining their compreſſibility, in the ſame manner as we have aſcertained the relation in the caſe of what we call *aerial fluids*, that is, ſuch as we have never obſerved in the form of liquids or ſolids, except in conſequence of their union with each other or with other bodies. In the article Pneumatics we took notice of it as ſomething like a natural law, that all theſe airs, or gaſes as they are now called, had their elaſticity very nearly, if not exactly proportional to their denſity. This appears from the experiments of Achard, of Fontana, and others, on vital air, inflammable air, fixed air, and ſome others. It gives us ſome preſumption to ſuppoſe that it holds in all elaſtic vapours whatever, and that it is connected with their elaſticity; and it renders it ſomewhat probable that they are all elaſtic, only becauſe the cauſe of heat (the matter of fire if you will) is elaſtic, and that their law of elaſticity, in reſpect of denſity, is the ſame with that of fire. But it muſt

14 Difference between their boiling points in air and *in vacuo* about 120°.

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rounded with many particles of fire, now communicated to the air, and how each of theſe veſicles ſhall include within it a ball of air; but we cannot refuſe the fact. We know, that if, while linſeed oil is boiling or nearly boiling, the ſurface be obliquely ſtruck with the ladle, it will be daſhed into a prodigious number of exceedingly ſmall veſicles, which will float about in the air for a long while. M. Sauſſure was (we think) the firſt who diſtinctly obſerved this veſicular form of miſts and clouds; and he makes conſiderable uſe of it in explaining ſeveral phenomena of the atmoſphere.

15 To what the elaſticity of fluids may be owing.

be obſerved, that although we thus aſſign the elaſticity of fire as the immediate cauſe of the elaſticity of vapour in the ſame way, and on the ſame grounds, that we aſcribe the fluidity of brine to the fluidity of the water which holds the ſolid ſalt in ſolution, it does not follow that this is owing, as is commonly ſuppoſed, to a repulſion or tendency to recede from each other exerted by the particles of fire. We are as much entitled to infer a repulſion of unlimited extent between the particles of water; for we ſee that by its means a ſingle particle of ſea ſalt becomes diſſeminated through the whole of a very large veſſel. If water had not been a viſible and palpable ſubſtance, and the ſalt only had been viſible and palpable, we might have formed a ſimilar notion of chemical ſolution. But we, on the contrary, have conſidered the *quaquaverſum* motion or expanſion of the ſalt as a diſſemination among the particles of water; and we have aſcribed it to the ſtrong attraction of the atoms of ſalt for the atoms of water, and the attraction of theſe laſt for each other, thinking that each atom of ſalt accumulates round itſelf a multitude of watery atoms, and by ſo doing muſt recede from the other ſaline atoms. Nay, we farther ſee, that by forces which we naturally conſider as attractions, an expanſion may be produced of the whole maſs, which will act againſt external mechanical forces. It is thus that wood ſwells with almoſt inſuperable force by imbibing moiſture; it is thus that a ſponge immerſed in water becomes really an elaſtic compreſſible body; reſembling a blown bladder; and there are appearances which warrant us to apply this mode of conception to elaſtic fluids.—When air is ſuddenly compreſſed, a thermometer included in it ſhows a riſe of temperature; that is, an appearance of heat now redundant which was formerly combined. The heat ſeems to be ſqueezed out as the water from the ſponge.

16 Aſcribed by ſome to attraction, but improperly.

Accordingly this opinion, that the elaſticity of ſteam and other vapours is owing merely to the attraction for fire, and the conſequent diſſemination of their particles through the whole maſs of fire, has been entertained by many naturaliſts, and it has been aſcribed entirely to attraction. We by no means pretend to decide; but we think the analogy by far too ſlight to found any confident opinion on it. The aim is to ſolve phenomena by attraction only, as if it were of more eaſy conception than repulſion. Conſidered merely as facts, they are quite on a par. The appearances of nature in which we obſerve actual receſſes of the parts of body from each other, are as diſtinct, and as frequent and familiar, as the appearances of actual reproach. And if we attempt to go farther in our contemplation, and to conceive the way and the forces by which either the approximation or receſſes of the atoms are produced, we muſt acknowledge that we have no conception of the matter; and we can only ſay, that there is a cauſe of theſe motions, and we call it a force, as in every caſe of the production of motion. We call it attraction or repulſion juſt as we happen to contemplate an acceſs or a receſs. But the analogy here is not only ſlight, but imperfect, and fails moſt in thoſe caſes which are moſt ſimple, and where we ſhould expect it to be moſt complete. We can ſqueeze water out of a ſponge, it is true, or out of a piece of green wood; but when the white of an egg, the tremella, or ſome gums, ſwell to a hundred times their dry dimenſions by imbibing water, we cannot ſqueeze out a particle. If fluidity (for the reaſoning muſt equally apply to this as to vapourouſneſs) being owing to an accumulation of the extended matter of fire, which gradually expanded the ſolid by its very minute additions; and if the accumulation round a particle of ice, which is neceſſary for making it a particle of water, be ſo great in compariſon of what gives it the expanſion of one degree, as experiment obliges us to conclude—it ſeems an inevitable conſequence that all fluids ſhould be many times rarer than the ſolids from which they are produced. But we know that the difference is trifling in all caſes, and in ſome (water, for inſtance, and iron) the ſolid is rarer than the fluid. Many other arguments, (each of them perhaps of little weight when taken alone, but which are all ſyſtematically connected) concur in rendering it much more probable that the matter of fire, in cauſing elaſticity, acts immediately by its own elaſticity, which we cannot conceive in any other way than as a mutual tendency in its particles to receive from each other; and we doubt not but that, if it could be obtained alone, we ſhould find it an elaſtic fluid like air. We even think that there are caſes in which it is obſerved in this ſtate. The elaſtic force of gunpowder is very much beyond the elaſticity of all the vapours which are produced in its deflagration, each of them being expanded as much as we can reaſonably ſuppoſe by the great heat to which they are expoſed. The writer of this article exploded ſome gunpowder mixed with a conſiderable portion of finely powdered quartz, and another parcel mixed with fine filings of copper. The elaſticity was meaſured by the penetration of the ball which was diſcharged, and was great in the degree now mentioned. The experiment was ſo conducted, that much of the quartz and copper was collected; none of the quartz had been melted, and ſome of the copper was not melted. The heat, therefore, could not be ſuch as to explain the elaſticity by expanſion of the vapours; and it became not improbable that fire was acting here as a detached chemical fluid by its own elaſticity. But to return to our ſubject.

17 More probably owing to a mutual repulſion between the particles o fire.

18 Probably a great difference between condenſible and incondenſible vapours;

There is one circumſtance in which we think our own experiments ſhow a remarkable difference (at leaſt in degree) between the condenſible and incondenſible vapours. It is well known, that when air is very ſuddenly expanded, cold is produced, and heat when it is ſuddenly condenſed. When making experiments with the hopes of diſcovering the connection between the elaſticity and denſity of the vapours of boiling water, and alſo of boiling ſpirits of turpentine, we found the change of denſity accompanied by a change of temperature vaſtly greater than in the caſe of incoercible gaſes. When the vapour of boiling water was ſuddenly allowed to expand into five times its bulk, we obſerved the depreſſion of a large and ſenſible air thermometer to be at leaſt four or five times greater than in a ſimilar expanſion of common air of the ſame temperature. The chemical reader will readily ſee reaſons for expecting, on the contrary, a ſmaller alteration of temperature, both on account of the much greater rarity of the fluid, and on account of a partial condenſation of its water and the conſequent diſengagement of combined heat.

19 and alſo ſome difference in the chemical conſtitution of vapour.

This difference in the quantity of fire which is combined in vapours and gaſes is ſo conſiderable, as to authorize us to ſuppoſe that there is ſome difference in the chemical conſtitution of vapours and gaſes, and that the connection between the ſpecific baſes of the vapour and the fire which it contains is not the ſame in air, for inſtance, as in the vapour of boiling water; and this difference may be the reaſon why the one is eaſily condenſible by cold, while the other has never been exhibited in a liquid or ſolid form, except by means of its chemical union with other ſubſtances. In this particular inſtance we know that there is an eſſential difference—that in vital or atmoſpheric air there is not only a prodigious quantity of fire which is not in the vapour of water, but that it alſo contains light, or the cauſe of light, in a combined ſtate. This is fully evinced by the great diſcovery of Mr Cavendiſh of the compoſition of water. Here we are taught that water (and conſequently its vapour) conſiſts of air from which the light and greateſt part of the fire have been ſeparated. And the ſubſequent diſcoveries of the celebrated Lavoiſier ſhow, that almoſt all the condenſible gaſes with which we are acquainted conſiſt either of airs which have already loſt much of their fire (and perhaps light too), or of matters in which we have no evidence of fire or light being combined in this manner.

This conſideration may go far in explaining this difference in the condenſibility of theſe different ſpecies of aerial fluids, the gaſes and the vapours; and it is with this qualification only that we are diſpoſed to allow that all bodies are condenſible into liquids or ſolids by abſtracting the heat. In order that vital air may become liquid or ſolid, we hold that it is not ſufficient that a body be preſented to it which ſhall ſimply abſtract its heat. This would only abſtract its uncombined fire. But another and much larger portion remains chemically combined by means of light. A chemical affinity muſt be brought into action which may abſtract, not the fire from the oxygen (to ſpeak the language of Mr Lavoiſier), but the oxygen from the fire and light. And our production is not the detached baſis of air, but detached heat and light, and the formation of an oxide of ſome kind.

ENERAL
BSERVA-
IONS.

To proſecute the chemical conſideration of STEAMS farther than theſe general obſervations, which are applicable to all, would be almoſt to write a treatiſe of chemiſtry, and would be a repetition of many things which have been treated of in ſufficient detail in other articles of this work. We ſhall therefore conclude this article with ſome other obſervations, which are alſo general, with reſpect to the different kinds of coercible vapours, but which have a particular relation to the following article.

20
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Steam or vapour is an elaſtic fluid, whoſe elaſticity balances the preſſure of the atmoſphere; and it has been produced from a ſolid or liquid body raiſed to a ſufficient temperature for giving it this elaſticity; that is, for cauſing the fluid to boil. This temperature muſt vary with the preſſure of the air. Accordingly it is found, that when the air is light (indicated by the barometer being low), the fluid will boil ſooner. When the barometer ſtands at 30 inches, water boils at the temperature 212°. If it ſtands ſo low as 28 inches, water will boil at 208½. In the plains of Quito, or at Gondar in Abyſſinia, where the barometer ſtands at about 21 inches, water will boil at 195°. Highly rectified alcohol will boil at 160°, and vitriolic ether will boil at 88° or 89°. This is a temperature by no means uncommon in theſe places; nay, the air is frequently warmer. Vitriolic ether, therefore, is a liquor which can hardly be known in thoſe countries. It is hardly poſſible to preſerve it in that form. If a phial have not its ſtopper firmly tied down, it will be blown out, and the liquor will boil and be diſſipated in ſteam. On the top of Chimboraçao, the human blood muſt be diſpoſed to give out air-bubbles.

21
As fluids boil under the preſſure of the vapour which aſcends from them, the concluſion mentioned in N° 14. is only a groſs approximation.

We ſaid ſome time ago, that we had concluded, from ſome experiments made in the receiver of an air-pump, that fluids boil *in vacuo* at a temperature nearly 120 degrees lower than that neceſſary for their boiling in the open air. But we now ſee that this muſt have been but a groſs approximation; for in theſe experiments the fluids were boiling under the preſſure of the vapour which they produced, and which could not be abſtracted by working the pump. It appears from the experiments of Lord Charles Cavendiſh, mentioned in the article PNEUMATICS, that water of the temperature 72° was converted into elaſtic vapour, which balanced a preſſure of ¾ths of an inch of mercury, and in this ſtate it occupied the receiver, and did not allow the mercury in the gauge to ſink to the level. As faſt as this was abſtracted by working the air-pump, more of it was produced from the ſurface of the water, ſo that the preſſure continued the ſame, and the water did not boil. Had it been poſſible to produce a vacuum above this water, it would have boiled for a moment, and would even have continued to boil, if the receiver could have been kept very cold.

22
Account of experiments to determine the relation between the temperature of vapour and its elaſticity.

Upon reading theſe experiments, and ſome very curious ones of Mr Nairne, in the Phil. Tranſ. vol. lxvii. the writer of this article was induced to examine more particularly the relation between the temperature of the vapour and its elaſticity, in the following manner:

Fig. 2.

ABCD (fig. 2.) is the ſection of a ſmall digeſter made of copper. Its lid, which is faſtened to the body with ſcrews, is pierced with three holes, each of which had a ſmall pipe ſoldered into it. The firſt hole was furniſhed with a braſs ſafety-valve V, nicely fitted to it by grinding. The area of this valve was exactly ¼th of an inch. There reſted on the ſtalk at top of this valve the arm of a ſteelyard carrying a ſliding weight. This arm had a ſcale of equal parts, ſo adjuſted to the weight that the number on the ſcale correſponded to the inches of mercury, whoſe preſſure on the under ſurface of the valve is equal to that of the ſteelyard on its top; ſo that when the weight was at the diviſion 10, the preſſure of the ſteelyard on the valve was juſt equal to that of a column of mercury 10 inches high, and ¼th of an inch baſe. The middle hole contained a thermometer T firmly fixed into it, ſo that no vapour could eſcape by its ſides. The ball of this thermometer was but a little way below the lid. The third hole received occaſionally the end of a glaſs-pipe SGF, whoſe deſcending leg was about 36 inches long. When this ſyphon was not uſed, the hole was properly ſhut with a plug.

The veſſel was half filled with diſtilled water which had been purged of air by boiling. The lid was then fixed on, having the third hole S plugged up. A lamp being placed under the veſſel, the water boiled, and the ſteam iſſued copiouſly by the ſafety-valve. The thermometer ſtood at 213, and a barometer in the room at 29.9 inches. The weight was then put on the fifth diviſion. The thermometer immediately began to riſe; and when it was at 220, the ſteam iſſued by the ſides of the valve. The weight was removed to the 10th diviſion; but before the thermometer could be diſtinctly obſerved, the ſteam was iſſuing at the valve. The lamp was removed farther from the bottom of the veſſel, that the progreſs of heating might be more moderate; and when the ſteam ceaſed to iſſue from the valve, the thermometer was at 227. The weight was now ſhifted to 15; and by gradually approaching the lamp, the ſteam again iſſued, and the thermometer was at 132½. This mode of trial was continued all the way to the 75th diviſion of the ſcale. The experiments were then repeated in the contrary order; that is, the weight being ſuſpended at the 75th diviſion, and the ſteam iſſuing ſtrongly at the valve, the lamp was withdrawn, and the moment the ſteam ceaſed to come out, the thermometer was obſerved. The ſame was done at the 70th, 65th, diviſion, &c. Theſe experiments were ſeveral times repeated both ways; and the means of all the reſults for each diviſion are expreſſed in the following table, where column 1ſt expreſſes the elaſticity of the ſteam, being the ſum of 29.9, and the diviſion of the ſteelyard; column 2d expreſſes the temperature of the ſteam correſponding to this elaſticity.

I.	II.
35 inches.	219°
40	226
45	232
50	237
55	242
60	247
65	251
70	255
75	259
80	263
85	267
90	270½
95	274½
100	278
105	281

A very different proceſs was neceſſary for aſcertaining the elaſticity of the ſteam in lower temperatures, and conſequently under ſmaller preſſures than that of the atmoſphere. The glaſs ſyphon SGF was now fixed into its hole in the lid of the digeſter. The water was made to boil ſmartly for ſome time, and the ſteam iſſued copiouſly both at the valve and at the ſyphon. The lower end of the ſyphon was now immerſed into a broad ſaucer of mercury, and the lamp inſtantly removed, and every thing was allowed to grow cold. By this the ſteam was gradually condenſed, and the mercury roſe in the ſyphon, without ſenſibly ſinking in the ſaucer. The valve and all the joints were ſmeared with a thick clammy cement, compoſed of oil, tallow, and roſin, which effectually prevented all ingreſs of air. The weather was clear and froſty, and the barometer ſtanding at 29.84, and the thermometer in the veſſel at 42°. The mercury in the ſyphon ſtood at 29.7, or ſomewhat higher, thus ſhowing a very complete condenſation. The whole veſſel was ſurrounded with pounded ice, of the temperature 32°. This made no ſenſible change in the height of the mercury. A mark was now made at the ſurface of the mercury. One obſerver was ſtationed at the thermometer, with inſtructions to call out as the thermometer reached the diviſions 42, 47, 52, 57, and ſo on by every five degrees till it ſhould attain the boiling heat. Another obſerver noted the correſponding deſcents of the mercury by a ſcale of inches, which had its beginning placed at 29.84 from the ſurface of the mercury in the ſaucer.

The pounded ice was now removed, and the lamp placed at a conſiderable diſtance below the veſſel, ſo as to warm its contents very ſlowly. Theſe obſervations being very eaſily made, were ſeveral times repeated, and their mean reſults are ſet down in the following table: Only obſerve, that it was found difficult to note down the deſcents for every fifth degree, becauſe they ſucceeded each other ſo faſt. Every 10th was judged ſufficient for eſtabliſhing the law of variation. The firſt column of the table contains the temperature, and the ſecond the deſcent (in inches) of the mercury from the mark 29.84.

32°	☿
40	0.1
50	0.2
60	0.35
70	0.55
80	0.82
90	1.18
100	1.61
110	2.25
120	3.00
130	3.95
140	5.15
150	6.72
160	8.65
170	11.05
180	14.05
190	17.85
200	22.62
210	28.65

Four or five numbers at the top of the column of elaſticities are not ſo accurate as the others, becauſe the mercury paſſed pretty quickly through theſe points. But the progreſs was extremely regular through the remaining points; ſo that the elaſticities correſponding to temperatures above 70° may be conſidered as very accurately aſcertained.

Not being altogether ſatisfied with the method employed for meaſuring the elaſticity in temperatures above that of boiling water, a better form of experiment was adopted. (Indeed it was the want of other apparatus which made it neceſſary to employ the former). A glaſs tube was procured of the form repreſented in fig. 3. having a little ciſtern L, from the top and bottom of which proceeded the ſyphons K and MN. The ciſtern contained mercury, and the tube MN was of a ſlender bore, and was about ſix feet two inches long. The end K was firmly fixed in the third hole of the lid, and the long leg of the ſyphon was furniſhed with a ſcale of inches, and firmly faſtened to an upright poſt.

Fig. 3.

The lamp was now applied at ſuch a diſtance from the veſſel as to warm it ſlowly, and make the water boil, the ſteam eſcaping for ſome time through the ſafety-valve. A heavy weight was then ſuſpended on the ſteelyard; ſuch as it was known that the veſſel would ſupport, and at the ſame time, ſuch as would not allow the ſteam to force the mercury out of the long tube. The thermometer began immediately to riſe, as alſo the mercury

mercury in the tube MN. Their correſpondent ſtations are marked in the following table:

Temperature.	*Elaſticity.*
212°	0.0
220	5.9
230	14.6
240	25.0
250	36.9
260	50.4
270	64.2
280	106.0

This form of the experiment is much more ſuſceptible of accuracy than the other, and the meaſures of elaſticity are more to be depended on. In repeating the experiment, they were found much more conſtant; whereas, in the former method, differences occurred of two inches and upwards.

We may now connect the two ſets of experiments into one table, by adding to the numbers in this laſt table the conſtant height 29.9, which was the height of the mercury in the barometer during the laſt ſet of obſervations.

Temperature.	*Elaſticity.*
32°	0.0
40	0.1
50	0.1
60	0.35
70	0.55
80	0.82
90	1.25
100	1.6
110	2.25
120	3.0
130	3.95
140	5.15
150	6.72
160	8.65
170	11.05
180	14.05
190	17.85
200	22.62
210	28.65
220	35.8
230	44.7
240	54.9
250	66.8
260	80.3
270	94.1
280	105.9

23
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hard.

In the memoirs of the Royal Academy of Berlin for 1782, there is an account of ſome experiments made by Mr Achard on the elaſtie force of ſteam, from the temperature 32° to 212°. They agree extremely well with thoſe mentioned here, rarely differing more than two or three tenths of an inch. He alſo examined the elaſticity of the vapour produced from alcohol, and found, that when the elaſticity was equal to that of the vapour of water, the temperature was about 35° lower. Thus, when the elaſticity of both was meaſured by 28.1 inches of mercury, the temperature of the watery vapour was 209°, and that of the ſpirituous vapour was 173°. When the elaſticity was 18.5, the temperature of the water was 189.5, and that of the alcohol 154.6. When the elaſticity was 11.05, the water was 168°, and the alcohol 134°.4. Obſerving the difference between the temperatures of equally elaſtic vapours of water and alcohol not to be conſtant, but gradually to diminiſh, in Mr Achard's experiments, along with the elaſticity, it became intereſting to diſcover whether and at what temperature this difference would vaniſh altogether. Experiments were accordingly made by the writer of this article, ſimilar to thoſe made with water. They were not made with the ſame ſcrupulous care, nor repeated as they deſerved, but they furniſhed rather an unexpected reſult. The following table will give the reader a diſtinct notion of them:

Temperature.	*Elaſticity.*
32°	0.0
40	0.1
60	0.8
80	0.8
100	3.9
120	6.9
140	12.2
160	21.3
180	34.
200	52.4
220	78.5
240	115.

24
An unexpected reſult in comparing the temperatures of equally elaſtic vapours of water and alcohol.

We ſay that the reſult was unexpected; for as the natural boiling point ſeemed by former experiments to be in all fluids about 120° or more below their boiling point in the ordinary preſſure of the atmoſphere, it was reaſonable to expect that the temperature at which they ceaſed to emit ſenſibly elaſtic ſteam would have ſome relation to their temperatures when emitting ſteam of any determinate elaſticity. Now as the vapour of alcohol of elaſticity 30 has its temperature about 36° lower than the temperature of water equally elaſtic, it was to be expected that the temperature at which it ceaſed to be ſenſibly affected would be ſeveral degrees lower than 32°. It is evident, however, that this is not the caſe. But this is a point that deſerves more attention, becauſe it is cloſely connected with the chemical relation between the element (if ſuch there be) of fire, and the bodies into whoſe compoſition it ſeems to enter as a conſtituent part. What is the temperature 32°, to make it peculiarly connected with elaſticity? It is a temperature aſſumed by us for our own conveniency, on account of the familiarity of water in our experiments. Ether, we know, boils in a temperature far below this, as appears from Dr Cullen's experiments narrated in the Eſſays Phyſical and Literary of Edinburgh. On the faith of former experiments, we may be pretty certain that it will boil in vacuo at the temperature —14°, becauſe in the air it boils at +106°. Therefore we may be certain, that the ſteam or vapour of ether, when of the temperature 32°, will be very ſenſibly elaſtic. Indeed Mr Lavoiſier ſays, that if it be expoſed in an exhauſted receiver in winter, its vapour will ſupport mercury at the height of 10 inches. A ſeries of experiments on this vapour ſimilar to the above would be very inſtructive. We even wiſh that thoſe on alcohol were more carefully repeated. If we draw a curve line, of which the abſciſſa is the line of temperatures, and the ordinates are the correſponding heights of the mercury in theſe experiments on water and alcohol, we ſhall obſerve, that although they both ſenſibly coincide at 32°, and have the abſciſſa for their common tangent, a very ſmall error of obſervation may be the cauſe of this, and the curve which expreſſes the elaſticity of ſpirituous vapour may really interſect the other, and go backwards conſiderably beyond 32°.

25 Theſe experiments give riſe to important reflections.

This range of experiments gives riſe to ſome curious and important reflections. We now ſee that no particular temperature is neceſſary for water aſſuming the form of permanently elaſtic vapour; and that it is highly probable that it aſſumes this form even at the temperature 32°; only its elaſticity is too ſmall to afford us any ſenſible meaſure. It is well known that even ice evaporates (ſee experiments to this purpoſe by Mr Wilſon in the Philoſophical Tranſactions, when a piece of poliſhed metal covered with hoar-froſt became perfectly clear by expoſing it to a dry froſty wind).

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Even mercury evaporates, or is converted into elaſtic vapour, when all external preſſure is removed. The dim film which may frequently be obſerved in the upper part of a barometer which ſtands near a ſtream of air, is found to be ſmall globules of mercury ſticking to the inſide of the tube. They may be ſeen by the help of a magnifying glaſs, and are the beſt teſt of a well made barometer. They will be entirely removed by cauſing the mercury to riſe along the tube. It will lick them all up. They conſiſt of mercury which had evaporated in the void ſpace, and was afterwards condenſed by the cold glaſs. But the elaſticity is too ſmall to occaſion a ſenſible depreſſion of the column, even when conſiderably warmed by a candle.

26 Spontaneous evaporation procured by the diſſolving power of the air.

Many philoſophers accordingly imagine, that ſpontaneous evaporation in low temperatures is produced in this way. But we cannot be of this opinion, and muſt ſtill think that this kind of evaporation is produced by the diſſolving power of the air. When moiſt air is ſuddenly rarefied, there is always a precipitation of water. This is moſt diſtinctly ſeen when we work an air-pump briſkly. A miſt is produced, which we ſee plainly fall to the bottom of the receiver. But by this new doctrine the very contrary ſhould happen, becauſe the tendency of water to appear in the elaſtic form is promoted by removing the external preſſure; and we really imagine that more of it now actually becomes ſimple elaſtic watery vapour. But the miſt or precipitation ſhows incontrovertibly, that there had been a previous ſolution. Solution is performed by forces which act in the way of attraction; or, to expreſs it more ſafely, ſolutions are accompanied by the mutual approaches of the particles of the menſtruum and ſolved: all ſuch tendencies are *obſerved* to increaſe by a diminution of diſtance. Hence it *muſt* follow, that air of double denſity will diſſolve more than twice as much water. Therefore when we ſuddenly rarefy ſaturated air (even though its heat ſhould not diminiſh) ſome water muſt be let go. What may be its quantity we know not; but it *may be more* than what would now become elaſtic by this diminution of ſurrounding preſſure; and it is not unlikely but this may have ſome effect in producing the veſicles which we found it ſo difficult to explain. Theſe may be filled with pure watery vapour, and be floating in a fluid compoſed of water diſſolved in air. An experiment of Fontana's ſeems to put this matter out of doubt. A diſtilling apparatus AB (fig. 4.) was ſo contrived, that the heat was applied above the ſurface of the water in the alembic A. This was done by incloſing it in another veſſel CC, filled with hot water. In the receiver B there was a ſort of barometer D, with an open ciſtern, in order to ſee what preſſure there was on the ſurface of the fluid. While the receiver and alembic contained air, the heat applied at A produced no ſenſible diſtillation during ſeveral hours: But on opening a cock E in the receiver at its bottom, and making the water in the alembic to boil, ſteam was produced which ſoon expelled all the air, and followed it through the cock. The cock was now ſhut, and the whole allowed to grow cold by removing the fire, and applying cold water to the alembic. The barometer fell to a level nearly. Then warm water was allowed to get into the outer veſſel CC. The barometer roſe a little, and the diſtillation went on briſkly without the ſmalleſt ebullition in the alembic. The concluſion is obvious: while there was air in the receiver and communicating pipe, the diſtillation proceeded entirely by the diſſolving power of this air. Above the water in the alembic it was quickly ſaturated; and this ſaturation proceeded ſlowly along the ſtill air in the communicating pipe, and at laſt might take place through the whole of the receiver. The ſides of the receiver being kept cold, ſhould condenſe part of the water diſſolved in the air in contact with them, and this ſhould trickle down the ſides and be collected. But any perſon who has obſerved how long a cryſtal of blue vitriol will lie at the bottom of a glaſs of ſtill water before the tinge will reach the ſurface, will ſee that it muſt be next to impoſſible for diſtillation to go on in theſe circumſtances; and accordingly none was obſerved. But when the upper part of the apparatus was filled with pure watery vapour, it was ſupplied from the alembic as faſt as it was condenſed in the receiver, juſt as in the pulſe glaſs.

Fig. 4.

27 A certai law in th dilatatio aeriform fluids by heat.

Another inference which may be drawn from theſe experiments is, that Nature ſeems to affect a certain law in the dilatation of aeriform fluids by heat. They ſeem to be dilatable nearly in proportion of their preſent dilatation. For if we ſuppoſe that the vapours reſemble air, in having their elaſticity in any given temperature proportional to their denſity, we muſt ſuppoſe that if ſteam of the elaſticity 60, that is, ſupporting 60 inches of mercury, were ſubjected to a preſſure of 30 inches, it would expand into twice its preſent bulk. The augmentation of elaſticity therefore is the meaſure of the bulk into which it would expand in order to acquire its former elaſticity. Taking the increaſe of elaſticity therefore as a meaſure of the bulk into which it would expand under one conſtant preſſure, we ſee that equal increments of temperature produce nearly equal multiplications of bulk. Thus if a certain diminution of temperature diminiſhes its bulk $\frac{1}{4}$th, another equal diminution of temperature will diminiſh this new bulk $\frac{1}{4}$th very nearly. Thus, in our experiments, the temperatures 110°, 140°, 170°, 200°, 230°, are in arithmetical progreſſion, having equal differences; and we ſee that the correſponding elaſticities 2.25, 5.15, 11.05, 22.62, 44.7, are very nearly in the continued proportion of 1 to 2. The elaſticity correſponding to the temperature 260 deviates conſiderably from this law, which would give 88 or 89 inſtead of 80; and the deviation

deviation increaſes in the higher temperatures. But ſtill we ſee that there is a conſiderable approximation to this law; and it will frequently aſſiſt us to recollect, that whatever be the preſent temperature, an increaſe of 30 degrees doubles the elaſticity and the bulk of watery vapour.

That 4°	will increaſe the elaſticity from	1 to $1\frac{1}{10}$
8	- -	1 to $1\frac{1}{5}$
10	- -	1 to $1\frac{1}{4}$
$12\frac{1}{2}$	- -	1 to $1\frac{1}{3}$
18	- -	1 to $1\frac{1}{2}$
22	- -	1 to $1\frac{2}{3}$
24	- -	1 to $1\frac{3}{4}$
26	- -	1 to $1\frac{4}{5}$

This is ſufficiently exact for moſt practical purpoſes. Thus an engineer finds that the injection cools the cylinder of a ſteam engine to 192°. It therefore leaves a ſteam whoſe elaſticity is three-fifths of its full elaſticity, = 18 inches ☿. But it is better at all times to have recourſe to the table. Obſerve, too, that in the lower temperatures, i. e. below 110°, this increment of temperature does more than double the elaſticity.

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This law obtains more remarkably in the incoercible vapours; ſuch as vital air, atmoſpheric air, fixed air, &c. all of which have alſo their elaſticity proportional to their bulk inverſely: and perhaps the deviation from the law in ſteams is connected with their chemical difference of conſtitution. If the bulk were always augmented in the ſame proportion by equal augmentations of temperature, the elaſticities would be accurately repreſented by the ordinates of a logarithmic curve, of which the temperatures are the correſponding abſciſſæ; and we might contrive ſuch a ſcale for our thermometer, that the temperatures would be the common logarithms of the elaſticities, or of the bulks having equal elaſticity; or, with our preſent ſcale, we may find ſuch a multiplier m for the number x of degrees of our thermometer (above that temperature where the elaſticity is equal to unity), that this multiple ſhall be the common logarithm of the elaſticity y; ſo that $mx = \log. y$.

But our experiments are not ſufficiently accurate for determining the temperature where the elaſticity is meaſured by 1 inch; becauſe in theſe temperatures the elaſticities vary by exceedingly ſmall quantities. But if we take 11.04 for the unit of elaſticity, and number our temperature from 170°, and make $m=0.010035$, we ſhall find the product mx to be very nearly the logarithm of the elaſticity. The deviations, however, from this law, are too great to make this equation of any uſe. But it is very practicable to frame an equation which ſhall correſpond with the experiments to any degree of accuracy; and it has been done for air in a tranſlation of General Roy's Meaſurement of the Baſe at Hounſlow Heath into French by Mr Prony. It is as follows: Let x be the degrees of Reaumur's thermometer; let y be the expanſion of 10,000 parts of air; let e be $= 10$, $m = 2.7979$, $n = 0.01768$: then $y=e^{m+nx}-627.5$. Now e being $=10$, it is plain that e^{m+nx} is the number, of which $m+nx$ is the common logarithm. This formula is very exact as far as the temperature 60°: but beyond this it needs a correction; becauſe air, like the vapour of water, does not expand in the exact proportion of its bulk.

29
And is conſiderably approximated to in the augmentation of the bulk or elaſticity of elaſtic vapours.

We obſerve this law conſiderably approximated to in the augmentation of the bulk or elaſticity of elaſtic vapours; that is, it is a fact that a given increment of temperature makes very nearly the ſame proportional augmentation of bulk and elaſticity. This gives us ſome notion of the manner in which the ſuppoſed expanding cauſe produces the effect. When vapour of the bulk 4 is expanded into a bulk 5 by an addition of 10 degrees of ſenſible heat, a certain quantity of fire goes into it, and is accumulated round each particle, in ſuch a manner that the temperature of each, which formerly was m, is now $m+10$. Let it now receive another equal augmentation of temperature. This is now $m+20$, and the bulk is $\frac{5\times5}{4}$ or $6\frac{1}{4}$, and the arithmetical increaſe of bulk is $1\frac{1}{4}$. The abſolute quantity of fire which has entered it is greater than the former, both on account of the greater augmentation of ſpace and the greater temperature. Conſequently if this vapour be compreſſed into the bulk 5, there muſt be heat or fire in it which is not neceſſary for the temperature $m+20$, far leſs for the temperature $m+10$. It muſt therefore emerge, and be diſpoſed to enter a thermometer which has already the temperature $m+20$: that is, the vapour muſt grow hotter by compreſſion; not by ſqueezing out the heat, like water out of a ſponge, but becauſe the law of attraction for heat is deranged. It would be a very valuable acquiſition to our knowledge to learn with preciſion the quantity of ſenſible heat produced in this way; but no ſatisfactory experiments have yet been made. M. Lavoiſier, with his chemical friends and colleagues, were buſily employed in this inquiry: but the wickedneſs of their countrymen deprived the world of this and many other important additions which we might have expected from this celebrated and unfortunate philoſopher. He had made, in conjunction with M. de la Place, a numerous train of accurate and expenſive experiments for meaſuring the quantity of latent or combined heat in elaſtic vapours. This is evidently a very important point to the diſtiller and practical chemiſt. This heat muſt all come from the fuel; and it is greatly worth while to know whether any ſaving may be made of this article. Thus we know that diſtillation will go on either under the preſſure of the air, or in an alembic and receiver from which the air has been expelled by ſteam; and we know that this laſt may be conducted in a very low temperature, even not exceeding that of the human body. But it is uncertain whether this may not employ even a greater quantity of fuel, as well as occaſion a great expence of time. We are diſpoſed to think, that when there is no air in the apparatus, and when the condenſation can be ſpeedily performed, the proportion of fuel expended to the fluid which comes over will diminiſh continually as the heat, and conſequently the denſity of the ſteam, is augmented; becauſe in this caſe the quantity of combined heat muſt be leſs. In the mean time, we earneſtly recommend the trial of this mode of diſtillation in veſſels cleared of air. It is undoubtedly of great advantage to be able to work with ſmaller fires; and it would ſecure us againſt all accidents of blowing off

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the head of the ſtill, often attended with terrible conſequences (B).

We muſt not conclude this article without taking notice of ſome natural phenomena which ſeem to owe their origin to the action of elaſtic ſteam.

We have already taken notice of the reſemblance of the tremor and ſucceſſions obſerved in the ſhocks of many earthquakes to thoſe which may be felt in a veſſel where water is made to boil internally, while the breaking out of the ebullition is ſtifled by the cold of the upper parts; and we have likewiſe ſtated the objections which are uſually made to this theory of earthquakes. We may perhaps reſume the ſubject under the article VOLCANO; but in the mean time we do not heſitate to ſay, that the wonderful appearances of the Geyzer ſpring in Iceland (ſee HUER; and ICELAND, N° 3—5.) are undoubtedly produced by the expanſion of ſteam in ignited caverns. Of theſe appearances we ſuppoſe the whole train to be produced as follows.

30
Explanation of the phenomena of the Geyzer ſpring in Iceland by the force of ſteam.
Fig. 5.

A cavern may be ſuppoſed of a ſhape analogous to CBDEF (fig. 5.), having a perpendicular funnel AB iſſuing from a depreſſed part of the roof. The part F may be lower than the reſt, remote, and red hot. Such places we know to be frequent in Iceland. Water may be continually trickling into the part CD. It will fill it up to B, and even up to E *e*, and then trickle ſlowly along into F. As ſoon as any gets into contact with an ignited part, it expands into elaſtic ſteam, and is partly condenſed by the cold ſides of the cavern, which it gradually warms, till it condenſes no more. This production of ſteam hinders not in the ſmalleſt degree the trickling of more water into F, and the continual production of more ſteam. This now preſſes on the ſurface of the water in CD, and cauſes it to riſe gradually in the funnel BA; but ſlowly, becauſe its cold ſurface is condenſing an immenſe quantity of ſteam. We may eaſily ſuppoſe that the water trickles faſter into F than it is expended in the production of ſteam; ſo that it reaches farther into the ignited part, and may even fall in a ſtream into ſome deeper pit highly ignited. It will now produce ſteam in vaſt abundance, and of prodigious elaſticity; and at once puſh up the water through the funnel in a ſolid jet, and to a great height. This muſt continue till the ſurface of the water ſinks to BD. If the lower end of the funnel have any inequalities or notches, as is moſt likely, the ſteam will get admiſſion along with the water, which in this particular place is boiling hot, being ſuperficial, and will get to the mouth of the funnel, while water is ſtill preſſed in below. At laſt the ſteam gets in at B on all ſides; and as it is converging to B, along the ſurface of the water, with prodigious velocity it ſweeps along with it much water, and blows it up through the funnel with great force. When this is over, the remaining ſteam blows out unmixed with water, growing weaker as it is expended, till the bottom of the funnel is again ſtopped by the water increaſing in the cavern CBD. All the phenomena above ground are perfectly conformable to the neceſſary conſequences of this very probable conſtruction of the cavern. The feeling of being lifted up, immediately before the jet, in all probability is owing to a real heaving up of the whole roof of the cavern by the firſt expanſion of the great body of ſteam. We had an accurate deſcription of the phenomena from perſons well qualified to judge of theſe matters who viſited theſe celebrated ſprings in 1789.

STEAM-Engine, is the name of a machine which derives its moving power from the elaſticity and condenſibility of the ſteam of boiling water. It is the moſt valuable preſent which the arts of life have ever received from the philoſopher. The mariner's compaſs, the teleſcope, gunpowder, and other moſt uſeful ſervants to human weakneſs and ingenuity, were the productions of chance, and we do not exactly know to whom we are indebted for them; but the ſteam-engine was, in the very beginning, the reſult of reflection, and the production of a very ingenious mind; and every improvement it has received, and every alteration in its conſtruction and principles, were alſo the reſults of philoſophical ſtudy.

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The ſteam-engine was beyond all doubt invented by the marquis of Worceſter during the reign of Charles II. This nobleman publiſhed in 1663 a ſmall book entitled A CENTURY OF INVENTIONS; giving ſome obſcure and enigmatical account of a hundred diſcoveries or contrivances of his own, which he extols as of great importance to the public. He appears to have been a perſon of much knowledge and great ingenuity: but his deſcription or accounts of theſe inventions ſeem not ſo much intended to inſtruct the public, as to raiſe wonder; and his encomiums on their utility and importance

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(B) We earneſtly recommend this ſubject to the conſideration of the philoſopher. The laws which regulate the formation of elaſtic vapour, or the general phenomena which it exhibits, give us that link which connects chemiſtry with mechanical philoſophy. Here we ſee chemical affinities and mechanical forces ſet in immediate oppoſition to each other, and the one made the indication, characteriſtic, and meaſure of the other. We have not the leaſt doubt that they make but one ſcience, the Science of Univerſal Mechanics; nor do we deſpair of ſeeing the phenomena of ſolution, precipitation, cryſtallization, fermentation, nay animal and vegetable ſecretion and aſſimilation, ſucceſsfully inveſtigated, as caſes of local motion, and explained by the agency of central forces. Some thing of this kind, and that not inconſiderable, was done when Dr Cullen firſt ſhowed how the double affinities might be illuſtrated by the aſſiſtance of numbers. Dr Black gave to this hint (for it was little more) that elegant preciſion which characterizes all his views. Mr Kirwan has greatly promoted this ſtudy by his numerous and ingenious examples of its application; and the moſt valuable paſſages of the writings of Mr Lavoiſier, are thoſe where he traces with logical preciſion the balancings of force which appear in the chemical phenomena. It is from the ſimilar balancings and conſequent meaſurements, which may be obſerved and obtained in the preſent caſe, that we are to hope for admiſſion into this almoſt unbounded ſcience of contemplation. We have another link equally intereſting and promiſing, viz. the production of heat by friction. This alſo highly deſerves the conſideration of the mathematical philoſopher.

ance are to a great degree extravagant, reſembling more the puff of an advertiſing tradeſman than the patriotic communications of a gentleman. The marquis of Worceſter was indeed a projector, and very importunate and myſterious withal in his applications for public encouragement. His account, however, of the ſteam-engine, although by no means fit to give us any diſtinct notions of its ſtructure and operation, is exact as far as it goes, agreeing preciſely with what we now know of the ſubject. It is N° 68. of his inventions. His words are as follow: "This admirable method which I propoſe of raiſing water by the force of fire has no bounds if the veſſels be ſtrong enough: for I have taken a cannon, and having filled it three-fourths full of water, and ſhut up its muzzle and touch-hole, and expoſed it to the fire for 24 hours, it burſt with a great exploſion. Having afterwards diſcovered a method of fortifying veſſels internally, and combined them in ſuch a way that they filled and acted alternately, I have made the water ſpout in an uninterrupted ſtream 40 feet high; and one veſſel of rarefied water raiſed 40 of cold water. The perſon who conducted the operation had nothing to do but turn two cocks; ſo that one veſſel of water being conſumed, another begins to force, and then to fill itſelf with cold water, and ſo on in ſucceſſion."

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But firſt reduced to practice by Captain Savary.

It does not appear that the noble inventor could ever intereſt the public by theſe accounts. His character as a projector, and the many failures which perſons of this turn of mind daily experience, probably prejudiced people againſt him, and prevented all attention to his projects. It was not till towards the end of the century, when experimental philoſophy was proſecuted all over Europe with uncommon ardour, that theſe notions again engaged attention. Captain Savary, a perſon alſo of great ingenuity and ardent mind, ſaw the reality and practicability of the marquis of Worceſter's project. He knew the great expanſive power of ſteam, and had diſcovered the inconceivable rapidity with which it is reconverted into water by cold; and he ſoon contrived a machine for raiſing water, in which both of theſe properties were employed. He ſays, that it was entirely his own invention. Dr Deſaguiliers inſiſts that he only copied the marquis's invention, and charges him with groſs plagiariſm, and with having bought up and burned the copies of the marquis's book, in order to ſecure the honour of the diſcovery to himſelf. This is a very grievous charge, and ſhould have been ſubſtantiated by very diſtinct evidence. Deſaguiliers produces none ſuch; and he was much too late to know what happened at that time. The argument which he gives is a very fooliſh one, and gave him no title to conſider Savary's experiment as a falſehood; for it might have happened preciſely as Savary relates, and not as it happened to Deſaguiliers. The fact is, that Savary obtained his patent of invention after a hearing of objections, among which the diſcovery of the marquis of Worceſter was not mentioned: and it is certain that the account given in the Century of Inventions could inſtruct no perſon who was not ſufficiently acquainted with the properties of ſteam to be able to invent the machine himſelf.

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Captain Savary obtained his patent *after having actually erected* ſeveral machines, of which he gave a deſcription in a book intitled THE MINER'S FRIEND, publiſhed in 1696, and in another work publiſhed in 1699. Much about this time Dr Papin, a Frenchman and fellow of the Royal Society, invented a method of diſſolving bones and other animal ſolids in water, by confining them in cloſe veſſels, which he called DIGESTERS, ſo as to acquire a great degree of heat. For it muſt be obſerved in this place, that it had been diſcovered long before (in 1684) by Dr Hooke, the moſt inquiſitive experimental philoſopher of that inquiſitive age, that water could not be made to acquire above a certain temperature in the open air; and that as ſoon as it begins to boil, its temperature remains fixed, and an increaſe of heat only produces a more violent ebullition, and a more rapid waſte. But Papin's experiments made the elaſtic power of ſteam very familiar to him: and when he left England and ſettled as profeſſor of mathematics at Marpurgh, he made many awkward attempts to employ this force in mechanics, and even for raiſing water. It appears that he had made experiments with this view in 1698, by order of Charles, landgrave of Heſſe. For this reaſon the French affect to conſider him as the inventor of the ſteam-engine. He indeed publiſhed ſome account of his invention in 1707; but he acknowledges that Captain Savary had alſo, and without any communication with him, invented the ſame thing. Whoever will take the trouble of looking at the deſcription which he has given of theſe inventions, which are to be ſeen in the *Acta Eruditorum Lipſiæ*, and in Leupold's *Theatrum Machinarum*, will ſee that they are moſt awkward, abſurd, and impracticable. His conceptions of natural operations were always vague and imperfect, and he was neither philoſopher nor mechanician.

We are thus anxious about the claim of thoſe gentlemen, becauſe a moſt reſpectable French author, Mr Boſſut, ſays in his *Hydrodynamique*, that the firſt notion of the ſteam-engine was *certainly* owing to Dr Papin, who had not only invented the digeſter, but had in 1695 publiſhed a little performance deſcribing a machine for raiſing water, in which the piſtons are moved by the vapour of boiling water alternately dilated and condenſed. Now the fact is, that Papin's firſt publication was in 1707, and his piſton is nothing more than a floater on the ſurface of the water, to prevent the waſte of ſteam by condenſation; and the return of the piſton is not produced, as in the ſteam engine, by the condenſation of the ſteam, but by admitting the air and a column of water to preſs it back into its place. The whole contrivance is ſo awkward, and ſo unlike any diſtinct notions of the ſubject, that it cannot do credit to any perſon. We may add, that much about the ſame time Mr Amontons contrived a very ingenious but intricate machine, which he called a *fire-wheel*. It conſiſted of a number of buckets placed in the circumference of a wheel, and communicating with each other by very intricate circuitous paſſages. One part of this circumference was expoſed to the heat of a furnace, and another to a ſtream or ciſtern of cold water. The communications were ſo diſpoſed, that the ſteam produced in the buckets on one ſide of the wheel drove the water into buckets on the other ſide, ſo that one ſide of the wheel was always much heavier than the other; and it muſt therefore turn round, and may execute ſome work. The death of the inventor, and the intricacy of the machine, cauſed it to be neglected. Another member of the Pariſian academy of ſciences (Mr Deſlandes) alſo preſented to the academy a project of a ſteam-wheel, where the impulſive force of the va-

Mr Amonton's fire-wheel.

pour was employed ; but it met with no encouragement. The Engliſh engineers had by this time ſo much improved Savary's firſt invention that it ſupplanted all others. We have therefore no heſitation in giving the honour of the firſt and complete invention to the marquis of Worceſter ; and we are not diſpoſed to refuſe Captain Savary's claim to originality as to the conſtruction of the machine, and even think it probable that his own experiments made him ſee the whole independent of the marquis's account.

Captain Savary's engine, as improved and ſimplified by himſelf is as follows.

5 Captain Savary's ſteam-engine deſcribed. Fig. 6.

A (fig. 6.) repreſents a ſtrong copper boiler properly built up in a furnace. There proceeds from its top a large ſteam-pipe B, which enters into the top of another ſtrong veſſel R called the RECEIVER. This pipe has a COCK at C called the STEAM COCK. In the bottom of the receiver is a pipe F, which communicates ſidewiſe with the riſing pipe KGH. The lower end H of this pipe is immerſed in the water of the pit or well, and its upper part K opens into the ciſtern into which the water is to be delivered. Immediately below the pipe of communication F there is a valve G, opening when preſſed from below, and ſhutting when preſſed downwards. A ſimilar valve is placed at I, immediately above the pipe of communication. Laſtly, there is a pipe ED which branches off from the riſing pipe, and enters into the top of the receiver. This pipe has a cock D called the INJECTION-COCK. The mouth of the pipe ED has a nozzle *f* pierced with ſmall holes, pointing from a centre in every direction. The keys of the two cocks C and D are united, and the handle *g h* is called the REGULATOR.

Let the regulator be ſo placed that the ſteam-cock C is open and the injection-cock D is ſhut; put water into the boiler A, and make it boil ſtrongly. The ſteam coming from it will enter the receiver, and gradually warm it, much ſteam being condenſed in producing this effect. When it has been warmed ſo as to condenſe no more, the ſteam proceeds into the riſing pipe; the valve G remains ſhut by its weight ; the ſteam lifts the valve I, and gets into the riſing pipe, and gradually warms it. When the workman feels this to be the caſe, or hears the rattling of the valve I, he immediately turns the ſteam-cock ſo as to ſhut it, the injection-cock ſtill remaining ſhut (at leaſt we may ſuppoſe this for the preſent). The apparatus muſt now cool, and the ſteam in the receiver collapſes into water. There is nothing now to balance the preſſure of the atmoſphere ; the valve I remains ſhut by its weight ; but the air incumbent on the water in the pit preſſes up this water through the ſuction-pipe HG, and cauſes it to lift the valve G, and flow into the receiver R, and fill it to the top, if not more than 20 or 25 feet above the ſurface of the pit water.

The ſteam cock is now opened. The ſteam which, during the cooling of the receiver, has been accumulating in the boiler, and acquiring a great elaſticity by the action of the fire, now ruſhes in with great violence, and, preſſing on the ſurface of the water in the receiver, cauſes it to ſhut the valve G and open the valve I by its weight alone, and it now flows into the riſing pipe, and would ſtand on a level if the elaſticity of the ſteam were no more than what would balance the atmoſpherical preſſure. But it is much more than this, and therefore it *preſſes* the water out of the receiver into the riſing pipe, and will even cauſe it to come out at K, if the elaſticity of the ſteam is ſufficiently great. In order to enſure this, the boiler has another pipe in its top, covered with a *ſafety*-valve V, which is kept down by a weight W ſuſpended on a ſteelyard LM. This weight is ſo adjuſted that its preſſure on the ſafety-valve is ſomewhat greater than the preſſure of a column of water V *k* as high as the point of diſcharge K. The fire is ſo regulated that the ſteam is always iſſuing a little by the the loaded valve V. The workman keeps the ſteam-valve open till he hears the valve I rattle. This tells him that the water is all forced out of the receiver, and that the ſteam is now following it. He immediately turns the regulator which turns the ſteam-cock, and now, for the firſt time, opens the injection-cock. The cold water trickles at firſt through the holes of the nozzle *f*, and falling down through the ſteam, begins to condenſe it ; and then its elaſticity being leſs than the preſſure of the water in the pipe KED*f*, the cold water ſpouts in all directions through the nozzle, and, quick as thought, produces a complete condenſation. The valve G now opens again by the preſſure of the atmoſphere on the water of the pit, and the receiver is ſoon filled with cold water. The injection-cock is now ſhut, and the ſteam-cock opened, and the whole operation is now repeated ; and ſo on continually.

This is the ſimple account of the proceſs, and will ſerve to give the reader an introductory notion of the operation ; but a more minute attention muſt be paid to many particulars before we can ſee the properties and defects of this ingenious machine.

6 Defects of this machine ſuch

The water is driven along the riſing pipe by the elaſticity of the ſteam. This muſt in the boiler, and every part of the machine, exert a preſſure on every ſquare inch of the veſſels equal to that of the upright column of water. Suppoſe the water to be raiſed 100 feet, about 25 of this may be done in the ſuction-pipe ; that is, the upper part of the receiver may be about 25 feet above the ſurface of the pit-water. The remaining 75 muſt be done by forcing, and every ſquare inch of the boiler will be ſqueezed out by a preſſure of more than 30 pounds. This very moderate height therefore requires very ſtrong veſſels ; and the marquis of Worceſter was well aware of the danger of their burſting. A copper boiler of ſix feet diameter muſt be nine-tenths of an inch thick to be juſt in equilibrio with this preſſure : and the ſoldered joint will not be able to withſtand it, eſpecially in the high temperature to which the water muſt be heated in order to produce ſteam of ſufficient elaſticity. By conſulting the table of the elaſticity of ſteam deduced from our experiments mentioned in the preceding article, we ſee that this temperature muſt be at leaſt 280° of Fahrenheit's thermometer. In this heat ſoft ſolder is juſt ready to melt, and has no tenacity ; even ſpelter ſolder is conſiderably weakened by it. Accordingly, in a machine erected by Dr Deſaguiliers, the workman having loaded the ſafety-valve a little more than uſual to make the engine work more briſkly, the boiler burſt with a dreadful exploſion, and blew up the furnace and adjoining parts of the building as if it had been gunpowder. Mr Savary ſucceeded pretty well in raiſing moderate quantities of water to ſmall heights, but could make nothing of deep mines. Many attempts were made, on the marquis's principle, to ſtrengthen the veſſels from within by radiated bars and by hoops, but in vain. Very ſmall boilers or evaporators were then tried, kept red hot, or nearly ſo, and ſupplied with a ſlender ſtream of water trickling into them; but this afforded no opportunity of making a collection of ſteam during the refrigeration of the receiver, ſo as to have a magazine of ſteam in readineſs for the next forcing operation; and the working of ſuch machines was always an employment of great danger and anxiety.

7 that it can be employed with advantage only in certain ſituations.

The only ſituation in which this machine could be employed with perfect ſafety, and with ſome effect, was where the whole lift did not exceed 30 or 35 feet. In this caſe the greateſt part of it was performed by the ſuction-pipe, and a very manageable preſſure was ſufficient for the reſt. Several machines of this kind were erected in England about the beginning of this century. A very large one was erected at a ſalt-work in the ſouth of France. Here the water was to be raiſed no more than 18 feet. The receiver was capacious, and it was occaſionally ſupplied with ſteam from a ſmall ſalt-pan conſtructed on purpoſe with a cover. The entry of the ſteam into the receiver merely allowed the water to run out of it by a large valve, which was opened by the hand, and the condenſation was produced by the help of a ſmall forcing pump alſo worked by the hand. In ſo particular a ſituation as this (and many ſuch may occur in the endleſs variety of human wants), this is a very powerful engine; and having few moving and rubbing parts, it muſt be of great durability. This circumſtance has occaſioned much attention to be given to this firſt form of the engine, even long after it was ſupplanted by thoſe of a much better conſtruction. A very ingenious attempt was made very lately to adopt this conſtruction to the uſes of the miners. The whole depth of the pit was divided into lifts of 15 feet, in the ſame manner as is frequently done in pump-machines. In each of theſe was a ſuction-pipe 14 feet long, having above it a ſmall receiver like R, about a foot high, and its capacity ſomewhat greater than that of the pipe. This receiver had a valve at the head of the ſuction-pipe, and another opening outwards into the little ciſtern, into which the next ſuction-pipe above dipped to take in water. Each of theſe receivers ſent up a pipe from its top, which all met in the cover of a large veſſel above ground, which was of double the capacity of all the receivers and pipes. This veſſel was cloſe on all ſides. Another veſſel of equal capacity was placed immediately above it, with a pipe from its bottom paſſing through the cover of the lower veſſel and reaching near to its bottom. This upper veſſel communicates with the boiler, and conſtitutes the receiver of the ſteam-engine. The operation is as follows: The lower veſſel is full of water. Steam is admitted into the upper veſſel, which expels the air by a valve, and fills the veſſel. It is then condenſed by cold water. The preſſure of the atmoſphere would cauſe it to enter by all the ſuction-pipes of the different lifts, and preſs on the ſurface of the water in the lower receiver, and force it into the upper one. But becauſe each ſuction-pipe dips in a ciſtern of water, the air preſſes this water before it, raiſes it into each of the little receivers which it fills, and allows the ſpring of the air (which was formerly in them, but which now paſſes up into the lower receiver) to force the water out of the lower receiver into the upper one. When this has been completed, the ſteam is again admitted into the upper receiver. This allows the water to run back into the lower receiver, and the air returns into the ſmall receivers in the pit, and allows the water to run out of each into its proper ciſtern. By this means the water of each pipe has been raiſed 15 feet. The operation may thus be repeated continually.

The contrivance is ingenious, and ſimilar to thoſe which are to be met with in the hydraulics of Schottus, Sturmius, and other German writers. But the operation muſt be exceedingly ſlow; and we imagine that the expence of ſteam muſt be great, becauſe it muſt fill a very large and very cold veſſel, which muſt waſte a great portion of it by condenſation. We ſee by ſome late publications of the very ingenious Mr Blackey, that he is ſtill attempting to maintain the reputation of this machine by ſome contrivances of this kind; but we imagine that they will be ineffectual, except in ſome very particular ſituations.

8 Occaſions great waſte of ſteam and fuel.

For the great defect of the machine, even when we can ſecure it againſt all riſk of burſting, is the prodigious waſte of ſteam, and conſequently of fuel. Daily experience ſhows, that a few ſcattered drops of cold water are ſufficient for producing an almoſt inſtantaneous condenſation of a great quantity of ſteam. Therefore when the ſteam is admitted into the receiver of Savary's engine, and comes into contact with the cold top and cold water, it is condenſed with great rapidity; and the water does not *begin* to ſubſide till its ſurface has become ſo hot that it condenſes no more ſteam. It may now begin to yield to the preſſure of the incumbent ſteam; but as ſoon as it deſcends a little, more of the cold ſurface of the receiver comes into contact with the ſteam, and condenſes more of it, and the water can deſcend no farther till this addition of cold ſurface is heated up to the ſtate of evaporation. This rapid condenſation goes on all the while the water is deſcending. By ſome experiments frequently repeated by the writer of this article, it appears that no leſs than $\frac{11}{12}$ths of the whole ſteam is uſeleſsly condenſed in this manner, and not more than $\frac{1}{12}$th is employed in allowing the water to deſcend by its own weight; and he has reaſon to think that the portion thus waſted will be conſiderably greater, if the ſteam be employed to *force* the water out of the receiver to any conſiderable height.

Obſerve, too, that all this waſte muſt be repeated in every ſucceeding ſtroke; for the whole receiver muſt be cooled again in order to fill itſelf with water.

9 The attempts made to diminiſh this waſte unſucceſsful.

Many attempts have been made to diminiſh this waſte; but all to little purpoſe, becauſe the very filling of the receiver with cold water occaſions its ſides to condenſe a prodigious quantity of ſteam in the ſucceeding ſtroke. Mr Blackey has attempted to leſſen this by uſing two receivers. In the firſt was oil; and into this only the ſteam was admitted. This oil paſſed to and fro between the two receivers, and never touched the water except in a ſmall ſurface. But this hardly produced a ſenſible diminution of the waſte: for it muſt now be obſerved, that there is a neceſſity for the firſt cylinder's being cooled to a conſiderable degree below the boiling point; otherwiſe, though it will condenſe much ſteam, and allow the water to riſe into the receiver, there will be a great diminution of the height of ſuction, unleſs the veſſel be much cooled. This appears plainly by inſpecting the table of elaſticity. Thus, if the veſſel be cooled no lower than 180°, we ſhould loſe one half of the preſſure of the atmoſphere; if cooled to 120, we ſhould ſtill loſe $\frac{1}{10}$th. The inſpection of this table is of great uſe for underſtanding and improving this noble machine; and without a conſtant recollection of the elaſticity of ſteam correſponding to its actual heat, we ſhall never have a notion of the niceties of its operation.

10
The aſtoniſhing rapidity with which ſteam is condenſed.

The rapidity with which the ſteam is condenſed is really aſtoniſhing. Experiments have been made on ſteam-veſſels of ſix feet in diameter and ſeven feet high; and it has been found, that about four ounces of water, as warm as the human blood, will produce a complete condenſation in leſs than a ſecond; that is, will produce all the condenſation that it is capable of producing, leaving an elaſticity about one-fifth of the elaſticity of the air. In another experiment with the ſame ſteam-veſſel, no cold water was allowed to get into it, but it was made to communicate by a long pipe four inches in diameter with another veſſel immerſed in cold water. The condenſation was ſo rapid that the time could not be meaſured: it certainly did not exceed half a ſecond. Now this condenſation was performed by a very trifling ſurface of contact. Perhaps we may explain it a little in this way: When a maſs of ſteam, in immediate contact with the cold water, is condenſed, it leaves a void, into which the adjoining ſteam inſtantly expands; and by this very expanſion its capacity for heat is increaſed, or it grows cold, that is, abſtracts the heat from the ſteam ſituated immediately beyond it. And in this expanſion and refrigeration it is itſelf partly condenſed or converted into water, and leaves a void, into which the circumjacent ſteam immediately expands, and produces the ſame effect on the ſteam beyond it. And thus it may happen that the abſtraction of a ſmall quantity of heat from an inconſiderable maſs of ſteam may produce a condenſation which may be very extenſive. Did we know the change made in the capacity of ſteam for heat by a given change of bulk, we ſhould be able to tell exactly what would be the effect of this local actual condenſation. But experiment has not as yet given us any preciſe notions on this ſubject. We think that this rapid condenſation to a great diſtance by a very moderate actual abſtraction of heat is a proof that the capacity of ſteam for heat is prodigiouſly increaſed by expanſion. We ſay a *very moderate actual abſtraction* of heat, becauſe very little heat is neceſſary to raiſe four ounces of blood-warm water to a boiling temperature, which will unfit it for condenſing ſteam. The remarkable phenomenon of ſnow and ice produced in the Hungarian machine, when the air condenſed in the receiver is allowed to blow through the cock (ſee PNEUMATICS), ſhows this to be the caſe in moiſt air, that is, in air holding water in a ſtate of chemical ſolution. We ſee ſomething very like it in a thunder-ſtorm. A ſmall black cloud ſometimes appears in a particular ſpot, and in a very few ſeconds ſpreads over many hundred acres of ſky, that is, a precipitation of water goes on with that rapid diffuſion. We imagine that this increaſe of capacity or demand for heat, and the condenſation that muſt enſue if this demand is not ſupplied, is much more remarkable in pure watery vapours, and that this is a capital diſtinction of their conſtitution from vapours diſſolved in air (A).

The reader muſt now be ſo well acquainted with what paſſes in the ſteam-veſſel, and with the exterior reſults from it, as readily to comprehend the propriety of the changes which we ſhall now deſcribe as having been made in the conſtruction and principle of the ſteam engine.

11
Attempts to improve the ſteam-engine.

Of all places in England the tin-mines of Cornwall ſtood moſt in need of hydraulic aſſiſtance; and Mr Savary was much engaged in projects for draining them by his ſteam-engine. This made its conſtruction and principles well known among the machiniſts and engineers of that neighbourhood. Among theſe were a Mr Newcomen, an ironmonger or blackſmith, and Mr Cawley a glazier at Dartmouth in Devonſhire, who had dabbled much with this machine. Newcomen was a perſon of ſome reading, and was in particular acquainted with the perſon, writings, and projects of his countryman Dr Hooke. There are to be found among Hooke's papers, in the poſſeſſion of the Royal Society, ſome notes of obſervations, for the uſe of Newcomen his countryman, on Papin's boaſted method of tranſmitting to a great diſtance the action of a mill by means of pipes. Papin's project was to employ the mill to work two air-pumps of great diameter. The cylinders of theſe pumps were to communicate by means of pipes with equal cylinders furniſhed with piſtons, in the neighbourhood of a diſtant mine. Theſe piſtons were to be connected, by means of levers, with the piſton-rods of the mine. Therefore, when the piſton of the air-pump at the mill was drawn up by the mill, the correſponding piſton at the ſide of the mine would be preſſed down by the atmoſphere, and thus would raiſe the piſton-rod in the mine, and draw the water. It would appear from theſe notes, that Dr Hooke had diſſuaded Mr Newcomen from erecting a machine on this principle, of which he had expoſed the fallacy in ſeveral diſcourſes before the Royal Society. One paſſage is remarkable. "Could he (meaning Papin) make a ſpeedy vacuum under your ſecond piſton, your work is done."

It is highly probable that, in the courſe of this ſpeculation, it occurred to Mr Newcomen that the vacuum he ſo much wanted might be produced by ſteam, and that this gave riſe to his new principle and conſtruction of the ſteam-engine. The ſpecific deſideratum was in Newcomen's mind; and therefore, when Savary's engine appeared, and became known in his neighbourhood many years after, he would readily catch at the help which it promiſed.

Savary, however, claims the invention as his own; but Switzer, who was perſonally acquainted with both, is poſitive that Newcomen was the inventor. By his principles (as a Quaker) being averſe from contention, he was contented to ſhare the honour and the profits with Savary, whoſe acquaintance at court enabled him to procure the patent in 1705, in which all the three were aſſociated. Poſterity has done juſtice to the modeſt inventor, and the machine is univerſally called NEWCO-

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(A) But if it has been found that the condenſation requires more cold water than what is allowed above, and it is ſuſpected that the rapidity of condenſing a large volume of ſteam by the cold ſurface of a veſſel is overrated.

12
eſcription
New-
men's.
ig. 7.

MEN'S ENGINE. Its principle and mode of operation may be clearly conceived as follows.

Let A (fig. 7.) repreſent a great boiler properly built in a furnace. At a ſmall height above it is a cylinder CBBC of metal, bored very truly and ſmoothly. The boiler communicates with this cylinder by means of the throat or ſteam-pipe NQ. The lower aperture of this pipe is ſhut by the plate N, which is ground very flat, ſo as to apply very accurately to the whole circumference of the orifice. This plate is called the regulator or ſteam-cock, and it turns horizontally round an axis *b a* which paſſes through the top of the boiler, and is nicely fitted to the ſocket, like the key of a cock, by grinding. The upper end of this axis is furniſhed with a handle *b*T.

A piſton P is ſuſpended in this cylinder, and made air-tight by a packing of leather or ſoft rope, well filled with tallow; and, for greater ſecurity, a ſmall quantity of water is kept above the piſton. The piſton-rod PD is ſuſpended by a chain which is fixed to the upper extremity F of the arched head FD of the great lever or WORKING BEAM HK, which turns on the gudgeon O. There is a ſimilar arched head EG at the other end of the beam. To its upper extremity E is fixed a chain carrying the pump-rod XL, which raiſes the water from the mine. The load on this end of the beam is made to exceed conſiderably the weight of the piſton P at the other extremity.

At ſome ſmall height above the top of the cylinder is a ciſtern W, called the INJECTION CISTERN. From this deſcends the INJECTION PIPE ZSR, which enters the cylinder through its bottom, and terminates in a ſmall hole R, or ſometimes in a nozzle pierced with many ſmaller holes diverging from a centre in all directions. This pipe has at S a cock called the INJECTION COCK, fitted with a handle V.

At the oppoſite ſide of the cylinder, a little above its bottom, there is a lateral pipe, turning upwards at the extremity, and there covered by a clack-valve *f*, called the SNIFTING VALVE, which has a little diſh round it to hold water for keeping it air-tight.

There proceeds alſo from the bottom of the cylinder a pipe *d e g h* (paſſing behind the boiler), of which the lower end is turned upwards, and is covered with a valve *h*. This part is immerſed in a ciſtern of water Y, called the HOT WELL, and the pipe itſelf is called the EDUCTION PIPE. Laſtly, the boiler is furniſhed with a ſafety-valve called the PUPPET CLACK (which is not repreſented in this ſketch for want of room), in the ſame manner as Savary's engine. This valve is generally loaded with one or two pounds on the ſquare inch, ſo that it allows the ſteam to eſcape when its elaſticity is one-tenth greater than that of common air. Thus all riſk of burſting the boiler is avoided, and the preſſure outwards is very moderate; ſo alſo is the heat. For, by inſpecting the table of vaporous elaſticity, we ſee that the heat correſponding to 32 inches of elaſticity is only about 216° degrees of Fahrenheit's thermometer.

Theſe are all the eſſential parts of the engine, and are here drawn in the moſt ſimple form, till our knowledge of their particular offices ſhall ſhow the propriety of the peculiar forms which are given to them. Let us now ſee how the machine is put in motion, and what is the nature of its work.

13
How the machine is put in motion, and the nature of the work.

The water in the boiler being ſuppoſed to be in a ſtate of ſtrong ebullition, and the ſteam iſſuing by the ſafety-valve, let us conſider the machine in a ſtate of reſt, having both the ſteam-cock and injection cock ſhut. The reſting poſition or attitude of the machine muſt be ſuch as appears in ſketch, the pump rods preponderating, and the great piſton being drawn up to the top of the cylinder. Now open the ſteam cock by turning the handle T of the regulator. The ſteam from the boiler will immediately ruſh in, and flying all over the cylinder, will mix with the air. Much of it will be condenſed by the cold ſurface of the cylinder and piſton, and the water produced from it will trickle down the ſides, and run off by the eduction-pipe. This condenſation and waſte of ſteam will continue till the whole cylinder and piſton be made as hot as boiling water. When this happens, the ſteam will begin to open the ſnifting-valve *f*, and iſſue through the pipe; ſlowly at firſt and very cloudy, being mixed with much air. The blaſt at *f* will grow ſtronger by degrees, and more tranſparent, having already carried off the greateſt part of the common air which filled the cylinder. We ſuppoſed that the air was boiling briſkly, ſo that the ſteam was iſſuing by the ſafety-valve which is in the top of the boiler, and through every crevice. The opening of the ſteam-cock puts an end to this at once, and it has ſometimes happened that the cold cylinder abſtracts the ſteam from the boiler with ſuch aſtoniſhing rapidity, that the preſſure of the atmoſphere has burſt up the bottom of the boiler. We may here mention an accident of which we were witneſſes, which alſo ſhows the immenſe rapidity of the condenſation. The boiler was in a frail ſhed at the ſide of the engine-houſe; a ſhoot of ſnow from the top of the houſe fell down and broke through the roof of the ſhed, and was ſcattered over the head of the boiler, which was of an oblong or oval ſhape. In an inſtant the ſides of it were ſqueezed together by the preſſure of the atmoſphere.

When the manager of the engine perceives that not only the blaſt at the ſnifting valve is ſtrong and ſteady, but that the boiler is now fully ſupplied with ſteam of a proper ſtrength, appearing by the renewal of the diſcharge at the ſafety-valve, he ſhuts the ſteam-cock, and opens the injection-cock S by turning its handle V. The preſſure of the column of water in the injection-pipe ZS immediately forces ſome water through the ſpout R. This coming in contact with the pure wapour which now fills the cylinder, condenſes it, and thus makes a partial void, into which the more diſtant ſteam immediately expands, and by expanding collapſes (as has been already obſerved). What remains in the cylinder no longer balances the atmoſpherical preſſure on the ſurface of the water in the injection ciſtern, and therefore the water ſpouts rapidly through the hole R by the joint action of the column ZS, and the unbalanced preſſure of the atmoſphere; at the ſame time the ſnifting-valve *f*, and the eduction-valve *h*, are ſhut by the unbalanced preſſure of the atmoſphere. The velocity of the injection water muſt therefore rapidly increaſe, and the jet will daſh (if ſingle) againſt the bottom of the piſton, and be ſcattered through the whole capacity of the cylinder. In a very ſhort ſpace of time, therefore, the condenſation of the ſteam becomes univerſal, and the elaſticity of what remains is almoſt nothing. The whole preſſure

preſſure of the atmoſphere is exerted in the upper ſurface of the piſton, while there is hardly any on its under ſide. Therefore, if the load on the outer end E of the working beam is inferior to this preſſure, it muſt yield to it. The piſton P muſt deſcend, and the pump piſton L muſt aſcend, bringing along with it the water of the mine, and the motion muſt continue till the great piſton reaches the bottom of the cylinder; for it is not like the motion which would take place in a cylinder of air rarefied to the ſame degree. In this laſt caſe, the impelling force would be continually diminiſhed, becauſe the capacity of the cylinder is diminiſhed by the deſcent of the piſton, and the air in it is continually becoming more denſe and elaſtic. The piſton would ſtop at a certain height, where the elaſticity of the included air, together with the load at E, would balance the atmoſpherical preſſure on the piſton. But when the contents of the cylinder are pure vapour, and the continued ſtream of injected cold water keeps down its temperature to the ſame pitch as at the beginning, the elaſticity of the remaining ſteam can never increaſe by the deſcent of the piſton, nor exceed what correſponds to this temperature. The impelling or accelerating force therefore remains the ſame, and the deſcent of the piſton will be uniformly accelerated, if there is not an increaſe of reſiſtance ariſing from the nature of the work performed by the other end of the beam. This circumſtance will come under conſideration afterwards, and we need not attend to it at preſent. It is enough for our preſent purpoſe to ſee, that if the cylinder has been completely purged of common air before the ſteam-cock was ſhut, and if none has entered ſince, the piſton will deſcend to the very bottom of the cylinder. And this may be frequently obſerved in a good ſteam-engine, where every part is air-tight. It ſometimes happens, by the pit-pump drawing air, or ſome part of the communication between the two ſtrains giving way, that the piſton comes down with ſuch violence as to knock out the bottom of the cylinder with the blow.

14
The piſton does not begin to deſcend the moment the injection is made.

The only obſervation which remains to be made on the motion of the piſton in deſcending is, that it does not begin at the inſtant the injection is made. The piſton was kept at the top by the preponderancy of the outer end of the working beam, and it muſt remain there till the difference between the elaſticity of the ſteam below it and the preſſure of the atmoſphere exceeds this preponderancy. There muſt therefore be a ſmall ſpace of time between the beginning of the condenſation and the beginning of the motion. This is very ſmall, not exceeding the third or the fourth part of a ſecond; but it may be very diſtinctly obſerved by an attentive ſpectator. He will ſee, that the inſtant the injection cock is opened, the cylinder will ſenſibly riſe upwards a little by the preſſure of the air on its bottom. Its whole weight is not nearly equal to this preſſure; and inſtead of its being neceſſary to *ſupport* it by a ſtrong floor, we muſt *keep it down* by ſtrong joints loaded by heavy walls. It is uſual to frame theſe joints into the poſts which carry the axis of the working-beam, and are therefore loaded with the whole ſtrain of the machine. This riſing of the cylinder ſhows the inſtantaneous commencement of the condenſation; and it is not till *after* this has been diſtinctly obſerved that the piſton is ſeen to ſtart, and begin to deſcend.

15
The circumſtanc that ſucceed the deſcent o the piſto

When the manager ſees the piſton as low as he thinks proper, he ſhuts the injection-cock, and opens the ſteam-cock. The ſteam has been accumulating above the water in the boiler during the whole time of the piſton's deſcent, and is now ruſhing violently through the puppet clack. The moment, therefore, that the ſteam-cock is opened, it ruſhes violently into the cylinder, having an elaſticity greater than that of the air. It therefore immediately blows open the ſnifting valve, and allows (at leaſt) the water which had come in by the former injection, and what aroſe from the condenſed ſteam, to deſcend by its own weight through the eduction pipe *d e g h* to open the valve *h*, and to run out into the hot well. And we muſt eaſily ſee that this water is boiling hot; for while lying in the bottom of the cylinder, it will condenſe ſteam till it acquires this temperature, and therefore cannot run down till it condenſes no more. There is ſtill a waſte of ſteam at its firſt admiſſion, in order to heat the inſide of the cylinder and the injected water to the boiling temperature: but the ſpace being ſmall, and the whole being already very warm, this is very ſoon done; and when things are properly conſtructed, little more ſteam is wanted than what will warm the cylinder; for the eduction pipe receives the injection water even during the deſcent of the piſton, and it is therefore removed pretty much out of the way of the ſteam.

16
Effects of the firſt puff of entering ſteam

This firſt puff of the entering ſteam is of great ſervice; it drives out of the cylinder the vapour which it finds there. This is ſeldom pure watery vapour: all water contains a quantity of air in a ſtate of chemical union. The union is but feeble, and a boiling heat is ſufficient for diſengaging the greateſt part of it by increaſing its elaſticity. It may alſo be diſengaged by ſimply removing the external preſſure of the atmoſphere. This is clearly ſeen when we expoſe a glaſs of water in an exhauſted receiver. Therefore the ſmall ſpace below the piſton contains watery vapour mixed with all the air which had been diſengaged from the water in the boiler by ebullition, and all that was ſeparated from the injection water by the diminution of external preſſures. All this is blown out of the cylinder by the firſt puff of ſteam. We may obſerve in this place, that waters differ exceedingly in the quantity of air which they hold in a ſtate of ſolution. All ſpring water contains much of it: and water newly brought up from deep mines contains a great deal more, becauſe the ſolution was aided in theſe ſituations by great preſſures. Such waters ſparkle when poured into a glaſs. It is therefore of great conſequence to the good performance of a ſteam-engine to uſe water containing little air, both in the boiler and in the injection-ciſtern. The water of running brooks is preferable to all others, and the freer it is from any ſaline impregnation it generally contains leſs air. Such engines as are ſo unfortunately ſituated that they are obliged to employ the very water which they have brought up from great depths, are found greatly inferior in their performance to others. The air collected below the piſton greatly diminiſhes the accelerating force, and the expulſion of ſuch a quantity requires a long-continued blaſt of the beſt ſteam at the beginning of every ſtroke. It is adviſable to keep ſuch water in a large ſhallow pond for a long while before uſing it.

17
Of great conſequence to the good performance of a ſteam-engine, that the water employed contain little air.

18
How the piſton riſes.

Let us now conſider the ſtate of the piſton. It is evident that it will ſtart or begin to riſe the moment the

the ſteam-cock is opened; for at that inſtant the exceſs of atmoſpherical preſſure, by which it was kept down in oppoſition to the preponderancy of the outer end of the beam, is diminiſhed. The piſton is therefore *dragged* upwards, and it will riſe even although the ſteam which is admitted be not ſo elaſtic as common air. Suppoſe the mercury in the barometer to ſtand at 30 inches, and that the preponderancy at the outer end of the beam is $\frac{1}{9}$th of the preſſure of the air on the piſton, the piſton will not riſe if the elaſticity of the ſteam is not equal to $30 - \frac{30}{9}$, that is, to 26.7 inches nearly; but if it is juſt this quantity, the piſton will riſe as faſt as this ſteam can be ſupplied through the ſteam-pipe, and the velocity of its aſcent depends entirely on the velocity of this ſupply. This obſervation is of great importance; and it does not ſeem to have occurred to the mathematicians, who have paid moſt attention to the mechaniſm of the motion of this engine. In the mean time, we may clearly ſee that the entry of the ſteam depends chiefly on the counter weight at E: for ſuppoſe there was none, ſteam no ſtronger than air would not enter the cylinder at all; and if the ſteam be ſtronger, it will enter only by the exceſs of its ſtrength. Writers on the ſteam-engine (and even ſome of great reputation) familiarly ſpeak of the ſteam giving the piſton a puſh: But this is ſcarcely poſſible. During the riſe of the piſton the ſnifting valve is never obſerved to blow; and we have not heard any well-atteſted accounts of the piſton-chains ever being ſlackened by the upward preſſure of the ſteam, even at the very beginning of the ſtroke. During the riſing of the piſton the ſteam is (according to the common conception and manner of ſpeaking) *ſucked in*, in the ſame way that air is ſucked into a common ſyringe or pump when we draw up the piſton; for in the ſteam-engine the piſton is really drawn up by the counter weight. But it is ſtill more ſucked in, and requires a more copious ſupply, for another reaſon. As the piſton deſcended only in conſequence of the inſide of the cylinder's being ſufficiently cooled to condenſe the ſteam, this cooled ſurface muſt again be preſented to the ſteam during the riſe of the piſton, and muſt condenſe ſteam a ſecond time. The piſton cannot riſe another inch till the part of the cylinder which the piſton has already quitted has been warmed up to the boiling point, and ſteam muſt be expended in this warming. The inner ſurface of the cylinder is not only of the heat of boiling water while the piſton riſes, but is alſo perfectly dry; for the film of water left on it by the aſcending piſton muſt be completely evaporated, otherwiſe it will be condenſing ſteam. That the quantity thus waſted is conſiderable, appears by the experiments of Mr Beighton. He found that five pints of water were boiled off in a minute, and produced 16 ſtrokes of an engine whoſe cylinder contained 113 gallons of 282 inches each; and he thence concluded that ſteam was 2886 times rarer than water. But in no experiment made with ſcrupulous care on the expanſion of boiling water does it appear that the denſity of ſteam exceeds $\frac{1}{10{,}000}$th of the denſity of water. Deſaguiliers ſays that it is above 14,000 times rarer than water. We have frequently attempted to meaſure the weight of ſteam which filled a very light veſſel, which held 12,600 grains of water, and found it always leſs than one grain; ſo that we have no doubt of its being much more than 10,000 times rarer than water. This being the caſe, we may ſafely ſuppoſe that the number of gallons of ſteam, inſtead of being 16 times 113, were nearly five times as much; and that only $\frac{1}{5}$th was employed in allowing the piſton to riſe, and the remaining $\frac{4}{5}$ths were employed to warm the cylinder. But no diſtinct experiment ſhews ſo great an expanſion of water when converted into ſteam at 212°. Mr Watt never found it under the preſſure of the air more than 1800 times rarer than water.

19
Its aſcent chiefly owing to the weight of the pit piſton-rods.

The moving force during the aſcent of the piſton muſt be conſidered as reſulting chiefly, if not ſolely, from the preponderating weight of the pit piſton-rods. The office of this is to return the ſteam-piſton to the top of the cylinder, where it may again be preſſed down by the air, and make another working ſtroke by raiſing the pump-rods. But the counter-weight at E has another ſervice to perform in this uſe of the engine; namely, to return the pump piſtons into their places at the bottom of their reſpective working barrels, in order that they alſo may make a working ſtroke. This requires force independent of the friction and inertia of the moving parts; for each piſton muſt be puſhed down through the water in the barrel, which muſt riſe through the piſton with a velocity whoſe proportion to the velocity of the piſton is the ſame with that of the bulk of the piſton to the bulk of the perforation through which the water riſes through the piſton. It is enough at preſent to mention this in general terms: we ſhall conſider it more particularly afterwards, when we come to calculate the performance of the engine, and to deduce from our acquired knowledge maxims of conſtruction and improvement.

20
The aſcent of the piſton differs greatly from the deſcent.

From this general conſideration of the aſcent of the piſton, we may ſee that the motion differs greatly from the deſcent. It can hardly be ſuppoſed to accelerate, even if the ſteam in the cylinder were in a moment annihilated. For the reſiſtance to the deſcent of the piſton is the ſame with the weight of the column of water, which would cauſe it to flow through the box of the pump piſton with the velocity with which it really riſes through it, and muſt therefore increaſe as the ſquare of that velocity increaſes; that is, as the ſquare of the velocity of the piſton increaſes. Independent of friction, therefore, the velocity of deſcent through the water muſt ſoon become a maximum, and the motion become uniform. We ſhall ſee by and by, that in ſuch a pump as is generally uſed this will happen in leſs than the 10th part of a ſecond. The friction of the pump will diminiſh this velocity a little, and retard the time of its attaining uniformity. But, on the other hand, the ſupply of ſteam which is neceſſary for this motion, being ſuſceptible of no acceleration from its previous motion, and depending entirely on the briſkneſs of the ebullition, an almoſt inſtantaneous ſtop is put to acceleration.

Accordingly, any perſon who obſerves with attention the working of a ſteam-engine, will ſee that the riſe of the piſton and deſcent of the pump-rods is extremely uniform, whereas the working ſtroke is very ſenſibly accelerated. Before quitting this part of the ſubject, and leſt it ſhould afterwards eſcape our recollection, we may obſerve, that the counter-weight is different during the two motions of the pump-rods. While the machine is making a working ſtroke, it is lifting not only the column

21
The counter-weight is different during the two motions of the pump-rods.

lumn of water in the pump, but the abſolute weight of the piſtons and piſton-rods alſo: but while the pump-rods are deſcending, there is a diminution of the counter-weight by the whole weight loſt by the immerſion of the rod in water. The wooden rods which are generally uſed, ſoaked in water, and joined by iron ſtraps, are heavier, and but a little heavier, than water, and they are generally about one-third of the bulk of the water in the pumps.

Theſe two motions complete the period of the operation; and the whole may be repeated by ſhutting the ſteam-cock and opening the injection-cock whenever the piſton has attained the proper height. We have been very minute in our attention to the different circumſtances, that the reader may have a diſtinct notion of the ſtate of the moving forces in every period of the operation. It is by no means ſufficient that we know in general that the injection of cold water makes a void which allows the air to preſs down the piſton, and that the readmiſſion of the ſteam allows the piſton to riſe again. This lumping and ſlovenly way of viewing it has long prevented even the philoſopher from ſeeing the defects of the conſtruction, and the methods of removing them.

22 Difference between Savary's and Newcomen's machines.

We now ſee the great difference between Savary's and Newcomen's engine in reſpect of principle. Savary's was really an engine which raiſed water by the force of ſteam; but Newcomen's raiſes water entirely by the preſſure of the atmoſphere, and ſteam is employed merely as the moſt expeditious method of producing a void, into which the atmoſpherical preſſure may impel the *firſt mover* of his machine. The elaſticity of the ſteam is not the firſt mover.

23 Superiority of Newcomen's.

We ſee alſo the great ſuperiority of this new machine. We have no need of ſteam of great and dangerous elaſticity; and we operate by means of very moderate heats, and conſequently with much ſmaller quantities of fuel; and there is no bounds to the power of this machine. How deep ſoever a mine may be, a cylinder may be employed of ſuch dimenſions that the preſſure of the air on its piſton may exceed in any degree the weight of the column of water to be raiſed. And laſtly, this form of the machine renders it applicable to almoſt every mechanical purpoſe; becauſe a ſkilful mechanic can readily find a method of converting the reciprocating motion of the working beam into a motion of any kind which may ſuit his purpoſe. Savary's engine could hardly admit of ſuch an immediate application, and ſeems almoſt reſtricted to raiſing water.

24 Gradually improved

Inventions improve by degrees. This engine was firſt offered to the public in 1705. But many difficulties occurred in the execution, which were removed one by one; and it was not till 1712 that the engine ſeemed to give confidence in its efficacy. The moſt exact and unremitting attention of the manager was required to the preciſe moment of opening and ſhutting the cocks; and neglect might frequently be ruinous, by beating out the bottom of the cylinder, or allowing the piſton to be wholly drawn out of it. Stops were contrived to prevent both of theſe accidents; then ſtrings were uſed to connect the handles of the cocks with the beam, ſo that they ſhould be turned whenever it was in certain poſitions. Theſe were gradually changed and improved into detents and catches of different ſhapes; at laſt, in 1717, Mr Beighton, a very ingenious and well-informed artiſt, ſimplified the whole of theſe ſubordinate movements, and brought the machine into the form in which it has continued, without the ſmalleſt material change, to the preſent day. We ſhall now deſcribe one of theſe improved engines, copying almoſt exactly the drawings and deſcription given by Boſſut in his *Hydrodynamique;* theſe being by far the moſt accurate and perſpicuous of any that have been publiſhed.

25 and ſimplified.

26 Deſcription of Beighton's ſteam-engine. Plate DII. fig. 8.

Fig. 8. N° 1. is a perſpective view of the boiler cylinder, and all the parts neceſſary for turning the cocks. Fig. 8. N° 2. is a vertical ſection of the ſame; and the ſame pieces of both are marked with the ſame letters of reference.

The rod X of the piſton P is ſuſpended from the arch of the working-beam, as was repreſented in the preceding ſketch (fig. 7.). An upright bar of timber FG is alſo ſeen hanging by a chain. This is ſuſpended from a concentric arch of the beam, as may be ſeen alſo in the ſketch at $\varphi\,\delta$. The bar is called the *plug-beam;* and it muſt riſe and fall with the piſton, but with a ſlower motion. The uſe of this plug-beam is to give motion to the different pieces which turn the cocks.

The ſteam-pipe K is of one piece with the bottom of the cylinder, and riſes within it an inch or two, to prevent any of the cold injection water from falling into the boiler. The lower extremity Z of the ſteam-pipe penetrates the head of the boiler, projecting a little way. A flat plate of braſs, in ſhape reſembling a racket or battledore, called the *regulator*, applies itſelf exactly to the whole circumference of the ſteam-pipe, and completely excludes the ſteam from the cylinder. Being moveable round an upright axis, which is repreſented by the dotted lines at the ſide of the ſteam-pipe in the profile, it may be turned aſide by the handle *i*, N° 1. The profile ſhows in the ſection of this plate a protuberance in the middle. This reſts on a ſtrong flat ſpring, which is fixed below it athwart the mouth of the ſteam-pipe. This ſpring preſſes it ſtrongly towards the ſteam-pipe, cauſing it to apply very cloſe; and this knob ſlides along the ſpring, while the regulator turns to the right or left.

We have ſaid that the injection-water is furniſhed from a ciſtern placed above the cylinder. When the ciſtern cannot be ſupplied by pipes from ſome more elevated ſource, its water is raiſed by the machine itſelf. A ſmall lifting pump *i k* (fig. 7.), called the *jack-head* or *jacquette*, is worked by a rod $\gamma\,\iota$, ſuſpended from a concentric arch $\varepsilon\,\mu$ near the outer end of the working beam. This forces a ſmall portion of the pit water along the riſing pipe *i* LM into the injection ciſtern.

In fig. 8. N° 1. and 2. the letters QM 3′ repreſent the pipe which brings down the water from the injection ciſtern. This pipe has a cock at R to open or ſhut the paſſage of this water. It ſpouts through the jet 3′, and daſhing againſt the bottom of the piſton, it is diſperſed into drops, and ſcattered through the whole capacity of the cylinder, ſo as to produce a rapid condenſation of the ſteam.

An upright poſt A may be obſerved in the perſpective view of the cylinder, &c. This ſupports one end B of a horizontal iron axis BC. The end C is ſupported by a ſimilar poſt, of which the place only is marked by the dotted lines A, that the pieces connected

ted with this axis may not be hid by it. A kind of ſtirrup *a b c d* hangs from this axis, ſupported by the hooks *a* and *d*. This ſtirrup is croſſed near the bottom by a round bolt or bar *e*, which paſſes through the eyes or rings that are at the ends of the horizontal fork *h f g*, whoſe long tail *h* is double, receiving between its branches the handle *i* of the regulator. It is plain from this conſtruction, that when the ſtirrup is made to vibrate round the horizontal axis BC, on which it hangs freely by its hooks, the bolt *e* muſt pull or puſh the long fork *h f g* backwards and forwards horizontally, and by ſo doing will move the regulator round its axis by means of the handle *i*. Both the tail of the fork and the handle of the regulator are pierced with ſeveral holes, and a pin is put through them which unites them by a joint. The motion of the handle may be increaſed or diminiſhed by chooſing for the joint a hole near to the axis or remote from it; and the exact poſition at which the regulator is to ſtop on both ſides is determined by pins ſtuck in the horizontal bar on which the end of the handle appears to reſt.

This alternate motion of the regulator to the right and left is produced as follows: There is fixed to the axis BC a piece of iron *o k l*, called the Y, on account of its reſemblance to that letter of the alphabet inverted. The ſtalk *o* carries a heavy lump *p* of lead or iron; and a long leather ſtrap *q p r* is faſtened to *p* by the middle, and the two ends are faſtened to the beam above it, in ſuch a manner that the lump may be alternately catched and held up to the right and left of the perpendicular. By adjuſting the length of the two parts of the ſtrap, the Y may be ſtopped in any deſired poſition. The two claws *k* and *l* ſpread out from each other, and from the line of the ſtalk, and they are of ſuch length as to reach the horizontal bolt *e*, which croſſes the ſtirrup below, but not to reach the bottom of the fork *h f g*. Now ſuppoſe the ſtirrup hanging perpendicularly, and the ſtalk of the Y alſo held perpendicular; carry it a little outward from the cylinder, and then let it go. It will tumble farther out by its weight, without affecting the ſtirrup till the claw *l* ſtrikes on the horizontal bolt *e*, and then it puſhes the ſtirrup and the fork towards the cylinder, and opens the regulator. It ſets it in motion with a ſmart jerk, which is an effectual way of overcoming the coheſion and friction of the regulator with the mouth of the ſteam-pipe. This puſh is adjuſted to a proper length by the ſtrap *q p*, which ſtops the Y when it has gone far enough. If we now take hold of the ſtalk of the Y, and move it up to the perpendicular, the width between its claws is ſuch as to permit this motion, and ſomething more, without affecting the ſtirrup. But when puſhed ſtill nearer to the cylinder, it tumbles towards it by its own weight, and then the claw *k* ſtrikes the bolt *e*, and drives the ſtirrup and fork in the oppoſite direction, till the lump *p* is catched by the ſtrap *r p*, now ſtretched to its full length, while *q p* hangs ſlack. Thus by the motion of the Y the regulator is opened and ſhut. Let us now ſee how the motion of the Y is produced by the machine itſelf. To the horizontal axis BC are attached two ſpanners or handles *m* and *n*. The ſpanner *m* paſſes through a long ſlit in the plug-beam, and is at liberty to move upwards or downwards by its motion round the axis BC. A pin π which goes through the plug-beam catches hold of *m* when the beam riſes along with the piſton; and the pin is ſo placed, that when the beam is within an inch or two of its higheſt riſe, the pin has lifted *m* and thrown the ſtalk of the Y paſt the perpendicular. It therefore tumbles over with great force, and gives a ſmart blow to the fork, and immediately ſhuts the regulator. By this motion the ſpanner *m* is removed out of the neighbourhood of the plug-beam. But the ſpanner *n*, moving along with it in the ſame direction, now comes into the way of the pins of the plug-beam. Therefore, when the piſton deſcends again by the condenſation of the ſteam in the cylinder, a pin marked & in the ſide of the plug-beam catches hold of the tail of the ſpanner *n*, and by preſſing it down raiſes the lump on the ſtalk of the Y till it paſſes the perpendicular, and it then falls down, outwards from the cylinder, and the claw *l* again drives the fork in the direction *h i*, and opens the ſteam valve. This opening and ſhutting of the ſteam valve is executed in the preciſe moment that is proper, by placing the pins π and & at a proper height of the plug-beam. For this reaſon, it is pierced through with a great number of holes, that the places of theſe pins may be varied at pleaſure. This, and a proper curvature of the ſpanners *m* and *n*, make the adjuſtment as nice as we pleaſe.

The injection-cock R is managed in a ſimilar manner. On its key may be obſerved a forked arm *s t*, like a crab's claw; at a little diſtance above it is the gudgeon or axis *u* of a piece *y u z*, called the hammer or the F, from its reſemblance to that letter. It has a lump of metal *y* at one end, and a ſpear *u s* projects from its middle, and paſſes between the claws *s* and *t* of the arm of the injection-cock. The hammer *y* is held up by a notch in the under ſide of a wooden lever DE, moveable round the centre D, and ſupported at a proper height by a ſtring *r* E, made faſt to the joiſt above it.

Suppoſe the injection-cock ſhut, and the hammer in the poſition repreſented in the figure. A pin β of the plug-frame riſes along with the piſton, and catching hold of the detent DE, raiſes it, and diſengages the hammer *y* from its notch. This immediately falls down, and ſtrikes a board L put in the way to ſtop it. The ſpear *u s* takes hold of the claw *t*, and forces it aſide towards *x*, and opens the injection-cock. The piſton immediately deſcends, and along with it the plug-frame. During its deſcent the pin β meets with the tail *u z* of the hammer, which is now raiſed conſiderably above the level, and brings it down along with it, raiſing the lump *y*, and gradually ſhutting the injection-cock, becauſe the ſpear takes hold of the claw *s* of its arm. When the beam has come to its loweſt ſituation, the hammer is again engaged in the notch of the detent DE, and ſupported by it till the piſton again reaches the top of the cylinder.

In this manner the motions of the injection-cock are alſo adjuſted to the preciſe moment that is proper for them. The different pins are ſo placed in the plug-frame, that the ſteam-cock may be completely ſhut before the injection-cock is opened. The inherent motion of the machine will give a ſmall addition to the aſcent of the piſton without expending ſteam all the while; and by leaving the ſteam rather leſs elaſtic than before, the ſubſequent deſcent of the piſton is promoted. There was a conſiderable propriety in the gradual ſhutting of the injection-cock. For after the firſt daſh of the cold water againſt the bottom of the piſton, the condenſation is nearly complete, and very little more water is needed; but a continual acceſſion of ſome is abſolutely neceſſary for completing the condenſation, as the capacity of the cylinder diminiſhes, and the water warms which is already injected.

In this manner the motion of the machine will be repeated as long as there is a ſupply of ſteam from the boiler, and of water from the injection ciſtern, and a diſcharge procured for what has been injected. We proceed to conſider how far theſe conditions alſo are provided by the machine itſelf.

The injection ciſtern is ſupplied with water by the jackhead pump, as we have already obſerved. From this ſource all the parts of the machine receive their reſpective ſupplies. In the firſt place, a ſmall branch 13, 13, is taken off from the injection pipe immediately below the ciſtern, and conducted to the top of the cylinder, where it is furniſhed with a cock. The ſpout is ſo adjuſted, that no more runs from it than what will keep a conſtant ſupply of a foot of water above the piſton to keep it tight. Every time the piſton comes to the top of the cylinder, it brings this water along with it, and the ſurplus of its evaporation and leakage runs off by a waſte pipe 14, 14. This water neceſſarily becomes almoſt boiling hot, and it was thought proper to employ its overplus for ſupplying the waſte of the boiler. This was accordingly practiſed for ſome time. But Mr Beighton improved this economical thought, by ſupplying the boiler from the eduction-pipe, 2, 2, the water of which muſt be ſtill hotter than that above the piſton. This contrivance required attention to many circumſtances, which the reader will underſtand by conſidering the perſpective and profile. The eduction-pipe comes out of the bottom of the cylinder at 1 with a perpendicular part, which bends ſidewiſe below, and is ſhut at the extremity 1. A deep cup 5 communicates with it, holding a metal valve nicely fitted to it by grinding, like the key of a cock. To ſecure its being always air-tight, a ſlender ſtream of water trickles into it from a branch 6 of the waſte-pipe from the top of the cylinder. The eduction-pipe branches off at 2, and goes down to the hot well, where it turns up, and is covered with a valve. In the perſpective view may be obſerved an upright pipe 4, 4, which goes through the head of the boiler, and reaches to within a few inches of its bottom. This pipe is called the *feeder*, and riſes about three or four feet above the boiler. It is open at both ends, and has a branch 3, 3, communicating with the bottom of the cup 5, immediately above the metal valve, and alſo a few inches below the level of the entry 2 of the eduction-pipe. This communicating branch has a cock by which its paſſage may be diminiſhed at pleaſure. Now ſuppoſe the ſteam in the boiler to be very ſtrong, it will cauſe the boiling water to riſe in the feeding-pipe above 3, and coming along this branch, to riſe alſo in the cup 5, and run over. But the height of this cup above the ſurface of the water in the boiler is ſuch, that the ſteam is never ſtrong enough to produce this effect. Therefore, on the contrary, any water that may be in the cup 5 will run off by the branch 3, 3, and go down into the boiler by the feeding-pipe.

Theſe things being underſtood, let us ſuppoſe a quantity of injected water lying at the bottom of the cylinder. It will run into the eduction-pipe, fill the crooked branch 1, 1, and open the valve in the bottom of the cup (its weight being ſupported by a wire hanging from a ſlender ſpring), and it will fill the cup to the level of the entry 2 of the eduction pipe, and will then flow along 3, 3, and ſupply the boiler by the feeder 4, 4. What more water runs in at 1 will now go along the eduction-pipe 2, 2, to the hot well. By properly adjuſting the cock on the branch 3, 3, the boiler may be ſupplied as faſt as the waſte in ſteam requires. This is a moſt ingenious contrivance, and does great honour to Mr Beighton. It is not, however, of much importance. The ſmall quantity which the boiler requires may be immediately taken even from a cold ciſtern, without ſenſibly diminiſhing the production of ſteam: for the quantity of heat neceſſary for raiſing the ſenſible heat of cold water to the boiling temperature is ſmall, when compared with the quantity of heat which muſt then be combined with it in order to convert the water into ſteam. For the heat expended in boiling off a cubic foot of water is about ſix times as much as would bring it to a boiling heat from the temperature of 55°. No difference can be obſerved in the performance of ſuch engines, and of thoſe which have their boilers ſupplied from a brook. It has, however, the advantage of being purged of air; and when an engine muſt derive all its ſupplies from pit water, the water from the eduction-pipe is vaſtly preferable to that from the top of the cylinder.

27 An ingenious contrivance.

We may here obſerve, that many writers (among them the Abbé Boſſut), in their deſcriptions of the ſteam-engine, have drawn the branch of communication 3, 3, from the feeding-pipe to a part of the crooked pipe 1, 1, lying below the valve in the cup 5. But this is quite erroneous; for, in this caſe, when the injection is made into the cylinder, and a vacuum produced, the water from the boiler would immediately ruſh up through the pipes 4, 3, and ſpout up into the cylinder: ſo would the external air coming in at the top of the feeder.

28 Which enables us to form ſome judgment of the internal ſtate of the engine during the performance.

This contrivance has alſo enabled us to form ſome judgment of the internal ſtate of the engine during the performance. Mr Beighton paid a minute attention to the ſituation of the water in the feeders and eduction-pipe of an engine, which ſeems to have been one of the beſt which has yet been erected. It was lifting a column of water whoſe weight was four-ſevenths of the preſſure of the air on its piſton, and made 16 ſtrokes, of ſix feet each, in a minute. This is acknowledged by all to be a very great performance of an engine of this form. He concluded that the elaſticity of the ſteam in the cylinder was never more than one-tenth greater or leſs than the elaſticity of the air. The water in the feeder never roſe more than three feet and a half above the ſurface of the boiling water, even though it was now lighter by $\frac{1}{27}$th than cold water. The eduction pipe was only four feet and a half long (vertically), and yet it always diſcharged the injection water completely, and allowed ſome to paſs into the feeder. This could not be if the ſteam was much more than one-tenth weaker than air. By graſping this pipe in his hand during the riſe of the piſton, he could gueſs very well whereabouts the ſurface of the hot water in it reſted during the motion, and he never found it ſupported ſo high as four feet. Therefore the ſteam in the cylinder had at leaſt eight-ninths of the elaſticity of the air. Mr Buat, in his examination of an engine which is erected at Montrelaix, in France, by an Engliſh engineer, and has always been conſidered as the pattern in that country, finds it neceſſary to ſuppoſe a much greater variation in the ſtrength of the ſteam, and ſays, that it muſt have been one-fifth ſtronger and one-fifth weaker than common air. But this engine has not been nearly ſo perfect. Its lift was not more than one-half the preſſure of the atmoſphere, and it made but nine ſtrokes in a minute.—At W is a valve covering the mouth of a ſmall pipe, and ſurrounded with a cup containing water to keep it air-tight. This allows the air to eſcape which had been extricated from the water of laſt injection. It is driven out by the firſt ſtrong puff of ſteam which is admitted into the cylinder, and makes a noiſe in its exit. The valve is therefore called the ſnifting-valve.

To finiſh our deſcription, we obſerve, that beſides the ſafety valve 9 (called the PUPPET CLACK), which is loaded with about 3 pounds on the ſquare inch (though the engine will work very well with a load of 1 or 2 pounds), there is another DISCHARGER 10,10, having a clack at its extremity ſupported by a cord. Its uſe is to diſcharge the ſteam without doors, when the machine gives over working. There is alſo a pipe SI near the bottom of the boiler, by which it may be emptied when it needs repairs or cleanſing.

There are two ſmall pipes 11,11, and 12,12, with cocks called GAGE PIPES. The firſt deſcends to within two inches of the ſurface of the water in the boiler, and the ſecond goes about 2 inches below that ſurface. If both cocks emit ſteam, the water is too low, and requires a recruit. If neither give ſteam, it is too high, and there is not ſufficient room above it for a collection of ſteam. Laſtly, there is a filling pipe Q, by which the boiler may be filled when the machine is to be ſet to work.

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The engine has continued in this form for many years. The only remarkable change introduced has been the manner of placing the boiler. It is no longer placed below the cylinder, but at one ſide, and the ſteam is introduced by a pipe from the top of the boiler into a flat box immediately below the cylinder. The uſe of this box is merely to lodge the regulator, and give room for its motions. This has been a very conſiderable improvement. It has greatly reduced the height of the building. This was formerly a tower. The wall which ſupported the beam could hardly be built with ſufficient ſtrength for withſtanding the violent ſhocks which were repeated without ceaſing; and the buildings ſeldom laſted more than a very few years. But the boiler is now ſet up in an adjoining ſhed, and the gudgeons of the main beam reſt on the top of upright poſts, which are framed into the joiſts which ſupport the cylinder. Thus the whole moving parts of the machine are contained in one compact frame of carpentry, and have little or no connection with the ſlight walls of the building, which is merely a caſe to hold the machine, and protect it from the weather.

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It is now time to inquire what is to be expected from this machine, and to aſcertain the moſt advantageous proportion between the moving power and the load that is to be laid on the machine.

It may be conſidered as a great pulley, and is indeed ſometimes ſo conſtructed, the arches at the ends of the working beam being completed to a circle. It muſt be unequally loaded that it may move. It is loaded, during the working ſtroke, by the preſſure of the atmoſphere on the piſton ſide, and by the column of water to be raiſed and the pump-gear on the pump ſide.—During the returning ſtroke it is loaded, on the piſton ſide, by a ſmall part of the atmoſpheric preſſure, and on the pump ſide by the pump-gear acting as a counter weight. The load during the working ſtroke muſt therefore conſiſt of the column of water to be raiſed and this counter weight. The performance of the machine is to be meaſured only by the quantity of water raiſed in a given time to a given height. It varies, therefore, in the joint proportion of the weight of the column of water in the pumps, and the number of ſtrokes made by the machine in a minute. Each ſtroke conſiſts of two parts, which we have called the working and the returning ſtroke. It does not, therefore, depend ſimply on the velocity of the working ſtroke and the quantity of water raiſed by it. If this were all that is to be attended to, we know that the weight of the column of water ſhould be nearly $\frac{2}{5}$ths of the preſſure of the atmoſphere, this being the proportion which gives the maximum in the common pulley. But the time of the returning ſtroke is a neceſſary part of the whole time elapſed, and therefore the velocity of the returning ſtroke equally merits attention. This is regulated by the counter weight. The number of ſtrokes per minute does not give an immediate proof of the goodneſs of the engine. A ſmall load of water and a great counter weight will enſure this, becauſe theſe conditions will produce a briſk motion in both directions.—The proper adjuſtment of the preſſure of the atmoſphere on the piſton, the column of water to be raiſed, and the counter weight, is a problem of very great difficulty; and mathemhticians have not turned much of their attention to the ſubject, although it is certainly the moſt intereſting queſtion that practical mechanics affords them.

31
Mr Boſſut's ſolution,

Mr Boſſut has ſolved it very ſhortly and ſimply, upon this ſuppoſition, that the working and returning ſtroke ſhould be made in equal times. This, indeed, is generally aimed at in the erection of theſe machines, and they are not reckoned to be well arranged if it be otherwiſe. We doubt of the propriety of the maxim. Suppoſing, however, this condition for the preſent, we may compute the loadings of the two ends of the beam as follows. Let a be the length of the inner arm of the working beam, or that by which the great piſton is ſupported. Let b be the outer arm carrying the pump rods, and let W be a weight equivalent to all the load which is laid on the machine. Let c^2 be the area of the piſton; let H be the height of a column of water having c^2 for its baſe, and being equal in weight to the preſſure exerted by the ſteam on the under ſide of the piſton; and let h be the preſſure of the atmoſphere on the ſame area, or the height of a column of water of equal weight. It is evident that both ſtrokes will be performed in equal times, if $h c^2 a - \mathrm{W} b$ be equal to $(h - \mathrm{H})\, c^2 a + \mathrm{W} b$. The firſt of theſe quantities is the energy of the machine during the working ſtroke, and the ſecond expreſſes the ſimilar energy during the returning ſtroke. This equation gives us $\mathrm{W} = \frac{2 h c^2 a - \mathrm{H} c^2 a}{2 b} = \frac{(2 h - \mathrm{H})\, c^2 a}{2 b}$. If

32 founded on an erroneous maxim,

we ſuppoſe the arms of the lever equal and $H=h$, we have $W=c^2\frac{h}{2}$; that is, the whole weight of the outer end of the beam ſhould be half the preſſure of the air on the great piſton. This is nearly the uſual practice; and the engineers expreſs it by ſaying, that the engine is loaded with ſeven or eight pounds on the ſquare inch. This has been found to be nearly the moſt advantageous load. This way of expreſſing the matter would do well enough, if the maxim were not founded on erroneous notions, which hinder us from ſeeing the ſtate of the machine, and the circumſtances on which its improvement depends. The piſton bears a preſſure of 15 pounds, it is ſaid, on the ſquare inch, if the vacuum below it be perfect; but as this is far from being the caſe, we muſt not load it above the power of its vacuum, which very little exceeds eight pounds. But this is very far from the truth. When the cylinder is tight, the vacuum is not more than $\frac{1}{20}$th deficient, when the cylinder is cooled by the injection to the degree that is every day practicable, and the piſton really bears during its deſcent a preſſure very near to 14 pounds on the inch. The load muſt be diminiſhed, not on account of the imperfect vacuum, but to give the machine a reaſonable motion. We muſt conſider not only the moving force, but alſo the quantity of matter to be put in motion. This is ſo great in the ſteam-engine, that even if it were balanced, that is, if there were ſuſpended on the piſton arm a weight equal to the whoſe column of water and the counter weight, the full preſſure of the atmoſphere on the ſteam piſton would not make it move twice as faſt as it does.

33 and faulty in another reſpect.

This equation by Mr Boſſut is moreover eſſentially faulty in another reſpect. The W in the firſt member is not the ſame with the W in the ſecond. In the firſt it is the column of water to be raiſed, together with the counter weight. In the ſecond it is the counter weight only. Nor is the quantity H the ſame in both caſes, as is moſt evident. The proper equation for enſuring the equal duration of the two ſtrokes may be had in the following manner. Let it be determined by experiment what portion of the atmoſpheric preſſure is exerted on the great piſton during its deſcent. This depends on the remaining elaſticity of the ſteam. Suppoſe it $\frac{9}{10}$ths: this we may expreſs by $a\,h$, a being $=\frac{9}{10}$ths. Let it alſo be determined by experiment what portion of the atmoſpheric preſſure on the piſton remains unbalanced by the ſteam below it during its aſcent. Suppoſe this $\frac{1}{10}$th, we may expreſs this by $b\,h$. Then let W be the weight of the column of water to be raiſed, and c the counter weight. Then, if the arms of the beam are equal, we have the energy during the working ſtroke $=a\,h-W-c$, and during the returning ſtroke it is $=c-b\,h$. Therefore $c-b\,h=a\,h-W-c$; and $c=\frac{h(a+b)-W}{2}$; which, on the above ſuppoſition of the values of a and b, gives us $c=\frac{h-W}{2}$. We ſhall make ſome uſe of this equation afterwards; but it affords us no information concerning the moſt advantageous proportion of h and W, which is the material point.

34 Another way of conſidering the matter.

We muſt conſider this matter in another way: And that we may not involve ourſelves in unneceſſary difficulties, let us make the caſe as ſimple as poſſible, and ſuppoſe the arms of the working-beam to be of equal length.

We ſhall firſt conſider the adjuſtment of things at the outer end of the beam.

35 Adjuſtment of things at the outer end of the beam conſidered.

Since the ſole uſe of the ſteam is to give room for the action of the atmoſpheric preſſure by its rapid condenſibility, it is admitted into the cylinder only to allow the piſton to riſe again, but without giving it any impulſe. The pump-rods muſt therefore be returned to the bottom of the working barrels, by means of a preponderancy at the outer end of the beam. It may be the weight of the pump-rods themſelves, or may be conſidered as making part of this weight. A weight at the end of the beam will not operate on the rods which are ſuſpended there by chains, and it muſt therefore be attached to the rods themſelves, but above their reſpective pump-barrels, ſo that it may not loſe part of its efficacy by immerſion in the water. We may conſider the whole under the notion of the pump-gear, and call it p. Its office is to depreſs the pump-rods with ſufficient velocity, by overcoming the reſiſtances ariſing from the following cauſes.

1. From the inertia of the beams and all the parts of the apparatus which are in motion during the deſcent of the pump-rods.

2. From the loſs of weight ſuſtained by the immerſion of the pump-rods in water.

3. From the friction of all the piſtons and the weight of the plug-frame.

4. From the reſiſtance to the piſton's motion, ariſing from the velocity which muſt be generated in the water in paſſing through the deſcending piſtons.

The ſum of all theſe reſiſtances is equal to the preſſure of ſome weight (as yet unknown), which we may call m.

When the pump-rods are brought up again, they bring along with them a column of water, whoſe weight we may call w.

It is evident that the load which muſt be overcome by the preſſure of the atmoſphere on the ſteam piſton conſiſts of w and p. Let this load be called L, and the preſſure of the air be called P.

If p be $=$ L, no water will be raiſed; if p be $=o$, the rods will not deſcend: therefore there is ſome intermediate value of p which will produce the greateſt effect.

In order to diſcover this, let g be the fall of a heavy body in a ſecond.

The deſcending maſs is p: but it does not deſcend with its full weight; becauſe it is overcoming a ſet of reſiſtances which are equivalent to a weight m, and the moving force is $p-m$. In order to diſcover the ſpace through which the rods will deſcend in a ſecond, when urged by the force $p-m$ (ſuppoſed conſtant, notwithſtanding the increaſe of velocity, and conſequently of m), we muſt inſtitute this proportion $p:p-m=g:\frac{g(p-m)}{p}$.

The fourth term of this analogy is the ſpace required.

Let t be the whole time of the deſcent in ſeconds. Then $1^2:t^2=\frac{g(p-m)}{p}:\frac{t^2g(p-m)}{p}$. This laſt term

is

is the whole deſcent or length of the ſtroke accompliſhed in the time t.

The weight of the column of water, which has now got above the piſton, is $w, = L - p$. This muſt be lifted in the next working ſtroke through the ſpace $\frac{t^2 g (p - m)}{p}$. Therefore the performance of the engine muſt be $\frac{t^2 g (p - m) (L - p)}{p}$.

That this may be the greateſt poſſible, we muſt conſider p as the variable quantity, and make the fluxion of the fraction $\frac{\overline{p - m} \times \overline{L - p}}{p} = o$.

This will be found to give us $p = \sqrt{L m}$; that is, the counter weight or preponderancy of the outer end of the beam is $= \sqrt{L m}$.

This gives us a method of determining m experimentally. We can diſcover by actual meaſurement the quantity L in any engine, it being equal to the unbalanced weights on the beam and the weight of the water in the pumps. Then $m = \frac{p^2}{L}$.

Alſo we have the weight of the column of water $= L - p, = L - \sqrt{L m}$.

When therefore we have determined the load which is to be on the outer end of the beam during the working ſtroke, it muſt be diſtributed into two parts, which have the proportion of $\sqrt{L m}$ to $L - \sqrt{L m}$. The firſt is the counter weight, and the ſecond is the weight of the column of water.

If m is a fraction of L, ſuch as an aliquot part of it; that is, if

$$m = \frac{L}{1}, \frac{L}{4}, \frac{L}{9}, \frac{L}{16}, \frac{L}{25}, \&c.$$
$$p = \frac{L}{1}, \frac{L}{2}, \frac{L}{3}, \frac{L}{4}, \frac{L}{5}, \&c.$$

The circumſtance which is commonly obtruded on us by local conſiderations is the quantity of water, and the depth from which it is to be raiſed; that is, w: and it will be convenient to determine every thing in conformity to this.

We ſaw that $w = L - \sqrt{L m}$. This gives us $L = \pm \sqrt{w m + \frac{m^2}{4}} + \frac{m}{2} + w$, and the counter weight $p = \sqrt{w m + \frac{m^2}{4}} + \frac{m}{2}$.

36 V t proportion of m ing fo e may b pplied to he g teſt advaage.

Having thus aſcertained that diſtribution of the load on the outer end of the beam which produces the greateſt effect, we come now to conſider what proportion of moving force we muſt apply, ſo that it may be employed to the beſt advantage, or ſo that any expence of power may produce the greateſt performance. It will be ſo much the greater as the work done is greater, and the power employed is leſs; and will therefore be properly meaſured by the quotient of the work done divided by the power employed.

The work immediately done is the lifting up the weight L. In order to accompliſh this, we muſt employ a preſſure P, which is greater than L. Let it be $= L + y$; alſo let s be the length of the ſtroke.

If the maſs L were urged along the ſpace s by the force $L + y$, it would acquire a certain velocity, which we may expreſs by $\sqrt{s}$; but it is impelled only by the force y, the reſt of P being employed in balancing L. The velocities which different forces generate by impelling a body along the ſame ſpace are as the ſquare roots of the forces. Therefore $\sqrt{L + y} : \sqrt{y} = \sqrt{s} : \frac{\sqrt{s y}}{\sqrt{L + y}}$. The fourth term of this analogy expreſſes the velocity of the piſton at the end of the ſtroke. The quantity of motion produced will be had by multiplying this velocity by the maſs L. This gives $\frac{L \times \sqrt{s y}}{\sqrt{L + y}}$; and this divided by the power expended, or by $L + y$, gives us the meaſure of the performance; namely, $\frac{L \sqrt{s y}}{\overline{L + y} \times \sqrt{L + y}}$.

That this may be a maximum, conſider y as the variable quantity, and make the fluxion of this formula $= o$. This will give us $y = \frac{L}{2}$.

Now $P = L + y, = L + \frac{L}{2}, = \frac{3}{2} L$. Therefore the *whole* load on the outer end of the beam, conſiſting of the water and the counter weight, muſt be two-thirds of the preſſure of the atmoſphere on the ſteam piſton.

We have here ſuppoſed that the expenditure is the atmoſpheric preſſure; and ſo it is if we conſider it mechanically. But the expenditure of which we are ſenſible, and which we are anxious to employ to the beſt advantage, is fuel. Suppoſing this to be employed with the ſame judgment in all caſes, we are almoſt intitled, by what we now know of the production of ſteam, to ſay that the ſteam produced is proportional to the fuel expended. But the ſteam requiſite for merely filling the cylinder is proportional to the area of the piſton, and therefore to the atmoſpheric preſſure. The reſult of our inveſtigation therefore is ſtill juſt; but the ſteam waſted by condenſation on the ſides of the cylinder does not follow this ratio, and this is more than what is neceſſary for merely filling it. This deranges our calculations, and is in favour of large cylinders; but this advantage muſt be in a great meaſure compenſated by a ſimilar variation in the production of the ſteam; for in ſimilar boilers of greater dimenſions the fuel is leſs advantageouſly employed, becauſe the ſurface to which the fuel is applied does not increaſe in the ratio of the capacity, juſt as the ſurface of the cylinder which waſtes the ſteam. The rule may therefore be confided in as pretty exact.

37 Theſe reſults agree with the moſt ſucceſsful practice.

It is a ſatisfactory thing to obſerve theſe reſults agree very well with the moſt ſucceſsful practice. By many changes and trials engineers have eſtabliſhed maxims of conſtruction, which are probably not very far from the beſt. It is a pretty general maxim, that the load of water ſhould be one-half of the atmoſpheric preſſure. They call this loading the engine with $7\frac{1}{2}$ pounds on the inch, and they ſay that ſo ſmall a load is neceſſary on account of the imperfect vacuum. But we have now ſeen that it is neceſſary for giving a reaſonable velocity of motion. Since, in this practice, w is made $\frac{1}{2}$ or $\frac{6}{12}$ths of P, and L ſhould be $\frac{8}{12}$ths of P, and L is $= w + p$; it follows, that the counter weight ſhould be

$\frac{1}{6}$th of P; and we have found this to be nearly the caſe in ſeveral very good engines.

It muſt be remarked, that in the preceding inveſtigation we introduced a quantity M to expreſs the reſiſtances to the motion of the engine. This was done in order to avoid a very troubleſome inveſtigation. The reſiſtances are of ſuch a nature as to vary with the velocity, and moſt of them as the ſquare of the velocity. This is the caſe with the reſiſtance ariſing from the motion of the water through the piſtons of the pumps, and that ariſing from the friction in the long lift during the working ſtroke. Had we taken the direct method, which is ſimilar to the determination of the motion through a medium which reſiſts in the duplicate ratio of the velocity, we muſt have uſed a very intricate exponential calculus, which few of our readers would have the patience to look at.

But the greateſt part of the quantity m ſuppoſes a motion already known, and its determination depends on this motion. We muſt now ſhow how its different component parts may be computed.

38 Reſiſtance to the motion of the engine computed.

1. What ariſes from the inertia of the moving parts is by far the moſt conſiderable portion of it. To obtain it, we muſt find a quantity of matter which, when placed at the end of the beam, will have the ſame momentum of inertia with that of the whole moving parts in their natural places. Therefore (in the returning ſtroke) add together the weight of the great piſton with its rod and chains; the pit pump-rods, chains, and any weight that is attached to them; the arch-heads and iron-work at the ends of the beam, and $\frac{4}{9}$ths of the weight of the beam itſelf; alſo the plug-beam with its arch-head and chain, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of half the length of the beam; alſo the jack-head pump-rod, chain, and arch-head, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of the half length of the beam. Theſe articles added into one ſum may be called M, and may be ſuppoſed to move with the velocity of the end of the beam. Suppoſe this beam to have made a ſix-foot ſtroke in two ſeconds, with an uniformly accelerated motion. In one ſecond it would have moved $1\frac{1}{2}$ feet, and would have acquired the velocity of three feet per ſecond. But in one ſecond gravity would have produced a velocity of 32 feet in the ſame maſs. Therefore the accelerating force, which has produced the velocity of three feet, is nearly $\frac{1}{11}$th of the weight. Therefore $\frac{M}{11}$ is the firſt conſtituent of m in the above inveſtigation. If the obſerved velocity is greater or leſs than three feet per ſecond, this value muſt be increaſed or diminiſhed in the ſame proportion.

The ſecond cauſe of reſiſtance, viz. the immerſion of the pump rods in water, is eaſily computed, being the weight of the water which they diſplace.

The third cauſe, the friction of the piſtons, &c. is almoſt inſignificant, and muſt be diſcovered by experiment.

The fourth cauſe depends on the ſtructure of the pumps. Theſe pumps, when made of a proper ſtrength, can hardly have the perforation of the piſton more than a fourth part of the area of the working-barrel; and the velocity with which the water paſſes through it is increaſed at leaſt $\frac{1}{4}$th by the contraction (ſee Pump). The velocity of the water is therefore five times greater than that of the piſton. A piſton 12 inches diameter, and moving one foot per ſecond, meets with a reſiſtance equal to 20 pounds; and this increaſes as the ſquare of the diameter and as the ſquare of the velocity. If the whole depth of the pit be divided into ſeveral lifts, this reſiſtance muſt be multiplied by the number of lifts, becauſe it obtains in each pump.

Thus we make up the value of m; and we muſt acknowledge that the method is ſtill indirect, becauſe it ſuppoſes the velocity to be known.

We may obtain it more eaſily in another way, but ſtill with this circumſtance of being indirect. We found that p was equal to $\sqrt{\mathrm{L}m}$, and conſequently $m = \frac{p^2}{\mathrm{L}}$. Now in any engine L and p can always be had; and unleſs p deviates greatly from the proportion which we determined to be the beſt, the value of m thus obtained will not be very erroneous.

39 Obſervations concerning ſomething preſumed in the inveſtigation

It was farther preſumed in this inveſtigation, that the motions both up and down were uniformly accelerated; but this cannot be the caſe when the reſiſtances increaſe with the velocity. This circumſtance makes very little change in the working-ſtroke, and therefore the theorem which determines the beſt relation of P to L may be confided in. The reſiſtances which vary with the velocity in this caſe are a mere trifle when compared with the moving power y. Theſe reſiſtances are, 1ſt, The ſtrangling of the water at the entry and at the ſtanding valve of each pump: This is about 37 pounds for a pump 12 inches diameter, and the velocity one foot per ſecond, increaſing in the duplicate ratio of the diameter and velocity. And, 2d, The friction of the water along the whole lift: This for a pump of the ſame ſize and with the ſame velocity, lifting 20 fathoms, is only about $2\frac{1}{3}$ pounds, and varies in the ſimple proportion of the diameter and the depth, and in the duplicate proportion of the velocity. The reſiſtance ariſing from inertia is greater than in the returning ſtroke; becauſe the M in this caſe muſt contain the momentum of the water both of the pit-pumps and the jackhead-pump: but this part of the reſiſtance does not affect the uniform acceleration. We may therefore confide in the propriety of the formula $y = \frac{\mathrm{L}}{2}$. And we may obtain the velocity of this ſtroke at the end of a ſecond with great accuracy as follows. Let $2g$ be the velocity communicated by gravity in a ſecond, and the velocity at the end of the firſt ſecond of the ſteam piſton's deſcent will be ſomewhat leſs than $\frac{y}{\mathrm{M}}2g$; where M expreſſes the inertia of all the parts which are in motion during the deſcent of the ſteam piſton, and therefore includes L. Compute the two reſiſtances juſt mentioned for this velocity. Call this r. Then $\frac{y - \frac{1}{2}r}{\mathrm{M}}\,2g$ will give another velocity infinitely near the truth.

But the caſe is very different in the returning ſtroke, and the proper ratio of p to L is not aſcertained with the ſame certainty: for the moving force p is not ſo great in proportion to the reſiſtance m; and therefore the acceleration of the motion is conſiderably affected by it, and the motion itſelf is conſiderably retarded, and in a very moderate time it becomes ſenſibly uniform: for it is preciſely ſimilar to the motion of a heavy body falling

falling through the air, and may be determined in the manner laid down in the article *RESISTANCE of Fluids*, viz. by an exponential calculus. We ſhall content ourſelves here with ſaying, that the reſiſtances in the preſent caſe are ſo great that the motion would be to all ſenſe uniform before the piſtons have deſcended one-third of their ſtroke, even although there were no other circumſtance to affect it.

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But this motion is affected by a circumſtance quite unconnected with any thing yet conſidered, depending on conditions not mechanical, and ſo uncertain, that we are not yet able to aſcertain them with any preciſion; yet they are of the utmoſt importance to the good performance and improvement of the engine, and therefore deſerve a particular conſideration.

The counter weight has not only to puſh down the pump rods, but alſo to *drag* up the great piſton. This it cannot do unleſs the ſteam be admitted into the cylinder. If the ſteam be no ſtronger than common air, it cannot enter the cylinder except *in conſequence* of the piſton's being dragged up. If common air were admitted into the cylinder, ſome force would be required to drag up the piſton, in the ſame manner as it is required to draw up the piſton of a common ſyringe; for the air would ruſh through the ſmall entry of the cylinder in the ſame manner as through the ſmall nozzle of the ſyringe. Some part of the atmoſpheric preſſure is employed in driving in the air with ſufficient velocity to fill the ſyringe, and it is only with the remainder that the admitted air preſſes on the under ſurface of the ſyringe. Therefore ſome of the atmoſpheric preſſure on its upper ſurface is not balanced. This is felt by the hand which draws it up. The ſame thing muſt happen in the ſteam engine, and ſome part of the counter weight is expended in drawing up the ſteam piſton. We could tell how much is thus expended if we knew the denſity of the ſteam; for this would tell us the velocity with which its elaſticity would cauſe it to fill the cylinder. If we ſuppoſe it 12 times rarer than air, which it certainly is, and the piſton riſes to the top of the cylinder in two ſeconds, we can demonſtrate that it will enter with a velocity not leſs than 1400 feet per ſecond, whereas 500 feet is enough to make it maintain a denſity $\frac{9}{10}$ths of that of ſteam in equilibrio with the air. Hence it follows, that its elaſticity will not be leſs than $\frac{29}{30}$ths of the elaſticity of the air, and therefore not more than $\frac{1}{30}$th of counter weight will be expended in drawing up the ſteam-piſton.

But all this is on the ſuppoſition that there is an unbounded ſupply of ſteam of undiminiſhed elaſticity. This is by no means the caſe. Immediately before opening the ſteam-cock, the ſteam was iſſuing through the ſafety-valve and all the crevices in the top of the boiler, and (in good engines) was about $\frac{1}{10}$th ſtronger or more elaſtic than air. This had been gathering during ſomething more than the deſcent of the piſton, viz. in about three ſeconds. The piſton riſes to the top in about two ſeconds; therefore about twice and a half as much ſteam as fills the dome of the boiler is now ſhared between the boiler and cylinder. The dome is commonly about ſix times more capacious than the cylinder. If therefore no ſteam is condenſed in the cylinder, the denſity of the ſteam, when the piſton has reached the top, muſt be about $\frac{15}{16}$ths of its former denſity, and ſtill more elaſtic than air. But as much ſteam is condenſed by the cold cylinder, its elaſticity muſt be leſs than this. We cannot tell how much leſs, both becauſe we do not know how much is thus condenſed, and becauſe by this diminution of its preſſure on the ſurface of the boiling water, it muſt be more copiouſly produced in the boiler; but an attentive obſervation of the engine will give us ſome information. The moment the ſteam-cock is opened we have a ſtrong puff of ſteam through the ſnifting valve. At this time, therefore, it is ſtill more elaſtic than air; but after this, the ſnifting valve remains ſhut during the whole riſe of the piſton, and no ſteam any longer iſſues through the ſafety-valve or crevices; nay, the whole dome of the boiler may be obſerved to ſink.

41
The elaſticity of the ſteam during the aſcent of the piſton greatly diminiſhed.

Theſe facts give abundant proof that the elaſticity of the ſteam during the aſcent of the piſton is greatly diminiſhed, and therefore much of the counter weight is expended in dragging up the ſteam piſton in oppoſition to the unbalanced part of the atmoſpheric preſſure. The motion of the returning ſtroke is therefore ſo much deranged by this foreign and inappreciated circumſtance, that it would have been quite uſeleſs to engage in the intricate exponential inveſtigation, and we muſt ſit down contented with a leſs perfect adjuſtment of the counter weight and weight of water.—Any perſon who attends to the motion of a ſteam-engine will perceive that the deſcent of the pump-rods is ſo far from being accelerated, that it is nearly uniform, and frequently it is ſenſibly retarded towards the end. We learn by the way, that it is of the utmoſt importance not only to have a quick production of ſteam, but alſo a very capacious dome, or empty ſpace above the water in the boiler. In engines where this ſpace was but four or five times the capacity of the cylinder, we have always obſerved a very ſenſible check given to the deſcent of the pump-rods after having made half their ſtroke. This obliges us to employ a greater counter weight, which diminiſhes the column of water, or retards the working ſtroke; it alſo obliges us to employ a ſtronger ſteam, at the riſk of burſting the boiler, and increaſes the expence of fuel.

42
How to know the elaſticity of the ſteam in the cylinder.

It would be a moſt deſirable thing to get an exact knowledge of the elaſticity of the ſteam in the cylinder; and this is by no means difficult. Take a long glaſs tube exactly calibered, and cloſe at the farther end. Put a ſmall drop of ſome coloured fluid into it, ſo as to ſtand at the middle nearly.—Let it be placed in a long box filled with water to keep it of a conſtant temperature. Let the open end communicate with the cylinder, with a cock between. The moment the ſteam-cock is opened, open the cock of this inſtrument. The drop will be puſhed towards the cloſe end of the tube, while the ſteam in the cylinder is more elaſtic than the air, and it will be drawn the other way while it is leſs elaſtic, and, by a ſcale properly adapted to it, the elaſticity of the ſteam correſponding to every poſition of the piſton may be diſcovered. The ſame thing may be done more accurately by a barometer properly conſtructed, ſo as to prevent the oſcillations of the mercury.

43
Neceſſary alſo to know the ſtate of the cylinder during the deſcent of the piſton.

It is equally neceſſary to know the ſtate of the cylinder during the deſcent of the ſteam-piſton. We have hitherto ſuppoſed P to be the full preſſure of the atmoſphere on the area of the piſton, ſuppoſing the vacuum below it to be complete. But the inſpection of our table of elaſticity ſhows that this can never be the caſe, becauſe the cylinder is always of a temperature far above 32°. We have made many attempts to diſcover its temperature.

perature. We have employed a thermometer in cloſe contact with the ſide of the cylinder, which ſoon acquired a ſteady temperature: this was never leſs than 145°. We have kept a thermometer in the water which lies on the piſton: this never ſunk below 135°. It is probable that the cylinder within may be cooled ſomewhat lower; but for this opinion we cannot give any very ſatisfactory reaſon. Suppoſe it cooled down to 120°; this will leave an elaſticity which would ſupport three inches of mercury. We cannot think, therefore, that the unbalanced preſſure of the atmoſphere exceeds that of 27 inches of mercury, which is about $13\frac{1}{3}$d pounds on a ſquare inch, or $10\frac{1}{4}$ on a circular inch. And this is the value which we ſhould employ in the equation $P=L+y$. This queſtion may be decided in the ſame way as the other, by a barometer connected with the inſide of the cylinder.

And thus we ſhall learn the ſtate of the moving forces in every moment of the performance, and the machine will then be as open to our examination as any water or horſe mill; and till this be done, or ſomething equivalent, we can only gueſs at what the machine is actually performing, and we cannot tell in what particulars we can lend it a helping hand. We are informed that Meſſrs Watt and Boulton have made this addition to ſome of their engines; and we are perſuaded that, from the information which they have derived from it, they have been enabled to make the curious improvements from which they have acquired ſo much reputation and profit.

44 Quantity of cold water to be injected.

There is a circumſtance of which we have as yet taken no notice, viz. the quantity of cold water injected. Here we confeſs ourſelves unable to give any preciſe inſtructions. It is clear at firſt ſight that no more than is abſolutely neceſſary ſhould be injected. It muſt generally be ſupplied by the engine, and this expends part of its power. An exceſs is much more hurtful by cooling the cylinder and piſton too much, and therefore waſting ſteam during the next riſe of the piſton. But the determination of the proper quantity requires a knowledge, which we have not yet acquired, of the quantity of heat contained in the ſteam in a latent form. As much water muſt be injected as will abſorb all this without riſing near to the boiling temperature. But it is of much more importance to know how far we may cool the cylinder with advantage; that is, when will the loſs of ſteam, during the next riſe of the piſton, compenſate for the diminution of its elaſticity during its preſent deſcent? Our table of elaſticities ſhows us, that by cooling the cylinder to 120°, we ſtill leave an elaſticity equal to one-tenth of the whole power of the engine; if we cool it only to 140, we leave an elaſticity of one-fifth; if we cool it to a blood-heat, we leave an elaſticity of one-twentieth. It is extremely difficult to chooſe among theſe varieties. Experience, however, informs us, that the beſt engines are thoſe which uſe the ſmalleſt quantities of injection water. We know an exceedingly good engine having a cylinder of 30 inches and a ſix feet ſtroke, which works with ſomething leſs than one-fifth of a cubic foot of water at each injection; and we imagine that the quantity ſhould be nearly in the proportion of the capacity of the cylinder. Deſaguliers obſerved, that a very good engine, with a cylinder of 32 inches, worked with 300 inches of water at each injection, which does not much exceed one-ſixth of a cubic foot. Mr Watt's obſervations, by means of the barometer, muſt have given him much valuable information in this particular, and we hope that he will not always withhold them from the public.

45 This examination, though no ſatisfactor may direct the attention to the principal circumſtances.

We have gone thus far in the examination, in order ſeemingly to aſcertain the motion of the engine when loaded and balanced in any known manner, and in order to diſcover that proportion between the moving power and the load which will produce the greateſt quantity of work. The reſult has been very unſatisfactory, becauſe the computation of the returning ſtroke is acknowledged to be beyond our abilities. But it has given us the opportunity of directing the reader's attention to the leading circumſtances in this inquiry. By knowing the internal ſtate of the cylinder in machines of very different goodneſs, we learn the connection between the ſtate of the ſteam and the performance of the machine; and it is very poſſible that the reſult of a full examination may be, that in ſituations where fuel is expenſive, it may be proper to employ a weak ſteam which will expend leſs fuel, although leſs work is performed by it. We ſhall ſee this confirmed in the cleareſt manner in ſome particular employments of the new engines invented by Watt and Boulton.

In the mean time, we ſee that the equation which we gave from the celebrated Abbé Boſſut, is in every reſpect erroneous even for the purpoſe which he had in view. We alſo ſee that the equation which we ſubſtituted in its place, and which was intended for determining that proportion between the counter-weight and the moving force, and the load which would render the working ſtroke and returning ſtroke of equal duration, is alſo erroneous, becauſe theſe two motions are extremely different in kind, the one being nearly uniform, and the other nearly uniformly accelerated. This being ſuppoſed true, it ſhould follow that the counter-weight ſhould be reduced to one-half; and we have found this to be very nearly true in ſome good engines which we have examined.

46 An erroneous maxim that the two motions are of equal duration.

We ſhall add but one obſervation more on this head. The practical engineers have almoſt made it a maxim, that the two motions are of equal duration. But the only reaſon which we have heard for the maxim, is, that it is awkward to ſee an engine go otherwiſe. But we doubt exceedingly the truth of this maxim; and, without being able to give any accurate determination, we think that the engine will do more work if the working ſtroke be made ſlower than the returning ſtroke. Suppoſe the engine ſo conſtructed that they are made in equal times; an addition to the counter-weight will accelerate the returning ſtroke and retard the working ſtroke. But as the counter-weight is but ſmall in proportion to the unbalanced portion of the atmoſpheric preſſure, which is the moving force of the machine, it is evident that this addition to the counter-weight muſt bear a much greater proportion to the counter-weight than it does to the moving force, and muſt therefore accelerate the returning ſtroke much more than it retards the working ſtroke, and the time of both ſtrokes taken together muſt be diminiſhed by this addition and the performance of the machine improved; and this muſt be the caſe as long as the machine is not extravagantly loaded. The beſt machine which we have ſeen, in reſpect of performance, raiſes a column of water whoſe weight is very nearly two-thirds of the preſſure of the atmoſphere

atmoſphere on the piſton, making 11 ſtrokes of ſix feet each per minute, and the working ſtroke was almoſt twice as ſlow as the other. This engine had worked pumps of 12 inches, which were changed for pumps of 14 inches, all other things remaining the ſame. In its former ſtate it made from 12 and a half to 13 and a half ſtrokes per minute, the working ſtroke being conſiderably ſlower than the returning ſtroke. The load was increaſed, by the change of the pumps, nearly in the proportion of three to four. This had retarded the working ſtroke; but the performance was evidently increaſed in the proportion of 3×13 to 4×11, or of 39 to 44. About 300 pounds were added to the counterweight, which increaſed the number of ſtrokes to more than 12 per minute. No ſenſible change could be obſerved in the time of the working ſtroke. The performance was therefore increaſed in the proportion of 39 to 48. We have therefore no heſitation in ſaying, that the ſeemly equality of the two ſtrokes is a ſacrifice to fancy. The engineer who obſerves the working ſtroke to be ſlow, fears that his engine may be thought feeble and unequal to its work; a ſimilar notion has long milled him in the conſtruction of water-mills, eſpecially of overſhot mills; and even now he is ſubmitting with heſitation and fear to the daily correction of experience.

It is needleſs to engage more deeply in ſcientific calculations in a ſubject where ſo many of the data are ſo very imperfectly underſtood.

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We venture to recommend as a maxim of conſtruction (ſuppoſing always a large boiler and plentiful ſupply of pure ſteam unmixed with air), that the load of work be not leſs than 10 pounds for every ſquare inch of the piſton, and the counter-weight ſo proportioned that the time of the returning ſtroke may not exceed two-thirds of that of the working ſtroke. A ſerious objection may be made to this maxim, and it deſerves mature conſideration. Such a load requires the utmoſt care of the machine, that no admiſſion be given to the common air; and it precludes the poſſibility of its working, in caſe the growth of water, or deepening the pit, ſhould make a greater load abſolutely neceſſary. Theſe conſiderations muſt be left to the prudence of the engineer. The maxim now recommended relates only to the beſt actual performance of the engine.

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Before quitting this machine, it will not be amiſs to give ſome eaſy rules, ſanctioned by ſucceſsful practice, for computing its performance. Theſe will enable any artiſt, who can go through ſimple calculations, to ſuit the ſize of his engine to the taſk which it is to perform.

The circumſtance on which the whole computation muſt be founded is the quantity of water which muſt be drawn in a minute, and the depth of the mine; and the performance which may be expected from a good engine is at leaſt 12 ſtrokes per minute of ſix feet each, working againſt a column of water whoſe weight is equal to half of the atmoſpheric preſſure on the ſteam-piſton, or rather to 7.64 pounds on every ſquare inch of its ſurface.

It is moſt convenient to eſtimate the quantity of water in cubic feet, or its weight in pounds, recollecting that a cubic foot of water weighs 62$\frac{1}{2}$ pounds. The depth of the pit is uſually reckoned in fathoms of ſix feet, and the diameter of the cylinder and pump is uſually reckoned in inches.

Let Q be the quantity of water to be drawn per minute in cubical feet, and f the depth of the mine in fathoms; let c be the diameter of the cylinder, and p that of the pump; and let us ſuppoſe the arms of the beam to be of equal length.

1ſt, To find the diameter of the pump, the area of the piſton in ſquare feet is $p^2 \times \frac{0.7854}{144}$. The length of the column drawn in one minute is 12 times 6 or 72 feet, and therefore its ſolid contents is $p^2 \times \frac{72 \times 0.7854}{144}$ cubical feet, or $p^2 \times 0.3927$ cubical feet. This muſt be equal to Q; therefore p^2 muſt be $\frac{Q}{0.3927}$ or nearly Q $\times 2\frac{1}{2}$. Hence this practical rule: Multiply the cubic feet of water which muſt be drawn in a minute by 2$\frac{1}{2}$, and extract the ſquare root of the product: this will be the diameter of the pump in inches.

Thus ſuppoſe that 58 cubic feet muſt be drawn every minute; 58 multiplied by 2$\frac{1}{2}$ gives 145, of which the ſquare root is 12, which is the required diameter of the pump.

2. To find the proper diameter of the cylinder.

The piſton is to be loaded with 7.64 pounds on every ſquare inch. This is equivalent to ſix pounds on a circular inch very nearly. The weight of a cylinder of water an inch in diameter and a fathom in height is 2$\frac{1}{24}$ pounds, or nearly two pounds. Hence it follows that $6c^2$ muſt be made equal to $2fp^2$, and that c^2 is equal to $\frac{2fp^2}{6}$, or to $\frac{fp^2}{3}$.

Hence the following rule: Multiply the ſquare of the diameter of the pump piſton (found as above) by the fathoms of lift, and divide the product by 3; the ſquare root of the quotient is the diameter of the cylinder.

Suppoſe the pit to which the foregoing pump is to be applied is 24 fathoms deep; then $\frac{24 \times 144}{3}$ gives 1152, of which the ſquare root is 34 inches very nearly.

This engine, conſtructed with care, will certainly do the work.

Whatever is the load of *water* propoſed for the engine, let 10 be the pounds on every circular inch of the ſteam piſton, and make $c^2 = p^2 \times \frac{2f}{m}$, and the ſquare root will be the diameter of the ſteam piſton in inches.

To free the practical engineer as much as poſſible from all trouble of calculation, we ſubjoin the following *TABLE of the Dimenſions and Power of the Steam Engine*, drawn up by Mr Beighton in 1717, and fully verified by practice ſince that time. The meaſure is in Engliſh ale gallons of 282 cubic inches.

49 Mr Beighton's table of the dimenſions and power of the ſteam-engine.

Diam. of pump.	Holds in one yard.	Draws by a ſix feet ſtroke.	Weighs in one yard.	At 16 ſtrokes per min.	Ditto in hogſheads.	Ditto per hour.
Inch.	Gall.	Gall.	Lb. avoir.	Gall.	Hd. Gal.	Hd. Gal.
12	14.4	28.8	146	462	7.21	440.
11	12.13	24.26	123.5	338	6.20	369.33
10	10.02	20.04	102	320	5.5	304.48
9	8.12	16.24	82.7	259.8	4.7	247.7
8½	7.26	14.52	73.9	232.3	3.43	221.15
8	6.41	12.82	65.3	205.2	3.16	195.22
7¾	6.01	12.02	61.2	192.3	3.2	182.13
7½	5.66	11.32	57.6	181.1	2.55	172.30
7	4.91	9.82	50.0	157.r	2.31	149.40
6½	4.23	8.46	43.	135.3	2.9	128.54
6	3.61	7.2	36.7	115.5	1.52	110.1
5½	3.13	6.2	31.8	99.2	1.36	94.30
5	2.51	5.0	25.5	80.3	1.7	66.61
4½	2.02	4.04	20.5	64.6	1.1	60.60
4	1.6	3.2	16.2	51.2	0.51	48.51

Diameter of cylinder in inches.

The depth to be drawn in yards.											
15	20	25	30	35	40	45	50	60	70	80	90
18½	21¾	24	26½	28½	30½	32½	34¼	37¼	40	43½	
17	19¾	22	25	26¼	28	29¼	31¼	34½	37	39½	
15½	18	20	22	23¾	25¼	27	28¾	31¼	34	36	38½
14	16¼	18	20	21½	23	24¼	25	28	30½	33	35
13½	15¼	17¼	19	20¼	21¾	23	24	26¼	28½	31	32½
12½	14½	16½	18½	19	20½	21½	23	25	27	29	30½
12	14	15½	17½	18¾	19¾	21	22	24¼	26	28	29½
11	13¾	15	16½	18	19	20	21¼	23¼	25	27	28½
10¾	13	14	15½	16¾	18¾	19	20½	22	24	25½	27
10	12	13	14	15½	16¼	18	19	20	22	23	24½
9½	11	12	13	14	15½	16	17	19	20½	22	23
	10	11	12	13	14	15	15¾	17	19	20	21
		10	11	11¾	13	13¾	14	15½	16¾	18½	19½
			10	11	11¾	12	13½	14	15	16	17
				9	10	11	11½	12	13½	14	15

The firſt part of the table gives the ſize of the pump ſuited to the growth of water. The ſecond gives the ſize of the cylinder ſuited to the load of water. If the depth is greater than any in this table, take its fourth part, and double the diameter of the cylinder. Thus if 150 hogſheads are to be drawn in an hour from the depth of 100 fathoms, the laſt column of part firſt gives for 149.40 a pump of ſeven inches bore. In a line with this, under the depth of 50 yards, which is one-fourth of 100 fathoms, we find 20½, the double of which is 41 inches for the diameter of the cylinder.

It is almoſt impoſſible to give a general rule for ſtrokes of different lengths, &c. but any one who profeſſes the ability to erect an engine, ſhould ſurely know as much arithmetic as will accommodate the rule now given to any length of ſtroke.

We venture to ſay, that no ordinary engineer can tell *à priori* the number per minute which an engine will give. We took 12 ſtrokes of ſix feet each for a ſtandard, which a careful engineer may eaſily accompliſh, and which an employer has a right to expect, the engine being loaded with water to half the preſſure of the atmoſphere: if the load be leſs, there is ſome fault—an improper counter weight, or too little boiler, or leaks, &c. &c.

50 Mr Fitzgerald's method of converting its reciprocating motion into a continued rotatory motion.

Such is the ſtate in which Newcomen's ſteam-engine had continued in uſe for 60 years, neglected by the philoſopher, although it is the moſt curious object which human ingenuity has yet offered to his contemplation, and abandoned to the efforts of the unlettered artiſt. Its uſe has been entirely confined to the raiſing of water. Mr Keane Fitzgerald indeed publiſhed in the Philoſophical Tranſactions a method of converting its reciprocating motion into a continued rotatory motion by employing the great beam to work a crank or a train of wheel-work. As the real action of the machine is confined to its working ſtroke, to accompliſh this, it became neceſſary to connect with the crank or wheeled work a very large and heavy fly, which ſhould accumulate in itſelf the whole preſſure of the machine during its time of action, and therefore continue in motion, and urge forward the working machinery, while the ſteam-engine was going through its inactive returning ſtroke. This will be the caſe, provided that the reſiſtance exerted by the working machine during the whole period of the working and returning ſtroke of the ſteam-engine, together with the friction of both, does not exceed the whole preſſure exerted by the ſteam-engine during its working ſtroke; and provided that the momentum of the fly, ariſing from its great weight and velocity, be very great, ſo that the reſiſtance of the work during one returning ſtroke of the ſteam-engine do not make any very ſenſible diminution of the velocity of the fly. This is evidently poſſible and eaſy. The fly may be made of any magnitude; and being exactly balanced round its axis, it will ſoon acquire any velocity conſiſtent with the motion of the ſteam-engine. During the working ſtroke of the engine it is uniformly accelerated, and by its acquired momentum it produces in the beam the movement of the returning ſtroke; but in doing this, its momentum is ſhared with the inert matter of the ſteam-engine, and conſequently its velocity diminiſhed, but not entirely taken away. The next working ſtroke therefore, by preſſing on it afreſh, increaſes its remaining velocity by a quantity nearly equal to the whole that it acquired during the firſt ſtroke. We ſay *nearly*, but not quite equal, becauſe the time of the ſecond working ſtroke muſt be ſhorter than that of the firſt, on account of the velocity already in the machine. In this manner the fly will be more and more accelerated every ſucceeding ſtroke, becauſe the preſſure of the engine during the working ſtroke does more than reſtore to the fly the momentum which it loſt in producing the returning movement of the ſteam-engine. Now ſuppoſe the working part of the machine to be added. The acceleration of the fly during each working ſtroke of the ſteam-engine will be leſs than it was before, becauſe the impelling preſſure is now partly employed in driving the working machine, and becauſe the fly will loſe more of its momentum during the returning ſtroke of the ſteam-engine, part of it being expended in driving the working machine. It is evident, therefore, that a time will come

come when the ſucceſſive augmentation of the fly's velocity will ceaſe; for, on the one hand, the continual acceleration diminiſhes the time of the next working ſtroke, and therefore the time of action of the accelerating power. The acceleration muſt diminiſh in the ſame proportion; and on the other hand, the reſiſtance of the working machine generally, though not always, increaſes with its velocity. The acceleration ceaſes whenever the addition made to the momentum of the fly during a working ſtroke of the ſteam-engine is juſt equal to what it loſes by driving the machine, and by producing the returning movement of the ſteam-engine.

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This muſt be acknowledged to be a very important addition to the engine, and though ſufficiently obvious, it is ingenious, and requires conſiderable ſkill and addreſs to make it effective (B).

The movement of the working machine, or mill of whatever kind, muſt be in ſome degree hobbling or unequal. But this may be made quite inſenſible, by making the fly exceedingly large, and diſpoſing the greateſt part of its weight in the rim. By theſe means its momentum may be made ſo great, that the whole force required for driving the mill and producing the returning movement of the engine may bear a very ſmall proportion to it. The diminution of its velocity will then be very trifling.

No counter weight is neceſſary here, becauſe the returning movement is produced by the inertia of the fly. A counter weight may, however, be employed, and ſhould be employed, viz. as much as will produce the returning movement of the ſteam-engine. It will do this better than the ſame force accumulated in the fly; for this force muſt be accumulated in the fly by the intervention of rubbing parts, by which ſome of it is loſt; and it muſt be afterwards returned to the engine with a ſimilar loſs. But, for the ſame reaſon, it would be improper to make the counter weight alſo able to drive the mill during the returning ſtroke.

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never
opted.

By this contrivance Mr Fitzgerald hoped to render the ſteam-engine of moſt extenſive uſe; and he, or others aſſociated with him, obtained a patent excluding all others from employing the ſteam-engine for turning a crank. They alſo publiſhed propoſals for erecting mills of all kinds driven by ſteam-engines, and ſtated very fairly their powers and their advantages. But their propoſals do not ſeem to have acquired the confidence of the public; for we do not know of any mill ever having been erected under this patent.

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penſe of
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The great obſtacle to this extenſive uſe of the ſteam-engine is the prodigious expence of fuel. An engine having a cylinder of four feet diameter, working night and day, conſumes about 3400 chaldron (London) of good coals in a year.

54
limits the
uſe of
ſteam-engines.

This circumſtance limits the uſe of ſteam-engines exceedingly. To draw water from coal-pits, where they can be ſtocked with unſaleable ſmall coal, they are of univerſal employment: alſo for valuable mines, for ſupplying a great and wealthy city with water, and a few other purpoſes where a great expence can be borne, they are very proper engines; but in a thouſand caſes where their unlimited powers might be vaſtly ſerviceable, the enormous expence of fuel completely excludes them. We cannot doubt but that the attention of engineers was much directed to every thing that could promiſe a diminution of this expence. Every one had his particular noſtrum for the conſtruction of his furnace, and ſome were undoubtedly more ſucceſsful than others. But ſcience was not yet ſufficiently advanced: It was not till Dr Black had made his beautiful diſcovery of latent heat, that we could know the intimate relation between the heat expended in boiling off a quantity of water and the quantity of ſteam that is produced.

55
Mr Watt
diſcovers
that ſteam
contains an
immenſe
quantity
of heat

Much about the time of this diſcovery, viz. 1763, Mr James Watt, eſtabliſhed in Glaſgow in the commercial line, was amuſing himſelf with repairing a working model of the ſteam-engine which belonged to the philoſophical apparatus of the univerſity. Mr Watt was a perſon of a truly philoſophical mind, eminently converſant in all branches of natural knowledge, and the pupil and intimate friend of Dr Black. In the courſe of the above-mentioned amuſement many curious facts in the production and condenſation of ſteam occurred to him; and among others, that remarkable fact which is always appealed to by Dr Black as the proof of the immenſe quantity of heat which is contained in a very minute quantity of water in the form of elaſtic ſteam. When a quantity of water is heated ſeveral degrees above the boiling point in a cloſe digeſter, if a hole be opened, the ſteam ruſhes out with prodigious violence, and the heat of the remaining water is reduced, in the courſe of three or four ſeconds, to the boiling temperature. The water of the ſteam which has iſſued amounts only to a very few drops; and yet theſe have carried off with them the whole exceſs of heat from the water in the digeſter.

56
in his attempts to
find out a
way to
huſband
this heat,

Since then a certain quantity of ſteam contains ſo great a quantity of heat, it muſt expend a great quantity of fuel; and no conſtruction of furnace can prevent this. Mr Watt therefore ſet his invention to work to diſcover methods of huſbanding this heat. The cylinder of his little model was heated almoſt in an inſtant, ſo that it could not be touched by the hand. It could not be otherwiſe, becauſe it condenſed the vapour by abſtracting its heat. But all the heat thus communicated to the cylinder, and waſted by it on ſurrounding bodies, contributed nothing to the performance of the engine,

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(B) We do not recollect at preſent the date of this propoſal of Mr Fitzgerald; but in 1781 the Abbé Arnal, canon of Alais in Languedoc, entertained a thought of the ſame kind, and propoſed it for working lighters in the inland navigations; a ſcheme which has been ſucceſsfully practiſed (we are told) in America. His brother, a major of engineers in the Auſtrian ſervice, has carried the thing much farther, and applied it to manufactures; and the Aulic Chamber of Mines at Vienna has patronized the project: (See *Journal Encyclopedique*, 1781). But theſe ſchemes are long poſterior to Mr Fitzgerald's patent, and are even later than the erection of ſeveral machines driven by ſteam-engines which have been erected by Meſſrs Watt and Boulton. We think it our duty to ſtate theſe particulars, becauſe it is very uſual for our neighbours on the continent to aſſume the credit of Britiſh inventions.

engine, and muſt be taken away at every injection, and again communicated and waſted. Mr Watt quickly underſtood the whole proceſs which was going on within the cylinder, and which we have conſidered ſo minutely, and ſaw that a very conſiderable portion of the ſteam muſt be waſted in warming the cylinder. His firſt attempts were made to aſcertain how much was thus waſted, and he found that it was not leſs than three or four times as much as would fill the cylinder and work the engine. He attempted to diminiſh this waſte by uſing wooden cylinders. But though this produced a ſenſible diminution of the waſte, other reaſons forced him to give them up. He then caſed his metal cylinders in a wooden caſe with light wood aſhes between. By this, and uſing no more injection than was abſolutely neceſſary for the condenſation, he reduced the waſte almoſt one half. But by uſing ſo ſmall a quantity of cold water, the inſide of the cylinder was hardly brought below the boiling temperature; and there conſequently remained in it a ſteam of very conſiderable elaſticity, which robbed the engine of a proportional part of the atmoſpherical preſſure. He ſaw that this was unavoidable as long as the condenſation was performed in the cylinder. The thought ſtruck him to attempt the condenſation in another place. His firſt experiment was made in the ſimpleſt manner. A globular veſſel communicated by means of a long pipe of one inch diameter with the bottom of his little cylinder of four inches diameter and 30 inches long. This pipe had a ſtop-cock, and the globe was immerſed in a veſſel of cold water. When the piſton was at the top, and the cylinder filled with ſtrong ſteam, he turned the cock. It was ſcarcely turned, nay he did not think it completely turned, when the ſides of his cylinder (only ſtrong tin-plate) were cruſhed together like an empty bladder. This ſurpriſed and delighted him. A new cylinder was immediately made of braſs ſufficiently thick, and nicely bored. When the experiment was repeated with this cylinder, the condenſation was ſo rapid, that he could not ſay that any time was expended in it. But the moſt valuable diſcovery was, that the vacuum in the cylinder was, as he hoped, almoſt perfect. Mr Watt found, that when he uſed water in the boiler purged of air by long boiling, nothing that was very ſenſibly inferior to the preſſure of the atmoſphere on the piſton could hinder it from coming quite down to the bottom of the cylinder. This alone was gaining a great deal, for in moſt engines the remaining elaſticity of the ſteam was not leſs than one-eighth of the atmoſpherical preſſure, and therefore took away one-eighth of the power of the engine.

57 diſcovers a method of condenſing the ſteam at a little diſtance from the cylinder,

58 and removes the difficulties which attended this improvement by means of pumps.

Having gained this capital point, Mr Watt found many difficulties to ſtruggle with before he could get the machine to continue its motion. The water produced from the condenſed ſteam, and the air which was extricated from it, or which penetrated through unavoidable leaks, behoved to accumulate in the condenſing veſſel, and could not be voided in any way ſimilar to that adopted in Newcomen's engine. He took another method: He applied pumps to extract both, which were worked by the great beam. The contrivance is eaſy to any good mechanic; only we muſt obſerve, that the piſton of the water-pump muſt be under the ſurface of the water in the condenſer, that the water may enter the pump by its own weight, becauſe there is no atmoſpherical preſſure there to force it in. We muſt alſo obſerve, that a conſiderable force is neceſſarily expended here, becauſe, as there is but one ſtroke for rarefying the air, and this rarefaction muſt be nearly complete, the air-pump muſt be of large dimenſions, and its piſton muſt act againſt the whole preſſure of the atmoſphere. Mr Watt, however, found that this force could be eaſily ſpared from his machine, already ſo much improved in reſpect of power.

59 Obſervations on advantages of theſe diſcoveries.

Thus has the ſteam-engine received a very conſiderable improvement. The cylinder may be allowed to remain very hot; nay, boiling hot, and yet the condenſation be completely performed. The only elaſtic ſteam that now remains is the ſmall quantity in the pipe of communication. Even this ſmall quantity Mr Watt at laſt got rid of, by admitting a ſmall jet of cold water up this pipe to meet the ſteam in its paſſage to the condenſer. This both cooled this part of the apparatus in a ſituation where it was not neceſſary to warm it again, and it quickened the condenſation. He found at laſt that the ſmall pipe of communication was of itſelf ſufficiently large for the condenſation, and that no ſeparate veſſel, under the name of condenſer, was neceſſary. This circumſtance ſhows the prodigious rapidity of the condenſation. We may add, that unleſs this had been the caſe, his improvement would have been vaſtly diminiſhed; for a large condenſer would have required a much larger air-pump, which would have expended much of the power of the engine. By theſe means the vacuum below the piſton is greatly improved: for it will appear clear to any perſon who underſtands the ſubject, that as long as any part of the condenſer is kept of a low temperature, it will abſtract and condenſe the vapour from the warmer parts, till the whole acquires the elaſticity correſponding to the coldeſt part. By the ſame means much of the waſte is prevented, becauſe the cylinder is never cooled much below the boiling temperature. Many engines have been erected by Mr Watt in this form, and their performance gave univerſal ſatisfaction.

We have contented ourſelves with giving a very ſlight deſcription without a figure of this improved engine, becauſe we imagine it to be of very eaſy comprehenſion, and becauſe it is only a preparation for ſtill greater improvements, which, when underſtood, will at the ſame time leave no part of this more ſimple form unexplained.

60 Mr Watt makes the piſton deſcend by the force of ſteam.

During the progreſs of theſe improvements Mr Watt made many experiments on the quantity and denſity of the ſteam of boiling water. Theſe fully convinced him, that although he had greatly diminiſhed the waſte of ſteam, a great deal yet remained, and that the ſteam expended during the riſe of the piſton was at leaſt three times more than what would fill the cylinder. The cauſe of this was very apparent, In the ſubſequent deſcent of the piſton, covered with water much below the boiling temperature, the whole cylinder was neceſſarily cooled and expoſed to the air. Mr Watt's fertile genius immediately ſuggeſted to him the expedient of employing the elaſticity of the ſteam from the boiler to impel the piſton down the cylinder, in place of the preſſure of the atmoſphere; and thus he reſtored the engine to its firſt principles, making it an engine *really moved by ſteam.* As this is a new epoch in its hiſtory, we ſhall be more particular in the deſcription; at the ſame

ſame time ſtill reſtricting ourſelves to the eſſential circumſtances, and avoiding every peculiarity which is to be found in the prodigious varieties which Mr Watt has introduced into the machines which he has erected, every individual of which has been adapted to local circumſtances, or diverſified by the progreſs of Mr Watt's improvements.

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g. 9.

Let A (fig. 9.) repreſent the boiler. This has received great improvements from his complete acquaintance with the procedure of nature in the production of ſteam. In ſome of his engines the fuel has been placed in the midſt of the water, ſurrounded by an iron or copper veſſel, while the exterior boiler was made of wood, which tranſmits, and therefore waſtes the heat very ſlowly. In others, the flame not only plays round the whole outſide, as in common boilers, but alſo runs along ſeveral flues which are conducted through the midſt of the water. By ſuch contrivances the fire is applied to the water in a moſt extenſive ſurface, and for a long time, ſo as to impart to it the greateſt part of its heat. So ſkilfully was it applied in the Albion mills, that although it was perhaps the largeſt engine in the kingdom, its unconſumed ſmoke was inferior to that of a very ſmall brew-houſe. In this ſecond engine of Mr Watt, the top of the cylinder is ſhut up by a ſtrong metal plate *g h*, in the middle of which is a collar or box of leathers *k l*, formed in the uſual manner of a jack-head pump, through which the piſton rod PD, nicely turned and poliſhed, can move up and down, without allowing any air to paſs by its ſides. From the dome of the boiler proceeds a large pipe BCIOQ, which, after reaching the cylinder with its horizontal part BC, deſcends parallel to its ſide, ſending off two branches, viz. IM to the top of the cylinder, and ON to its bottom. At I is a puppet valve opening from below upwards. At L, immediately below this branch, there is a ſimilar valve, alſo opening from below upwards. The pipe deſcends to Q, near the bottom of a large ciſtern *c d e f*, filled with cold water conſtantly renewed. The pipe is then continued horizontally along the bottom of this ciſtern (but not in contact), and terminates at R in a large pump ST. The piſton S has clack valves opening upwards, and its rod S *s*, paſſing through a collar of leathers at T, is ſuſpended by a chain to a ſmall arch head on the outer arm of the beam. There is a valve R in the bottom of this pump, as uſual, which opens when preſſed in the direction QR, and ſhuts againſt a contrary preſſure. This pump delivers its contents into another pump XY, by means of the ſmall pipe *t* X, which proceeds from its top. This ſecond pump has a valve at X, and a clack in its piſton Z as uſual, and the piſton rod Z *z* is ſuſpended from another arch head on the outer arm of the beam. The two valves I and L are opened and ſhut by means of ſpanners and handles, which are put in motion by a plug frame, in the ſame manner as in Newcomen's engine.

Laſtly, there may be obſerved a crooked pipe *a b o*, which enters the upright pipe laterally a little above Q. This has a ſmall jet hole at *o*; and the other end *a*, which is conſiderably under the ſurface of the water of the condenſing ciſtern, is covered with a puppet valve *v*, whoſe long ſtalk *v u* riſes above the water, and may be raiſed or lowered by hand or by the plug beam. The valves R and X, and the clacks in the piſtons S and Z, are opened or ſhut by the preſſure to which they are immediately expoſed.

This figure is not an exact copy of any of Mr Watt's engines, but has its parts ſo diſpoſed that all may come diſtinctly into view, and exactly perform their various functions. It is drawn in its quieſcent poſition, the outer end of the beam preponderating by the counter weight, and the piſton P at the top of the cylinder, and the piſtons S and Z in their loweſt ſituations.

In this ſituation let us ſuppoſe that a vacuum is (by any means) produced in all the ſpace below the piſton, the valve I being ſhut. It is evident that the valve R will alſo be ſhut, as alſo the valve *v*. Now let the valve I be opened. The ſteam from the boiler, as elaſtic as common air, will ruſh into the ſpace above the piſton, and will exert on it a preſſure as great as that of the atmoſphere. It will therefore preſs it down, raiſe the outer end of the beam, and cauſe it to perform the ſame work as an ordinary engine.

When the piſton P has reached the bottom of the cylinder, the plug frame ſhuts the valve I, and opens L. By ſo doing the communication is open between the top and bottom of the cylinder, and nothing hinders the ſteam which is above the piſton from going along the paſſage MLON. The piſton is now equally affected on both ſides by the ſteam, even though a part of it is continually condenſed by a cylinder, and in the pipe IOQ. Nothing therefore hinders the piſton from being dragged up by the counter weight, which acts with its whole force, undiminiſhed by any remaining unbalanced elaſticity of ſteam. Here therefore this form of the engine has an advantage (and by no means a ſmall one) over the common engines, in which a great part of the counter weight is expended in overcoming unbalanced atmoſpheric preſſure.

Whenever the piſton P arrives at the top of the cylinder, the valve L is ſhut by the plug frame, and the valves I and *v* are opened. All the ſpace below the piſton is at this time occupied by the ſteam which came from the upper part of the cylinder. This being a little waſted by condenſation, is not quite a balance for the preſſure of the atmoſphere. Therefore, during the aſcent of the piſton, the valve R was ſhut, and it remains ſo. When, therefore, the valve *v* is opened, the cold water of the ciſtern muſt ſpout up through the hole *o*, and condenſe the ſteam. To this muſt be added the coldneſs of the whole pipe OQS. As faſt as it is condenſed, its place is ſupplied by ſteam from the lower part of the cylinder. We have already remarked, that this ſucceſſive condenſation is accompliſhed with aſtoniſhing rapidity. In the mean time ſteam from the boiler preſſes on the upper ſurface of the piſton. It muſt therefore deſcend as before, and the engine muſt perform a ſecond working ſtroke.

But in the mean time the injection water lies in the bottom of the pipe OQR, heated to a conſiderable degree by the condenſation of the ſteam; alſo a quantity of air has been diſengaged from it and from the water in the boiler. How is this to be diſcharged?—This is the office of the pumps ST and XY. The capacity of ST is very great in proportion to the ſpace in which the air and water are lodged. When, therefore, the piſton S has got to the top of its courſe, there muſt be a vacuum in the barrel of this pump, and the water and air muſt open the valve R and come into it. When the

piſton

Steam-Engine.

piſton S comes down again in the next returning ſtroke, this water and air gets through the valve of the piſton; and in the next working ſtroke they are diſcharged by the piſton into the pump XY, and raiſed by its piſton. The air eſcapes at Y, and as much of the water as is neceſſary is delivered into the boiler by a ſmall pipe Y g to ſupply its waſte. It is a matter of indifference whether the piſtons S and Z riſe with the outer or inner end of the beam, but it is rather better that they riſe with the inner end. They are otherwiſe drawn here, in order to detach them from the reſt and ſhow them more diſtinctly.

Such is Mr Watt's ſecond engine. Let us examine its principles, that we may ſee the cauſes of its avowed and great ſuperiority over the common engines.

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Cauſes of its ſuperiority over common engines are, the full operation of the counter weight,

We have already ſeen one ground of ſuperiority, the full operation of the counter weight. We are authoriſed by careful examination to ſay, that in the common engines at leaſt one-half of the counter weight is expended in counteracting an unbalanced preſſure of the air on the piſton during its aſcent. In many engines, which are not the worſt, this extends to $\frac{1}{3}$th of the whole preſſure. This is evident from the examination of the engine at Montrelaix by Boſſut. This makes a very great counter weight neceſſary, which exhauſts a proportional part of the moving force,

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and great ſaving of ſteam.

But the great advantage of Mr Watt's form is the almoſt total annihilation of the waſte of ſteam by condenſation in the cylinder. The cylinder is always boiling hot, and therefore perfectly dry. This muſt be evident to any perſon who underſtands the ſubject By the time that Mr Watt had completed his improvements, his experiments on the production of ſteam had given him a pretty accurate knowledge of its denſity; and he found himſelf authoriſed to ſay, that the quantity of ſteam employed did not exceed twice as much as would fill the cylinder, ſo that not above one-half was unavoidably waſted. But before he could bring the engine to this degree of perfection, he had many difficulties to overcome: He incloſed the cylinder in an outer wooden caſe at a ſmall diſtance from it. This diminiſhed the expence of heat by communication to ſurrounding bodies. Sometimes he allowed the ſteam from the boiler to occupy this interval. This undoubtedly prevented all diſſipation from the inner cylinder; but in its turn it diſſipated much heat by the outer caſe, and a very ſenſible condenſation was obſerved between them. This has occaſioned him to omit this circumſtance in ſome of his beſt engines. We believe it was omitted in the Albion mills.

The greateſt difficulty was to make the great piſton tight. The old and effectual method, by water lying on it, was inadmiſſible. He was therefore obliged to have his cylinders moſt nicely bored, perfectly cylindrical, and finely poliſhed; and he made numberleſs trials of different ſoft ſubſtances for packing his piſton, which ſhould be tight without enormous friction, and which ſhould long remain ſo, in a ſituation perfectly dry, and hot almoſt to burning.

After all that Mr Watt has done in this reſpect, he thinks that the greateſt part of the waſte of ſteam which he ſtill perceives in his engines ariſes from the unavoidable eſcape by the ſides of the piſton during its deſcent.

But the fact is, that an engine of this conſtruction, of the ſame dimenſions with a common engine, making the ſame number of ſtrokes of the ſame extent, does not conſume above one-fourth part of the fuel that is conſumed by the beſt engines of the common form. It is alſo a very fortunate circumſtance, that the performance of the engine is not immediately deſtroyed, nor indeed ſenſibly diminiſhed, by a ſmall want of tightneſs in the piſton. In the common engine, if air get in, in this way, it immediately puts a ſtop to the work; but although even a conſiderable quantity of ſteam get paſt the piſton during its deſcent, the rapidity of condenſation is ſuch, that hardly any diminution of preſſure can be obſerved.

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Another valuable property of it

Mr Watt's penetration ſoon diſcovered another moſt valuable property of this engine. When an engine of the common form is erected, the engineer muſt make an accurate eſtimate of the work to be performed, and muſt proportion his engine accordingly. He muſt be careful that it be *fully* able to execute its taſk; but its power muſt not exceed its load in any extravagant degree. This would produce a motion which is too rapid, and which, being alternately in oppoſite directions, would occaſion jolts which no building or machinery could withſtand. Many engines have been ſhattered by the pumps drawing air, or a pump-rod breaking; by which accidents the ſteam-piſton deſcends with ſuch rapidity that every thing gives way. But in moſt operations of mining, the taſk of the engine increaſes, and it muſt be ſo conſtructed at firſt as to be able to bear this addition. It is very difficult to manage an engine that is much ſuperior to its taſk; and the eaſieſt way is, to have it almoſt full loaded, and to work it only during a few hours each day, and allow the pit water to accumulate during its repoſe. This increaſes the firſt coſt, and waſtes fuel during the inaction of the engine.

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is, that it can alway be exactl fitted to the load which hap pens to b on it.

But this new engine can at all times be exactly fitted (at leaſt during the working ſtroke) to the load of work that then happens to be on it. We have only to adminiſter ſteam of a proper elaſticity. At the firſt erection the engine may be equal to twice its taſk, if the ſteam admitted above the cylinder be equal to that of common boiling water; but when once the ebullition is fairly commenced, and the whole air expelled from all parts of the apparatus, it is evident, that by damping the fire, ſteam of half this elaſticity may be continually ſupplied, and the water will continue boiling although its temperature does not exceed 185° of Fahrenheit's thermometer. This appears by inſpecting our table of vaporous elaſticity, and affords another argument for rendering that table more accurate by new experiments. We hope that Mr Watt will not withhold from the public the knowledge which he has acquired on this ſubject. It may very poſſibly reſult from an accurate inveſtigation, that it would be adviſable to work our ſteam-engines with weak ſteams, and that the diminution of work may be more than compenſated by the diminution of fuel. It is more probable indeed, and it is Mr Watt's opinion, that the contrary is the caſe, and that it is much more economical to employ great heats. At any rate, the deciſion of this queſtion is of great importance for improving the engine; and we ſee, in the mean time, that the engine can at all times be fitted ſo as to perform its taſk with a moderate and manageable motion, and that as the taſk increaſes we can increaſe the power of the engine.

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ience

But the method now propoſed has a great inconvenience. While the ſteam is weaker than the atmoſphere, there is an external force tending to ſqueeze in the ſides and bottom of the boiler. This could not be reſiſted when the difference is conſiderable, and common air would ruſh in through every crevice of the boiler and ſoon choke the engine: it muſt therefore be given up.

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But the ſame effect will be produced by diminiſhing the paſſage for the ſteam into the cylinder. For this purpoſe, the puppet valve by which the ſteam enters the cylinder was made in the form of a long taper ſpigot, and it was lodged in a cone of the ſame ſhape; conſequently the paſſage could be enlarged or contracted at pleaſure by the diſtance to which the inner cone was drawn up.

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In this way ſeveral engines were conſtructed, and the general purpoſe of ſuiting the power of the engine to its taſk was completely anſwered: but (as the mathematical reader will readily perceive) it was extremely difficult to make this adjuſtment preciſe and conſtant. In a great machine like this going by jerks, it was hardly poſſible that every ſucceſſive motion of the valve ſhould be preciſely the ſame. This occaſioned very ſenſible irregularities in the motion of the engine, which increaſed and became hazardous when the joints worked looſe by long uſe.

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ved.

Mr Watt's genius, always fertile in reſources, found out a complete remedy for all theſe inconveniences. Making the valve of the ordinary form of a puppet clack, he adjuſted the button of its ſtalk or tail ſo that it ſhould always open full to the ſame height. He then regulated the pins of the plug-frame, in ſuch a manner that the valve ſhould ſhut the moment that the piſton had deſcended a certain proportion (ſuppoſe one-fourth, one-third, one-half, &c.) of the cylinder. So far the cylinder was occupied by ſteam as elaſtic as common air. In preſſing the piſton farther down, it behoved the ſteam to expand, and its elaſticity to diminiſh. It is plain that this could be done in any degree we pleaſe, and that the adjuſtment can be varied in a minute, according to the exigency of the caſe, by moving the plug pins.

In the mean time, it muſt be obſerved, that the preſſure on the piſton is continually changing, and conſequently the accelerating force. The motion therefore will no longer be uniformly accelerated: it will approach much faſter to uniformity; nay, it may be retarded, becauſe although the preſſure on the piſton at the beginning of the ſtroke may exceed the reſiſtance of the load, yet when the piſton is near the bottom the reſiſtance may exceed the preſſure. Whatever may be the law by which the preſſure on the piſton varies, an ingenious mechanic may contrive the connecting machinery in ſuch a way that the chains or rods at the outer end of the beam ſhall continually exert the ſame preſſure, or ſhall vary their preſſure according to any law he finds moſt convenient. It is in this manner that the watchmaker, by the form of the fuzee, produces an equal preſſure on the wheel-work by means of a very unequal action of the main-ſpring. In like manner, by making the outer arch heads portions of a proper ſpiral inſtead of a circle, we can regulate the force of the beam at pleaſure.

Thus we ſee how much more manageable an engine is in this form than Newcomen's was, and alſo more eaſily inveſtigated in reſpect of its power in its various poſitions. The knowledge of this laſt circumſtance was of mighty conſequence, and without it no notion could be formed of what it could perform. This ſuggeſted to Mr Watt the uſe of the barometer communicating with the cylinder; and by the knowledge acquired by theſe means has the machine been ſo much improved by its ingenious inventor.

We muſt not omit in this place one deduction made by Mr Watt from his obſervations, which may be called a diſcovery of great importance in the theory of the engine.

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A diſcovery
of Mr Watt
of great
importance
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the engine.
Fig. 10.

Let ABCD (fig. 10.) repreſent a ſection of the cylinder of a ſteam-engine, and EF the ſurface of its piſton. Let us ſuppoſe that the ſteam was admitted while EF was in contact with AB, and that as ſoon as it had preſſed it down to the ſituation EF the ſteam cock is ſhut. The ſteam will continue to preſs it down, and as the ſteam expands its preſſure diminiſhes. We may expreſs its preſſure (exerted all the while the piſton moves from the ſituation AB to the ſituation EF) by the line EF. If we ſuppoſe the elaſticity of the ſteam proportional to its denſity, as is nearly the caſe with air, we may expreſs the preſſure on the piſton in any other poſition, ſuch as KL or DC, by K*l* and D*c*, the ordinates of a rectangular hyperbola F*l c*, of which AE, AB are the aſſymptotes, and A the centre. The accumulated preſſure during the motion of the piſton from EF to DC will be expreſſed by the area EF*c*DE, and the preſſure during the whole motion by the area ABF*c*DA.

Now it is well known that the area EF*c*DE is equal to ABFE multiplied by the hyperbolic logarithm of $\frac{AD}{AE}$, $=\text{L}.\frac{AD}{AE}$, and the whole area ABF*c*DA is $=\text{ABFE}\times\left(1+\text{L}.\frac{AD}{AE}\right)$.

Thus let the diameter of the piſton be 24 inches, and the preſſure of the atmoſphere on a ſquare inch be 14 pounds; the preſſure on the piſton is 6333 pounds. Let the whole ſtroke be 6 feet, and let the ſteam be ſtopped when the piſton has deſcended 18 inches, or 1.5 feet. The hyperbolic logarithm of $\frac{6}{1.5}$ is 1.3862943. Therefore the accumulated preſſure ABF*c*DA is $=6333\times 2.3862943$, $=15114$ pounds.

As few profeſſional engineers are poſſeſſed of a table of hyperbolic logarithms, while tables of common logarithms are or ſhould be in the hands of every perſon who is much engaged in mechanical calculations, let the following method be practiſed. Take the common logarithm of $\frac{AD}{AE}$, and multiply it by 2.3026; the product is the hyperbolic logarithm of $\frac{AD}{AE}$.

The accumulated preſſure while the piſton moves from AB to EF is 6333×1, or ſimply 6333 pounds, Therefore the ſteam while it expands into the whole cylinder adds a preſſure of 8781 pounds.

Suppoſe that the ſteam had got free admiſſion during the whole deſcent of the piſton, the accumulated preſſure would have been 6333×4, or 25332 pounds.

Here Mr Watt obſerved a remarkable reſult. The ſteam expended in this caſe would have been four times greater

greater than when it was ſtopped at one-fourth, and yet the accumulated preſſure is not twice as great, being nearly five-thirds. One-fourth of the ſteam performs nearly three-fifths of the work, and an equal quantity performs more than twice as much work when thus admitted during one-fourth of the motion.

This is a curious and an important information, and the advantage of this method of working a ſteam-engine increaſes in proportion as the ſteam is ſooner ſtopped; but the increaſe is not great after the ſteam is rarefied four times. The curve approaches near to the axis, and ſmall additions are made to the area. The expence of ſuch great cylinders is conſiderable, and may ſometimes compenſate this advantage.

Let the ſteam be ſtopped at	Its performance is mult.
$\frac{1}{2}$ - -	1.7
$\frac{1}{3}$ - -	2.1
$\frac{1}{4}$ - -	2.4
$\frac{1}{5}$ -	2.6
$\frac{1}{6}$ -	2.8
$\frac{1}{7}$ - -	3.
$\frac{1}{8}$ - -	3.2
&c.	&c.

It is very pleaſing to obſerve ſo many unlooked-for advantages reſulting from an improvement made with the ſole view of leſſening the waſte of ſteam by condenſation. While this purpoſe is gained, we learn how to huſband the ſteam which is not thus waſted. The engine becomes more manageable, and is more eaſily adapted to every variation in its taſk, and all its powers are more eaſily computed.

The active mind of its ingenious inventor did not ſtop here: It had always been matter of regret that one-half of the motion was unaccompanied by any work. It was a very obvious thing to Mr Watt, that as the ſteam admitted above the piſton preſſed it down, ſo ſteam admitted below the piſton preſſed it up with the ſame force, provided that a vacuum were made on its upper ſide. This was eaſily done, by connecting the lower end of the cylinder with the boiler and the upper end with the condenſer.

Plate DIII. fig. 11.
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Deſcription of Mr Watt's ſteam-engine in its moſt improved ſtate.

Fig. 11. is a repreſentation of this conſtruction exactly copied from Mr Watt's figure accompanying his ſpecification. Here BB is a ſection of the cylinder, ſurrounded at a ſmall diſtance by the caſe 1111. The ſection of the piſton A, and the collar of leathers which embraces the piſton rod, gives a diſtinct notion of its conſtruction, of the manner in which it is connected with the piſton-rod, and how the packing of the piſton and collar contributes to make all tight.

From the top of the cylinder proceeds the horizontal pipe. Above the letter D is obſerved the ſeat of the ſteam valve, communicating with the box above it. In the middle of this may be obſerved a dark ſhaded circle. This is the mouth of the upper branch of the ſteam pipe coming from the boiler. Beyond D, below the letter N, is the ſeat of the upper condenſing valve. The bottom of the cylinder is made ſpherical, fitting the piſton, ſo that they may come into entire contact. Another horizontal pipe proceeds from this bottom. Above the letter E is the ſeat of the lower ſteam valve, opening into the valve box. This box is at the extremity of another ſteam pipe marked C, which branches off from the upper horizontal part, and deſcends obliquely, coming forward to the eye. The lower part is repreſented as cut open, to ſhow its interior conformation. Beyond this ſteam valve, and below the letter F, may be obſerved the ſeat of the lower condenſing valve. A pipe deſcends from hence, and at a ſmall diſtance below unites with another pipe GG, which comes down from the upper condenſing valve N. Theſe two eduction-pipes thus united go downwards, and open at L into a rectangular box, of which the end is ſeen at L. This box goes backward from the eye, and at its farther extremity communicates with the air-pump K, whoſe piſton is here repreſented in ſection with its butterfly valves. The piſton delivers the water and air laterally into another rectangular box M, darkly ſhaded, which box communicates with the pump I. The piſton-rods of this and of the air-pump are ſuſpended by chains from a ſmall arch head on the inner arm of the great beam. The lower part of the eduction-pipe, the horizontal box L, the air-pump K, with the communicating box M between it and the pump I, are all immerſed in the cold water of the condenſing ciſtern. The box L is made flat, broad, and ſhallow, in order to increaſe its ſurface and accelerate the condenſation. But that this may be performed with the greateſt expedition, a ſmall pipe H, open below (but occaſionally ſtopped by a plug valve), is inſerted laterally into the eduction-pipe G, and then divides into two branches; one of which reaches within a foot or two of the upper valve N, and the other approaches as near to the valve F.

As it is intended by this conſtruction to give the piſton a ſtrong impulſe in both directions, it will not be proper to ſuſpend its rod by a chain from the great beam; for it muſt not only pull down that end of the beam, but alſo puſh it upwards. It may indeed be ſuſpended by double chains like the piſtons of the engines for extinguiſhing fires; and Mr Watt has accordingly done ſo in ſome of his engines. But in his drawing from which this figure is copied, he has communicated the force of the piſton to the beam by means of a toothed rack OO, which engages or works in the toothed ſector QQ on the end of the beam. The reader will underſtand, without any farther explanation, how the impulſe given to the piſton in either direction is thus tranſmitted to the beam without diminution. The fly XX, with its pinion Y, which alſo works in the toothed arch QQ, may be ſuppoſed to be removed for the preſent, and will be conſidered afterwards.

We ſhall take the preſent opportunity of deſcribing Mr Watt's method of communicating the force of the ſteam-engine to any machine of the rotatory kind. VV repreſents the rim and arms of a very large and heavy metalline fly. On its axis is the concentric toothed wheel U. There is attached to the end of the great beam a ſtrong and ſtiff rod TT, to the lower end of which a toothed wheel W is firmly fixed by two bolts, ſo that it cannot turn round. This wheel is of the ſame ſize and in the ſame vertical plane with the wheel U; and an iron link or ſtrap (which cannot be ſeen here, becauſe it is on the other ſide of the two wheels) connects the centres of the two wheels, ſo that the one cannot quit the other. The engine being in the poſition repreſented in the figure, ſuppoſe the fly to be turned once round by any external force in the direction of the darts. It is plain, that ſince the toothed wheels cannot quit each other, being kept together by the

STEAM ENGINE. PLATE DI.

Fig. 2.

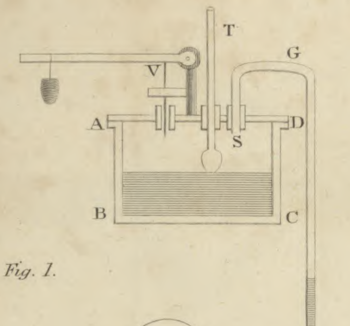


Fig. 1.

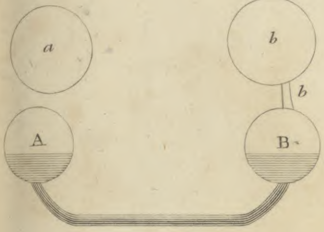


Fig. 7.

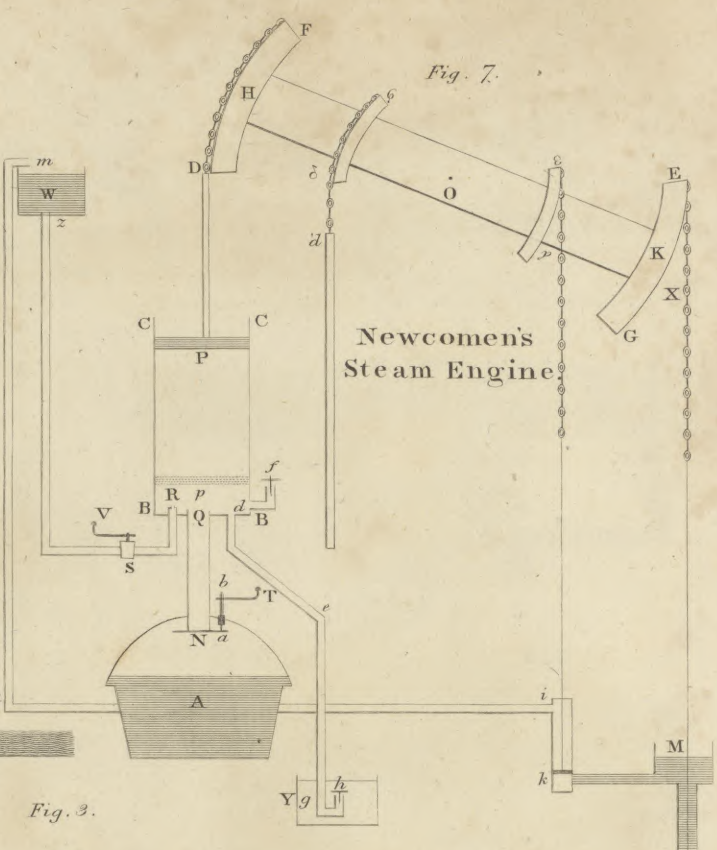


Fig. 6.

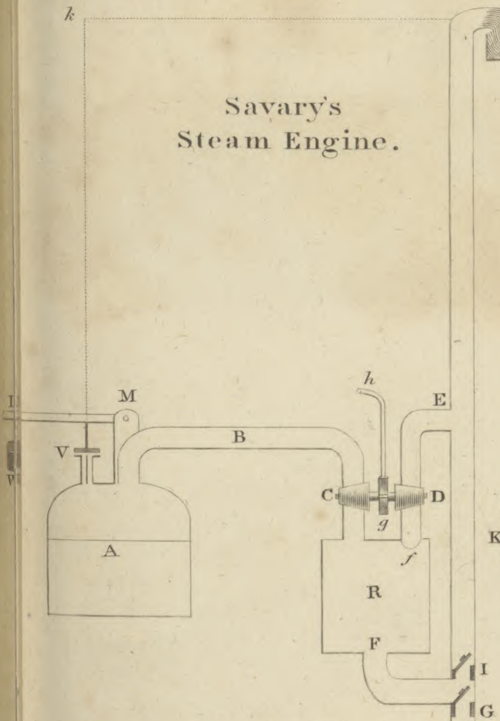


Fig. 3.

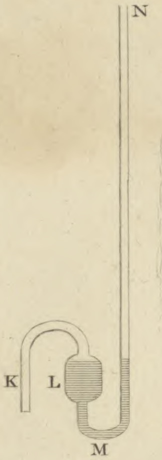


Fig. 5.

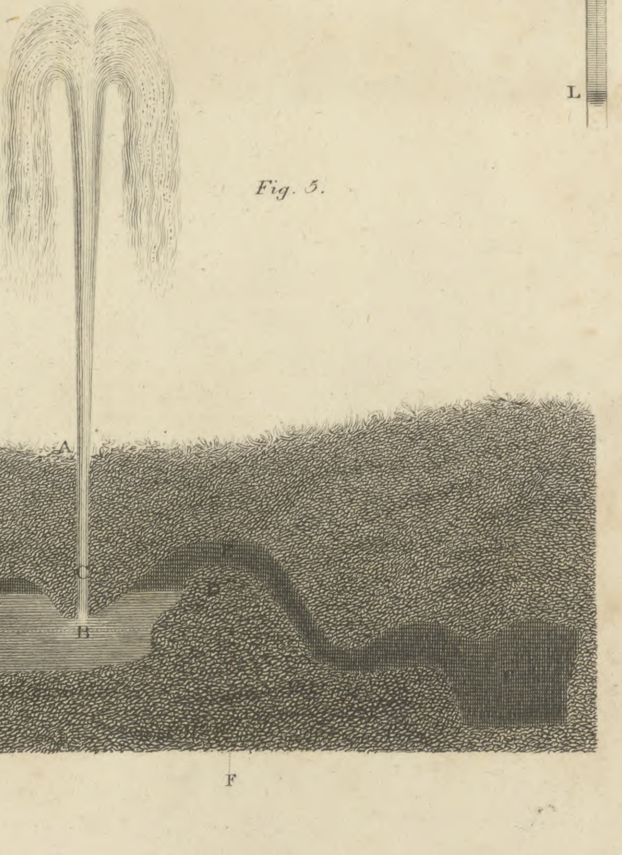
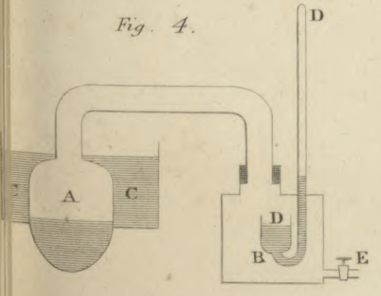


Fig. 4.



E. Mitchell sculp^t

BEIGHTON'S STEAM ENGINE. *PLATE DII.*

Fig. 8.

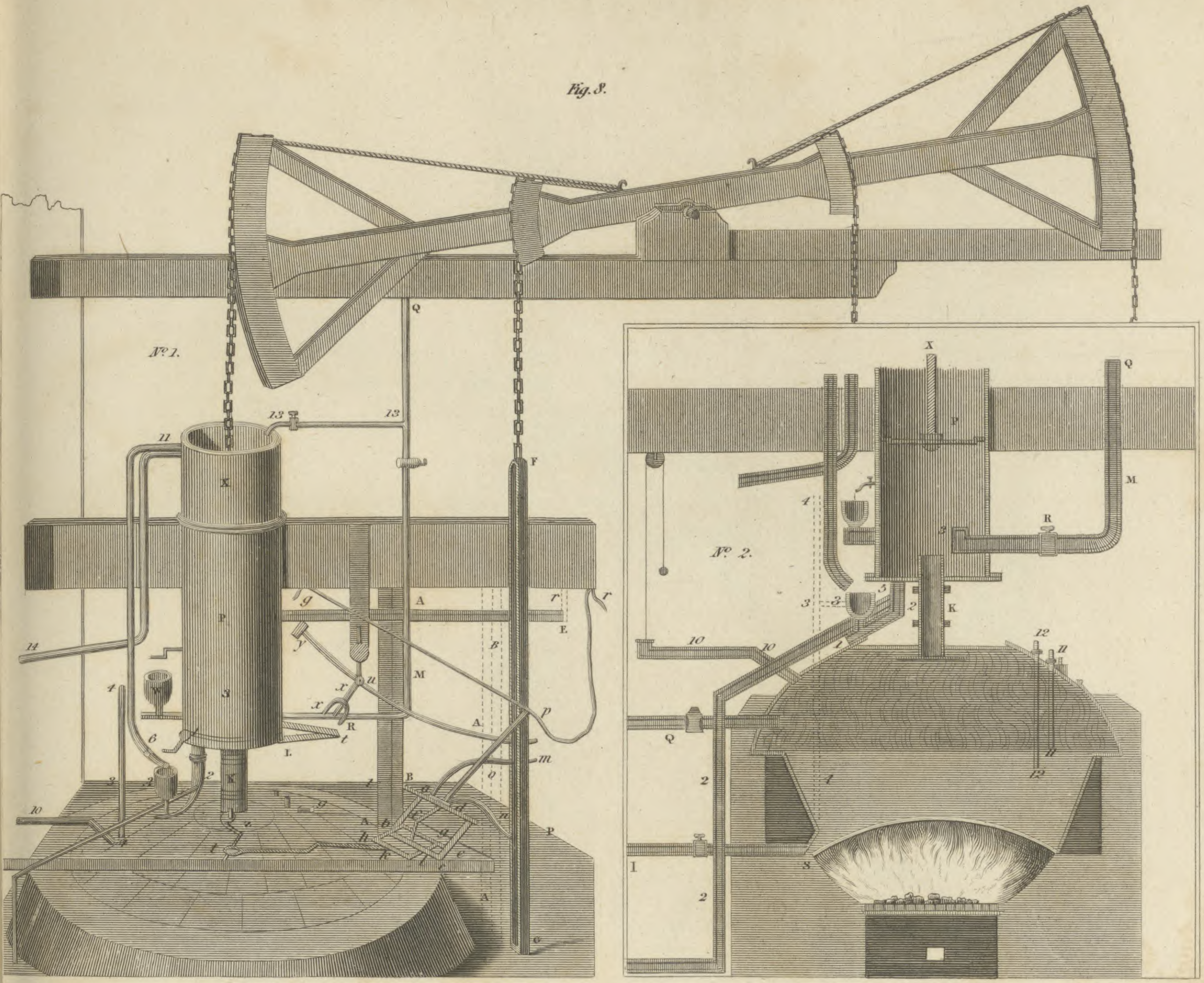


Fig. 9.

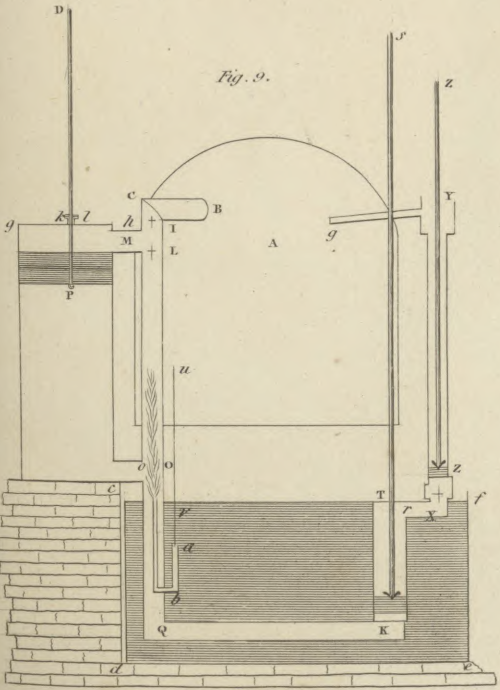
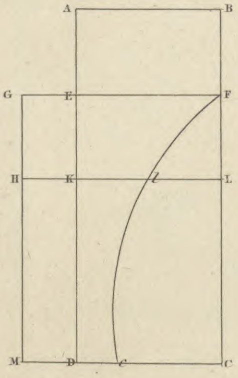


Fig. 10.



Engraved by W. & D. Lizars Edinburgh.

WATT'S STEAM ENGINE.

PLATE DIII.

Fig. 11.

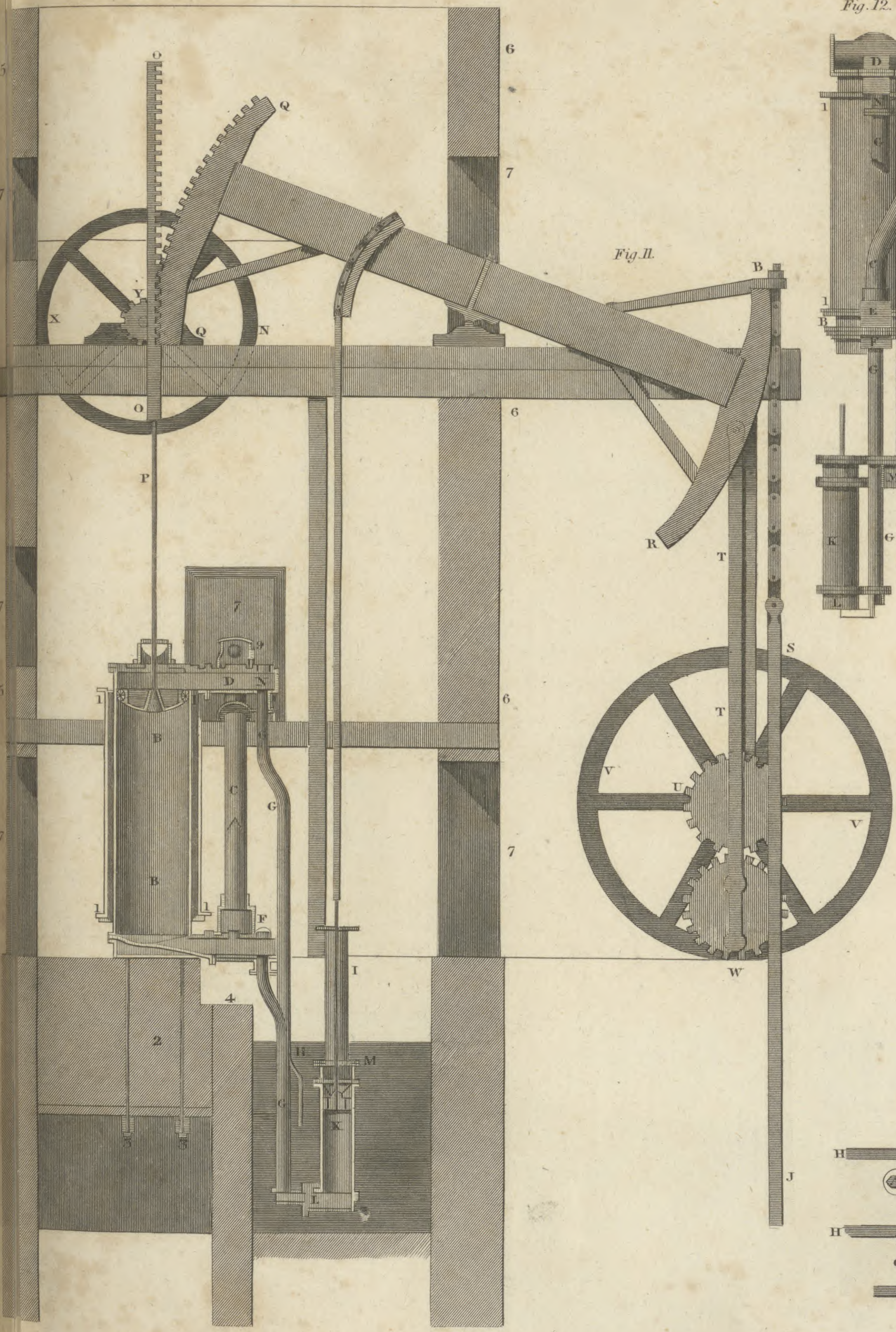


Fig. 12.

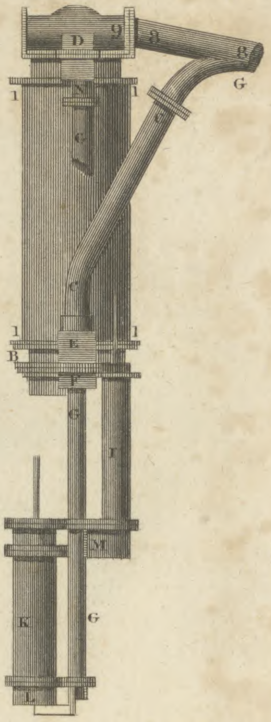


Fig. 13.

Eng.^d by W. & D. Lizars Edin.^r

HORNBLOWER'S STEAM ENGINE. PLATE DIV.

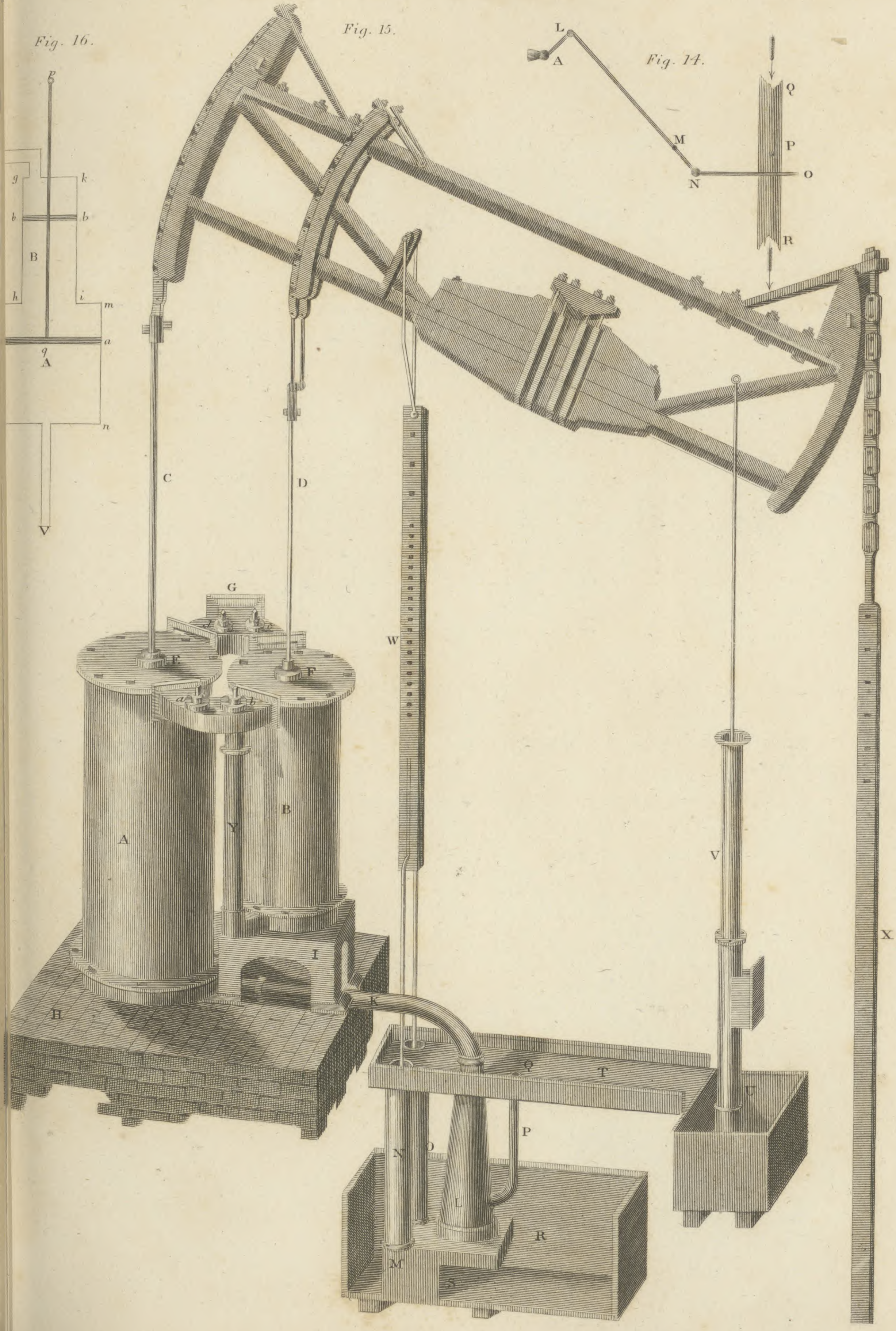


Fig. 16.
Fig. 15.
Fig. 14.

E. Mitchell Sculp^t

the link, the inner half (that is, the half next the cylinder) of the wheel U will work on the inner half of the wheel W, ſo that at the end of the revolution of the fly the wheel W muſt have got to the top of the wheel U, and the outer end of the beam muſt be raiſed to its higheſt poſition. The next revolution of the fly will bring the wheel W and the beam connected with it to their firſt poſitions; and thus every two revolutions of the fly will make a complete period of the beam's reciprocating movements. Now, inſtead of ſuppoſing the fly to drive the beam, let the beam drive the fly. The motions muſt be perfectly the ſame, and the aſcent or deſcent of the piſton will produce one revolution of the fly.

g. 12. A ſide view of this apparatus is given in fig. 12. marked by the ſame letters of reference. This ſhows the ſituation of parts which were fore-ſhortened in fig. 11. particularly the deſcending branch C of the ſteam-pipe, and the ſituation and communications of the two pumps K and I. 8, 8 is the horizontal part of the ſteam-pipe. 9 is a part of it whoſe box is repreſented by the dark circle of fig. 11. D is the box of the ſteam-clack; and the little circle at its corner repreſents the end of the axis which turns it, as will be deſcribed afterwards. N is the place of the upper eduction valve. A part only of the upper eduction-pipe G is repreſented, the reſt being cut off, becauſe it would have covered the deſcending ſteam-pipe CC. When continued down, it comes between the eye and the box E of the lower ſteam-valve, and the box F of the lower eduction-valve.

Let us now trace the operation of this machine through all its ſteps. Recurring to fig. 11. let us ſuppoſe that the lower part of the cylinder BB is exhauſted of all elaſtic fluids; that the upper ſteam-valve D and the lower eduction-valve F are open, and that the lower ſteam-valve E and upper eduction-valve N are ſhut. It is evident that the piſton muſt be preſſed toward the bottom of the cylinder, and muſt pull down the end of the working beam by means of the toothed rack OO and ſector QQ, cauſing the other end of the beam to urge forward the machinery with which it is connected. When the piſton arrives at the bottom of the cylinder, the valves D and F are ſhut by the plug frame, and E and N are opened. By this laſt paſſage the ſteam gets into the eduction-pipe, where it meets with the injection water, and is rapidly condenſed. The ſteam from the boiler enters at the ſame time by E, and preſſing on the lower ſide of the piſton, forces it upwards, and by means of the toothed rack OO and toothed ſector QQ forces up that end of the working beam, and cauſes the other end to urge forward the machinery with which it is connected: and in this manner the operation of the engine may be continued for ever.

The injection water is continually running into the eduction-pipe, becauſe condenſation is continually going on, and therefore there is a continual atmoſpheric preſſure to produce a jet. The air which is diſengaged from the water, or enters by leaks, is evacuated only during the riſe of the piſton of the air-pump K. When this is very copious, it renders a very large air-pump neceſſary; and in ſome ſituations Mr Watt has been obliged to employ two air-pumps, one worked by each arm of the beam. This in every caſe expends a very conſiderable portion of the power, for the air-pump is always working againſt the whole preſſure of the atmoſphere.

It is evident that this form of the engine, by maintaining an almoſt conſtant and uninterrupted impulſion, is much fitter for driving any machinery of continued motion than any of the former engines, which were inactive during half of their motion. It does not, however, ſeem to have this ſuperiority when employed to draw water: But it is equally fitted for this taſk. Let the engine be loaded with twice as much as would be proper for it if a ſingle-ſtroke engine, and let a fly be connected with it. Then it is plain that the power of the engine during the riſe of the ſteam-piſton will be accumulated in the fly; and this, in conjunction with the power of the engine during the deſcent of the ſteam-piſton, will be equal to the whole load of water.

In ſpeaking of the ſteam and eduction-valves, we ſaid that they were all puppet-valves. Mr Watt employed cocks, and alſo ſliding-valves, ſuch as the regulator or ſteam-valves in the old engines. But he found them always loſe their tightneſs after a ſhort time. This is not ſurpriſing, when we conſider that they are always perfectly dry, and almoſt burning hot. He was therefore obliged to change them all for puppet-clacks, which, when truly ground and nicely fitted in their motions at firſt, are not found to go out of order by any length of time. Other engineers now univerſally uſe them in the old form of the ſteam-engine, without the ſame reaſons, and merely by ſervile and ignorant imitation.

The way in which Mr Watt opens and ſhuts theſe valves is as follows. Fig. 13. repreſents a clack with its ſeat and box. Suppoſe it one of the eduction-valves. HH is part of the pipe which introduces the ſteam, and GG is the upper part of the pipe which communicates with the condenſer. At EE may be obſerved a piece more faintly ſhaded than the ſurrounding parts. This is the ſeat of the valve, and is a braſs or bell-metal ring turned conical on the outſide, ſo as to fit exactly into a conical part of the pipe GG. Theſe two pieces are fitted by grinding; and the cone being of a long taper, the ring ſticks firmly in it, eſpecially after having been there for ſome time and united by ruſt. The clack itſelf is a ſtrong braſs plate D, turned conical on the edge, ſo as to fit the conical or ſloping inner edge of the ſeat. Theſe are very nicely ground on each other with emery. This conical joining is much more obtuſe than the outer ſide of the ring; ſo that although the joint is air-tight, the two pieces do not ſtick ſtrongly together. The clack has a round tail DG, which is freely moveable up and down in the hole of a croſs piece FF. On the upper ſide of the valve is a ſtrong piece of metal DC firmly joined to it, one ſide of which is formed into a toothed rack. A is the ſection of an iron axle which turns in holes in the oppoſite ſides of the valve-box, where it is nicely fitted by grinding, ſo as to be air-tight. Collets of thick leather, well ſoaked in melted tallow and roſin, are ſcrewed on the outſide of theſe holes to prevent all ingreſs of air. One end of this axis projects a good way without the box, and carries a ſpanner or handle, which is moved by the plug-frame. To this axis is fixed a ſtrong piece of metal B, the edge of which is formed into an arch of a circle having the axis A in its centre, and is cut into teeth, which work in the teeth

Fig. 13.

teeth of the rack DC. K is a cover which is fixed by ſcrews to the top of the box HJJH, and may be taken off in order to get at the valve when it needs repairs.

From this deſcription it is eaſy to ſee that by turning the handle which is on the axis A, the ſector B muſt lift up the valve by means of its toothed rack DC, till the upper end of the rack touch the knob or button K. Turning the handle in the oppoſite direction brings the valve down again to its ſeat.

This valve is extremely tight. But in order to open it for the paſſage of the ſteam, we muſt exert a force equal to the preſſure of the atmoſphere. This in a large engine is a very great weight. A valve of ſix inches diameter ſuſtains a preſſure not leſs that 400 pounds. But this force is quite momentary, and hardly impedes the motion of the engine; for the inſtant the valve is detached from its ſeat, although it has not moved the 100th part of an inch, the preſſure is over. Even this little inconvenience has been removed by a delicate thought of Mr Watt. He has put the ſpanner in ſuch a poſition when it *begins* to raiſe the valve, that its mechanical energy is almoſt infinitely great. Let QR (fig. 14.) be part of the plug-frame deſcending, and P one of its pins juſt going to lay hold of the ſpanner NO moveable round the axis N. On the ſame axis is another arm NM connected by a joint with the leader ML, which is connected alſo by a joint with the ſpanner LA that is on the axis A of the ſector within the valve-box. Therefore when the pin P puſhes down the ſpanner NO, the arm NM moves ſidewiſe and pulls down the ſpanner AL by means of the connecting rod. Things are ſo diſpoſed, that when the cock is ſhut, LM and MN are in one ſtraight line. The intelligent mechanic will perceive that, in this poſition, the force of the lever ONM is inſuperable. It has this further advantage, that if any thing ſhould tend to force open the valve, it would be ineffectual; for no force exerted at A, and tranſmitted by the rod LM, can poſſibly puſh the joint M out of its poſition. Of ſuch importance is it to practical mechanics, that its profeſſors ſhould be perſons of penetration as well as knowledge. Yet this circumſtance is unheeded by hundreds who have ſervilely copied from Mr Watt, as may be ſeen in every engine that is puffed on the public as a diſcovery and an improvement. When theſe puppet-valves have been introduced into the common engine, we have not ſeen one inſtance where this has been attended to; certainly becauſe its utility has not been obſerved: and there is one ſituation where it is of more conſequence than in Mr Watt's engine, viz. in the injection cock. Here the valve is drawn back into a box, where the water is ſo awkwardly diſpoſed round it that it can hardly get out of its way, and where the preſſure even exceeds that of the atmoſphere. Indeed this particular ſubſtitution of the button valve for the cock is moſt injudicious.

We poſtponed any account of the office of the fly XX (fig. 11.), as it is not of uſe in an engine regulated by the fly VV. The fly XX is only for regulating the reciprocating motion of the beam when the ſteam is not admitted during the whole deſcent of the piſton. This it evidently muſt render more uniform, accumulating a momentum equal to the whole preſſure of the full ſupply of ſteam, and then ſharing it with the beam during the reſt of the deſcent of the piſton.

When a perſon properly ſkilled in mechanics and chemiſtry reviews theſe different forms of Mr Watt's ſteam-engine, he will eaſily perceive them ſuſceptible of many intermediate forms, in which any one or more of the diſtinguiſhing improvements may be employed. The firſt great improvement was the condenſation in a ſeparate veſſel. This increaſed the original powers of the engine, giving to the atmoſpheric preſſure and to the counter-weight their full energy; at the ſame time the waſte of ſteam is greatly diminiſhed. The next improvement, by employing the preſſure of the ſteam inſtead of that of the atmoſphere, aimed only at a ſtill farther diminution of the waſte; but was fertile in advantages, rendering the machine more manageable, and particularly enabled us at all times, and without trouble, to ſuit the power of the engine to its load of work, however variable and increaſing; and brought into view a very intereſting propoſition in the mechanical theory of the engine, viz. that the whole performance of a given quantity of ſteam may be augmented by admitting it into the cylinder only during a part of the piſton's motion. Mr Watt has varied the application of this propoſition in a thouſand ways; and there is nothing about the machine which gives more employment to the ſagacity and judgment of the engineer. The third improvement of the double impulſe may be conſidered as the finiſhing touch given to the engine, and renders it as uniform in its action as any water-wheel. In the engine in its moſt perfect form there does not ſeem to be above one-fourth of the ſteam waſted by warming the apparatus; ſo that *it is not poſſible* to make it one-fourth part more powerful than it is at preſent. The only thing that ſeems ſuſceptible of conſiderable improvement is the great beam. The enormous ſtrains exerted on its arms require a proportional ſtrength. This requires a vaſt maſs of matter, not leſs indeed in an engine with a cylinder of 54 inches than three tons and a half, moving with the velocity of three feet in a ſecond, which muſt be communicated in about half a ſecond. This maſs muſt be brought into motion from a ſtate of reſt, muſt again be brought to reſt, again into motion, and again to reſt, to complete the period of a ſtroke. This conſumes much power; and Mr Watt has not been able to load an engine with more than 10 or 11 pounds on the inch and preſerve a ſufficient quantity of motion, ſo as to make 12 or 15 ſix-feet ſtrokes in a ſecond. Many attempts have been made to leſſen this maſs by uſing a light framed wheel, or a light frame of carpentry, in place of a ſolid beam. Theſe have generally been conſtructed by perſons ignorant of the true ſcientific principles of carpentry, and have fared accordingly. Mr Watt has made ſimilar attempts; but found, that although at firſt they were abundantly ſtrong, yet after a ſhort time's employment the ſtraps and bolts with which the wooden parts were connected cut their way into the wood, and the framing grew looſe in the joints, and, without giving any warning, went to pieces in an inſtant. A ſolid maſſy ſimple beam, of ſufficient ſtrength, bends, and ſenſibly complains (as the carpenters expreſs it), before it breaks. In all great engines, therefore, ſuch only are employed, and in ſmaller engines he ſometimes uſes caſt-iron wheels or pulleys; nay, he frequently uſes no beam or equivalent whatever, but employs the ſteam-piſton rod to drive the machinery to which the engine is applied.

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Review of Mr Watt's three great improvements.

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The only improvement now wanting is to ſtrengthen the great beam.

We preſume that our thinking readers will not be

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diſpleaſed with this rational hiſtory of the progreſs of this engine in the hands of its ingenious and worthy inventor. We owe it to the communications of a friend, well acquainted with him, and able to judge of his merits. The public ſee him always aſſociated with the no leſs celebrated mechanic and philoſopher Mr Boulton of Soho near Birmingham (ſee SOHO). They have ſhared the royal patent from the beginning; and the alliance is equally honourable to both.

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The advantages derived from the patent right ſhow both the ſuperiority of the engine and the liberal minds of the proprietors. They erect the engines at the expence of the employers, or give working drafts of all the parts, with inſtructions, by which any reſident engineer may execute the work. The employers ſelect the beſt engine of the ordinary kind in the kingdom, compare the quantities of fuel expended by each, and pay to Meſſrs Watt and Boulton one-third of the annual ſavings for a certain term of years. By this the patentees are excited to do their utmoſt to make the engine perfect; and the employer pays in proportion to the advantage he derives from it.

It may not be here improper to ſtate the actual performance of ſome of theſe engines, as they have been aſcertained by experiment.

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An engine having a cylinder of 31 inches in diameter, and making 17 double ſtrokes per minute, performs the work of forty horſes working night and day (for which three relays or 120 horſes muſt be kept), and burns 11,000 pounds of Staffordſhire coal per day. A cylinder of 19 inches, making 25 ſtrokes of 4 feet each per minute, performs the work of 12 horſes working conſtantly, and burns 3700 pounds of coals per day. A cylinder of 24 inches, making 22 ſtrokes of 5 feet, burns 5500 pounds of coals, and is equivalent to the conſtant work of 20 horſes. And the patentees think themſelves authorized by experience to ſay in general, that theſe engines will raiſe more than 20,000 cubic feet of water 24 feet high for every hundred weight of good pit-coal conſumed by them.

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In conſequence of the great ſuperiority of Mr Watt's engines, both with reſpect to economy and manageableneſs, they have become of moſt extenſive uſe; and in every demand of manufacture on a great ſcale they offer us an indefatigable ſervant, whoſe ſtrength has no bounds. The greateſt mechanical project that ever engaged the attention of man was on the point of being executed by this machine. The States of Holland were treating with Meſſrs Watt and Boulton for draining the Haerlem Meer, and even reducing the Zuyder Zee: and we doubt not but that it will be accompliſhed whenever that unhappy nation has ſufficiently felt the difference between liberty and foreign tyranny. Indeed ſuch unlimited powers are afforded by this engine, that the engineer now thinks that no taſk can be propoſed to him which he cannot execute with profit to his employer.

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tage;

No wonder then that all claſſes of engineers have turned much of their attention to this engine; and ſeeing that it has done ſo much, that they try to make it do ſtill more. Numberleſs attempts have been made to improve Mr Watt's engine; and it would occupy a volume to give an account of them, whilſt that account would do no more than indulge curioſity. Our engineers by profeſſion are in general miſerably deficient in that accurate knowledge of mechanics and of chemiſtry which is neceſſary for underſtanding this machine; and we have not heard of one in this kingdom who can be put on a par with the preſent patentees in this reſpect. Moſt of the attempts of engineers have been made with the humbler view of availing themſelves of Mr Watt's diſcoveries, ſo as to conſtruct a ſteam-engine ſuperior to Newcomen's, and yet of a form ſufficiently different from Watt's to keep it without the reach of his patent. This they have in general accompliſhed by performing the condenſation in a place which, with a little ſtretch of fancy, not unfrequent in a court of law, may be called *part of the cylinder*.

79
and the
ſucceſs of
theſe has
not injured
the other.

The ſucceſs of moſt of theſe attempts has interfered ſo little with the intereſt of the patentees, that they have not hindered the erection of many engines which the law would have deemed encroachments. We think it our duty to give our opinion on this ſubject without reſerve. Theſe are moſt expenſive undertakings, and few employers are able to judge accurately of the merits of a project preſented to them by an ingenious artiſt. They may ſee the practicability of the ſcheme, by having a general notion of the expanſion and condenſation of ſteam, and they may be miſled by the ingenuity apparent in the conſtruction. The engineer himſelf is frequently the dupe of his own ingenuity; and it is not always diſhoneſty, but frequently ignorance, which makes him prefer his own invention or (as he thinks it) improvement. It is a moſt delicate engine, and requires much knowledge to ſee what does and what does not improve its performance. We have gone into the preceding minute inveſtigation of Mr Watt's progreſs with the expreſs purpoſe of making our readers fully maſters of its principles, and have more than once pointed out the real improvements, that they may be firmly fixed and always ready in the mind. By having recourſe to them, the reader may pronounce with confidence on the merits of any new conſtruction, and will not be deceived by the puffs of an ignorant or diſhoneſt engineer.

80
Exception
in favour
of Mr
Hornblow-
er.

We muſt except from this general criticiſm a conſtruction by Mr Jonathan Hornblower near Briſtol, on account of its ſingularity, and the ingenuity and real ſkill which appears in ſome particulars of its conſtruction. The following ſhort deſcription will ſufficiently explain its principle, and enable our readers to appreciate its merit.

Plate
DIV.
81
Deſcription
of his
ſteam-en-
gine.

A and B (fig. 15.) repreſent two cylinders, of which A is the largeſt. A piſton moves in each, having their rods C and D moving through collars at E and F. Theſe cylinders may be ſupplied with ſteam from the boiler by means of the ſquare pipe G, which has a flanch to connect it with the reſt of the ſteam-pipe. This ſquare part is repreſented as branching off to both cylinders. *c* and *d* are two cocks, which have handles and tumblers as uſual, worked by the plug-beam W. On the fore-ſide (that is, the ſide next the eye) of the cylinders is repreſented another communicating pipe, whoſe ſection is alſo ſquare or rectangular, having alſo two cocks *a*, *b*. The pipe Y, immediately under the cock *b*, eſtabliſhes a communication between the upper and lower parts of the ſmall cylinder B, by opening the cock *b*. There is a ſimilar pipe on the other ſide of the cylinder A, immediately under the cock *d*. When the cocks *c* and *a* are open, and the cocks *b* and *d* are ſhut, the ſteam from the boiler has free admiſſion into the upper part of the cylinder B, and the ſteam from the lower part of B has free admiſſion into the upper part of A; but the upper part of each cylinder has no communication with its lower part.

From the bottom of the great cylinder proceeds the eduction-pipe K, having a valve at its opening into the cylinder, which bends downwards, and is connected with the conical condenſer L (c). The condenſer is fixed on a hollow box M, on which ſtand the pumps N and O, for extracting the air and water; which laſt runs along the trough T into a ciſtern U, from which it is raiſed by the pump V for recruiting the boiler, being already nearly boiling hot. Immediately under the condenſer there is a ſpigot-valve at S, over which is a ſmall jet-pipe, reaching to the bend of the eduction-pipe. The whole of the condenſing apparatus is contained in a ciſtern R of cold water. A ſmall pipe P comes from the ſide of the condenſer, and terminates on the bottom of the trough T, and is there covered with a valve Q, which is kept tight by the water that is always running over it. Laſtly, the pump-rods X cauſe the outer end of the beam to preponderate, ſo that the quieſcent poſition of the beam is that repreſented in the figure, the piſtons being at the top of the cylinders.

Suppoſe all the cocks open, and ſteam coming in copiouſly from the boiler, and no condenſation going on in L; the ſteam muſt drive out all the air, and at laſt follow it through the valve Q. Now ſhut the valves *b* and *d*, and open the valve S of the condenſer. The condenſation will immediately commence. There is now no preſſure on the under ſide of the piſton of A, and it immediately deſcends. The communication between the lower part of B and the upper part of A being open, the ſteam will go from B into the ſpace left by the piſton of A. It muſt therefore expand, and its elaſticity muſt diminiſh, and will no longer balance the preſſure of the ſteam above the piſton of B. This piſton therefore, if not withheld by the beam, would deſcend till it is in equilibrio, having ſteam of equal denſity above and below it. But it cannot deſcend ſo far; for the cylinder A is wider than B, and the arm of the beam at which its piſton hangs is longer than the arm which ſupports the piſton of B: therefore when the piſton of B has deſcended as far as the beam will permit it, the ſteam between the two piſtons occupies a larger ſpace than it did when both piſtons were at the tops of their cylinders. Its denſity, therefore, and its elaſticity, diminiſh as its bulk increaſes. It is therefore not a balance; for the ſteam on the upper ſide of B, and the piſton B, *pulls* at the beam with all the difference of theſe preſſures. The ſlighteſt view of the ſubject muſt ſhow the reader, that as the piſtons deſcend, the ſteam that is between them will grow continually rarer and leſs elaſtic, and that both piſtons will pull the beam downwards.

Suppoſe now that each has reached the bottom of its cylinder. Shut the cock *a* and the eduction-cock at the bottom of A, and open the cocks *b* and *d*. The communication being now eſtabliſhed between the upper and lower part of each cylinder, nothing hinders the counter weight from raiſing the piſtons to the top. Let them arrive there. The cylinder B is at this time filled with ſteam of the ordinary denſity, and the cylinder A with an equal abſolute quantity of ſteam, but expanded into a larger ſpace.

Shut the cocks *b* and *d*, and open the cock *a*, and the eduction-cock at the bottom of A; the condenſation will again operate, and the piſtons deſcend. And thus the operation may be repeated as long as ſteam is ſupplied; and one full of the cylinder B of ordinary ſteam is expended during each working ſtroke.

Let us now examine the power of this engine. It is evident, that when both piſtons are at the top of their reſpective cylinders, the active preſſure (that is, the difference of the preſſure on its two ſides) on the piſton of B is nothing, while that on the piſton of A is equal to the full preſſure of the atmoſphere on its area. This, multiplied by the length of the arm by which it is ſupported, gives its mechanical energy. As the piſtons deſcend, the preſſure on the piſton of B increaſes, while that on the piſton of A diminiſhes. When both are at the bottom, the preſſure on the piſton of B is at its maximum, and that on the piſton of A at its minimum.

Mr Hornblower ſaw that this muſt be a beneficial employment of ſteam, and preferable to the practice of condenſing it while its full elaſticity remained; but he has not conſidered it with the attention neceſſary for aſcertaining the advantage with preciſion.

Let a and b repreſent the areas of the piſtons of A and B, and let α and β be the lengths of the arms by which they are ſupported. It is evident, that when both piſtons have arrived at the bottoms of their cylinders, the capacities of the cylinders are as $a\alpha$ and $b\beta$. Let this be the ratio of m to 1. Let $g\,h\,i\,k$ (fig. 16.) and $l\,m\,n\,o$ be two cylinders of equal length, communicating with each other, and fitted with a piſton-rod $p\,q$, on which are fixed two piſtons $a\,a$ and $b\,b$, whoſe areas are as m and 1. Let the diſtance between the piſtons be preciſely equal to the height of each cylinder, which height we ſhall call h. Let x be the ſpace $g\,b$ or $b\,a$, through which the piſtons have deſcended. Let the upper cylinder communicate with the boiler, and the lower cylinder with the condenſer or vacuum V.

Any perſon in the leaſt converſant in mechanics and pneumatics will clearly ſee that the ſtrain or preſſure on the piſton-rod $p\,q$ is preciſely the ſame with the united energies of the two piſton rods of Mr Hornblower's engine, by which they tend to turn the working beam round its axis.

The baſe of the upper cylinder being 1, and its height h, its capacity or bulk is $1\,h$ or h; and this expreſſes the natural bulk of the ſteam which formerly filled it, and is now expanded into the ſpace $b\,h\,l\,a\,a\,m\,i\,b$. The part $b\,h\,i\,b$ is plainly $=h-x$, and the part $l\,a\,a\,m$ is $=m\,x$. The whole ſpace, therefore, is $m\,x+h-x$, $=h+mx-x$, or $h+\overline{m-1}\,x$. Therefore the denſity of the ſteam between the piſtons is $\frac{h}{h+\overline{m-1}\,x}$.

Let p be the downward preſſure of the ſteam from the

(c) This, however, was ſtopped by Watt's patent; and the condenſation muſt be performed as in Newcomen's engine, or at leaſt in the cylinder A.

Steam-Engine.

the boiler on the upper piſton $b\,b$. This piſton is alſo preſſed up with a force $=p\frac{h}{h+\overline{m-1}\,x}$ by the ſteam between the piſtons. It is therefore, on the whole, preſſed downward with a force $=p\left(1-\frac{h}{h+\overline{m-1}\,x}\right)$. The lower piſton $a\,a$, having a vacuum below it, is preſſed downwards with a force $=p\frac{m\,h}{h+\overline{m-1}\,x}$. Therefore the whole preſſure on the piſton rod downwards is $=p\left(1+\frac{m\,h}{h+\overline{m-1}\,x}-\frac{h}{h+\overline{m-1}\,x}\right)$, $=p\left(1+\frac{\overline{m-1}\,h}{h+\overline{m-1}\,x}\right)$, $=p+\frac{p\,h\,\overline{m-1}}{h+\overline{m-1}\,x}=p+\frac{p\,h}{\frac{h}{m-1}+x}$.

This then is the momentary preſſure on the piſton rod correſponding to its deſcent x from its higheſt poſition. When the piſtons are in their higheſt poſition, this preſſure is equal to $m\,p$. When they are in their loweſt poſition, it is $=p\frac{2\,m-1}{m}$. Here therefore is an acceſſion of power. In the beginning the preſſure is greater than on a ſingle piſton in the proportion of m to 1; and at the end of the ſtroke, where the preſſure is weakeſt, it is ſtill much greater than the preſſure on a ſingle piſton. Thus, if m be 4, the preſſure at the beginning of the ſtroke is $4\,p$, and at the end it is $\frac{7}{4}\,p$, almoſt double, and in all intermediate poſitions it is greater. It is worth while to obtain the ſum total of all the accumulated preſſures, that we may compare it with the conſtant preſſure on a ſingle piſton.

We may do this by conſidering the momentary preſſure $p+\frac{p\,h}{\frac{h}{m-1}+x}$, as equal to the ordinate GF, H b, or M c, of a curve F b c (fig. 10.), which has for its axis the line GM equal to h the height of our cylinder. Call this ordinate y. We have $y=p+\frac{p\,h}{\frac{h}{m-1}x}$, and $y-p=\frac{p\,h}{\frac{h}{m-1}+x}$. Now it is plain that $\frac{p\,h}{\frac{h}{m-1}+x}$ is the ordinate of an equilateral hyperbola, of which $p\,h$ is the power or rectangle of the ordinate and abſciſs, and of which the abſciſs reckoned from the centre is $\frac{h}{m-1}+x$. Therefore make $\text{GE}=p$, and draw DEA parallel to MG, and make $\text{EA}=\frac{\text{GM}}{m-1}$, $=\frac{h}{m-1}$. The curve F b c is an equilateral hyperbola having A for its centre and AD for its aſſymptote. Draw the other aſſymptote AB, and its ordinate FB. Since the power of the hyperbola is $=p\,h$, $=$GEDM (for $\text{GE}=p$, and $\text{GM}=h$); and ſince all the inſcribed rectangles, ſuch as AEFB, are equal to $p\,h$, it follows that AEFB is equal to GEDM, and that the area ABF c DA is equal to the area GF c MG, which expreſſes the accumulated preſſure in Hornblower's engine.

We can now compute the accumulated preſſure very eaſily. It is evidently $=p\,h\times\left(1+\text{L.}\frac{\text{AD}}{\text{AE}}\right)$.

82
The accumulated preſſure the ſame with that of Mr Watt's engine.

The intelligent reader cannot but obſerve that this is preciſely the ſame with the accumulated preſſure of a quantity of ſteam admitted in the beginning, and ſtopped in Mr Watt's method, when the piſton has deſcended through the mth part of the cylinder. In conſidering Mr Hornblower's engine, the thing was preſented in ſo different a form that we did not perceive the analogy at firſt, and we were ſurpriſed at the reſult. We could not help even regretting it, becauſe it had the appearance of a new principle and an improvement: and we doubt not but that it appeared ſo to the ingenious author; for we have had ſuch proofs of his liberality of mind as permit us not to ſuppoſe that he ſaw it from the beginning, and availed himſelf of the difficulty of tracing the analogy. And as the thing may miſlead others in the ſame way, we have done a ſervice to the public by ſhowing that this engine, ſo coſtly and ſo difficult in its conſtruction, is no way ſuperior in power to Mr Watt's ſimple method of ſtopping the ſteam. It is even inferior, becauſe there muſt be a condenſation in the communicating paſſages. We may add, that if the condenſation is performed in the cylinder A, which it muſt be unleſs with the permiſſion of Watt and Boulton, the engine cannot be much ſuperior to a common engine; for much of the ſteam from below B will be condenſed between the piſtons by the coldneſs of the cylinder A; and this diminiſhes the downward preſſure on A more than it increaſes the downward preſſure on B. We learn however that, by confining the condenſation to a ſmall *part of the cylinder* A, Mr Hornblower has erected engines clear of Mr Watt's patent, which are conſiderably ſuperior to Newcomen's: ſo has Mr Symington.

83
Still, however, the engine diſcovers ingenuity and ſkill.

We ſaid that there was much ingenuity and real ſkill obſervable in many particulars of this engine. The diſpoſition and connection of the cylinders, and the whole condenſing apparatus, are contrived with peculiar neatneſs. The cocks are very ingenious; they are compoſed of two flat circular plates ground very true to each other, and one of them turns round on a pin through their centres; each is pierced with three ſectoral apertures, exactly correſponding with each other, and occupying a little leſs than one-half of their ſurfaces. By turning the moveable plate ſo that the apertures coincide, a large paſſage is opened for the ſteam; and by turning it ſo that the ſolid of the one covers the aperture of the other, the cock is ſhut. Such regulators are now very common in the caſt iron ſtoves for warming rooms.

Mr Hornblower's contrivance for making the collars for the piſton rods air-tight is alſo uncommonly ingenious. This collar is in fact two, at a ſmall diſtance from each other. A ſmall pipe, branching off from the main ſteam-pipe, communicates with the ſpace between the collars. This ſteam, being a little ſtronger than the preſſure of the atmoſphere, effectually hinders the air from penetrating by the upper collar; and though a little ſteam ſhould get through the lower collar into the cylinder A, it can do no harm. We ſee many caſes in which this pretty contrivance may be of ſignal ſervice. But

84 The greateſt improvement is the framing of the working beam.

But it is in the framing of the great working beam that Mr Hornblower's ſcientific knowledge is moſt conſpicuous; and we have no heſitation in affirming that it is ſtronger than a beam of the common form, and containing twenty times its quantity of timber. There is hardly a part of it expoſed to a tranſverſe ſtrain, if we except the ſtrain of the pump V on the ſtrutt by which it is worked. Every piece is either puſhed or pulled in the direction of its length. We only fear that the bolts which connect the upper beam with the two iron bars under its ends will work looſe in their holes, and tear out the wood which lies between them. We would propoſe to ſubſtitute an iron bar for the whole of this upper beam. This working beam highly deſerves the attention of all carpenters and engineers. We have that opinion of Mr Hornblower's knowledge and talents, that we are confident that he will ſee the fairneſs of our examination of his engine, and we truſt to his candour for an excuſe for our criticiſm.

85 The reciprocating motion of the ſteam-engine is a defect ſtill to be remedied.

The reciprocating motion of the ſteam-engine has always been conſidered as a great defect; for though it be now obviated by connecting it with a fly, yet, unleſs it is an engine of double ſtroke, this fly muſt be an enormous maſs of matter moving with great velocity. Any accident happening to it would produce dreadful effects: A part of the rim detaching itſelf would have the force of a bomb, and no building could withſtand it. Many attempts have been made to produce a circular motion at once by the ſteam. It has been made to blow on the vanes of a wheel of various forms. But the rarity of ſteam is ſuch, that even if none is condenſed by the cold of the vanes, the impulſe is exceedingly feeble, and the expence of ſteam, ſo as to produce any ſerviceable impulſe, is enormous. Mr Watt, among his firſt ſpeculations on the ſteam engine, made ſome attempts of this kind. One in particular was uncommonly ingenious. It conſiſted of a drum turning air-tight within another, with cavities ſo diſpoſed that there was a conſtant and great preſſure urging it in one direction. But no packing of the common kind could preſerve it air-tight with ſufficient mobility. He ſucceeded by immerſing it in mercury, or in an amalgam which remained fluid in the heat of boiling water; but the continual trituration ſoon calcined the fluid and rendered it uſeleſs. He then tried Parent's or Dr Barker's mill, incloſing the arms in a metal drum, which was immerſed in cold water. The ſteam ruſhed rapidly along the pipe which was the axis, and it was hoped that a great reaction would have been exerted at the ends of the arms; but it was almoſt nothing. The reaſon ſeems to be, that the greateſt part of the ſteam was condenſed in the cold arms. It was then tried in a drum kept boiling hot; but the impulſe was now very ſmall in compariſon with the expence of ſteam. This muſt be the caſe.

86 Mr Watt's attempts to produce a circular motion by ſteam unſucceſsful.

Mr Watt has deſcribed in his ſpecification to the patent office ſome contrivances for producing a circular motion by the immediate action of the ſteam. Some of theſe produce alternate motions, and are perfectly analogous to his double-ſtroke engine. Others produce a continued motion. But he has not given ſuch a deſcription of his valves for this purpoſe as can enable an engineer to conſtruct one of them. From any gueſs that we can form, we think the machine very imperfect; and we do not find that Mr Watt has ever erected a continuous circular engine. He has doubtleſs found all his attempts inferior to the reciprocating engine with a fly. A very crude ſcheme of this kind may be ſeen in the Tranſactions of the Royal Society of Dublin 1787. But although our attempts have hitherto failed, we hope that the caſe is not yet deſperate: we ſee different principles which have not yet been employed.

87 Still the caſe is not deſperate, for different principles may be employed.

88 Mr Watt's engine ſuggeſts the conſtruction of an excellent air-pump.

We ſhall conclude our account of this noble engine with obſerving, that Mr Watt's form ſuggeſts the conſtruction of an excellent air-pump. A large veſſel may be made to communicate with a boiler at one ſide, and with the pump-receiver on the other, and alſo with a condenſer. Suppoſe this veſſel of ten times the capacity of the receiver; fill it with ſteam from the boiler, and drive out the air from it; then open its communication with the receiver and the condenſer. This will rarefy the air of the receiver ten times. Repeating the operation will rarefy it 100 times; the third operation will rarefy it 1000 times; the fourth 10,000 times, &c. All this may be done in half a minute.

STEAM-Kitchen. Ever ſince Dr Papin contrived his digeſter (about the year 1690), ſchemes have been propoſed for dreſſing victuals by the ſteam of boiling water. A philoſophical club uſed to dine at Saltero's coffee-houſe, Chelſea, about 40 years ago, and had their victuals dreſſed by hanging them in the boiler of the ſteam-engine which raiſes water for the ſupply of Piccadilly and its neighbourhood. They were completely dreſſed, and both expeditiouſly and with high flavour.

A patent was obtained for an apparatus for this purpoſe by a tin-man in London; we think of the name of Tate. They were afterwards made on a much more effective plan by Mr Gregory, an ingenious tradeſman in Edinburgh, and are coming into very general uſe.

It is well known to the philoſopher that the ſteam of boiling water contains a prodigious quantity of heat, which it retains in a latent ſtate ready to be faithfully accounted for, and communicated to any colder body. Every cook knows the great ſcalding power of ſteam, and is diſpoſed to think that it is much hotter than boiling water. This, however, is a miſtake; for it will raiſe the thermometer no higher than the water from which it comes. But we can aſſure the cook, that if he make the ſteam from the ſpout of a tea-kettle paſs through a great body of cold water, it will be condenſed or changed into water; and when one pound of water has in this manner been boiled off, it will have heated the maſs of cold water as much as if we had thrown into it ſeven or eight hundred pounds of boiling hot water.

If, therefore, a boiler be properly fitted up in a furnace, and if the ſteam of the water boiling in it be conveyed by a pipe into a pan containing victuals to be dreſſed, every thing can be cooked that requires no higher degree of heat than that of boiling water: And this will be done without any riſk of ſcorching, or any kind of overheating, which frequently ſpoils our diſhes, and proceeds from the burning heat of air coming to thoſe parts of the pot or pan which is not filled with liquor, and is covered only with a film, which quickly burns and taints the whole diſh. Nor will the cook be ſcorched by the great heat of the open fire that is neceſſary for dreſſing at once a nnmber of diſhes, nor have his perſon and clothes ſoiled by the ſmoke and ſoot unavoidable in the cooking on an open fire. Indeed the whole proceſs is ſo neat, ſo manageable, ſo open to inſpection, and ſo cleanly, that it need neither fatigue nor offend the delicacy of the niceſt lady.

We had great doubts, when we firſt heard of this as a general mode of cookery, as to its economy; we had none as to its efficacy. We thought that the ſteam, and conſequently the fuel expended, muſt be vaſtly greater than by the immediate uſe of an open fire; but we have ſeen a large tavern dinner expeditiouſly dreſſed in this manner, ſeemingly with much leſs fuel than in the common method. The following ſimple narration of facts will ſhow the ſuperiority. In a paper manufactory in this neighbourhood, the vats containing the pulp into which the frames are dipped are about ſix feet diameter, and contain above 200 gallons. This is brought to a proper heat by means of a ſmall cockle or furnace in the middle of the liquor. This is heated by putting in about one hundred weight of coals about eight o'clock in the evening, and continuing this till four next morning, renewing the fuel as it burns away. This method was lately changed for a ſteam heater. A furnace, having a boiler of five or ſix feet diameter and three feet deep, is heated about one o'clock in the morning with two hundred weight of coals, and the water kept in briſk ebullition. Pipes go off from this boiler to ſix vats, ſome of which are at 90 feet diſtance. It is conveyed into a flat box or veſſel in the midſt of the pulp, where it condenſes, imparting its heat to the ſides of the box, and thus heats the ſurrounding pulp. Theſe ſix vats are as completely heated in three hours, expending about three hundred weight of coals, as they were formerly in eight hours, expending near eighteen hundred weight of coals. Mr Gregory, the inventor of this ſteam-heater, has obtained (in company with Mr Scott, plumber, Edinburgh) a patent for the invention; and we are perſuaded that it will come into very general uſe for many ſimilar purpoſes. The dyers, hatmakers, and many other manufacturers, have occaſion for large vats kept in a continual heat; and there ſeems no way ſo effectual.

Indeed when we reflect ſeriouſly on the ſubject, we ſee that this method has immenſe advantages conſidered merely as a mode of applying heat. The ſteam may be applied to the veſſel containing the victuals in every part of its ſurface: it may even be made to enter the veſſel, and apply itſelf immediately to the piece of meat that is to be dreſſed, and this without any riſk of ſcorching or overdoing.—And it will give out about $\frac{799}{800}$ of the heat which it contains, and will do this only if it be wanted; ſo that no heat whatever is waſted except what is required for heating the apparatus. Experience ſhows that this is a mere trifle in compariſon of what was ſuppoſed neceſſary. But with an open fire we only apply the flame and hot air to the bottom and part of the ſides of our boiling veſſels: and this application is hurried in the extreme; for to make a great heat, we muſt have a great fire, which requires a prodigious and moſt rapid current of air. This air touches our pans but for a moment, imparts to them but a ſmall portion of its heat; and we are perſuaded that three-fourths of the heat is carried up the chimney, and eſcapes in pure waſte, while another great portion beams out into the kitchen to the great annoyance of the ſcorched cook. We think, therefore, that a page or two of this work will not be thrown away in the deſcription of a contrivance by which a ſaving may be made to the entertainer, and the providing the pleaſures of his table prove a leſs fatiguing taſk to this valuable corps of practical chemiſts.

Plate DV. fig. 1.

Let A (fig. 1.) repreſent a kitchen-boiler, either properly fitted up in a furnace, with its proper fire-place, aſh-pit, and flue, or ſet on a tripod on the open fire, or built up in the general fire-place. The ſteam-pipe BC riſes from the cover of this boiler, and then is led away with a gentle aſcent in any convenient direction. C repreſents the ſection of this conducting ſteam-pipe. Branches are taken off from the ſide at proper diſtances. One of theſe is repreſented at CDE, furniſhed with a cock D, and having a taper nozzle E, fitted by grinding into a conical piece F, which communicates with an upright pipe GH, which is ſoldered to the ſide of the ſtewing veſſel PQRS, communicating with it by the ſhort pipe I. The veſſel is fitted with a cover OT, having a ſtaple handle V. The piece of meat M is laid on a tin-plate grate KL, pierced with holes like a cullender, and ſtanding on three ſhort feet *n n n*.

The ſteam from the boiler comes in by the pipe I, and is condenſed by the meat and by the ſides of the veſſel, communicating to them all its heat. What is not ſo condenſed eſcapes between the veſſel and its cover. The condenſed water lies on the bottom of the veſſel, mixed with a very ſmall quantity of gravy and fatty matter from the victuals. Frequently, inſtead of a cover, another ſtew-veſſel with a cullender bottom is ſet on this one, the bottom of the one fitting the mouth of the other: and *it is obſerved*, that when this is done, the diſh in the under veſſel is more expeditiouſly and better dreſſed, and the upper diſh is more ſlowly, but as completely, ſtewed.

This deſcription of one ſtewing veſſel may ſerve to give a notion of the whole; only we muſt obſerve, that when broths, ſoups, and diſhes with made ſauces or containing liquids, are to be dreſſed, they muſt be put into a ſmaller veſſel, which is ſet into the veſſel PQRS, and is ſupported on three ſhort feet, ſo that there may be a ſpace all round it of about an inch or three quarters of an inch. It is obſerved, that diſhes of this kind are not ſo expeditiouſly cooked as on an open fire, but as completely in the end, only requiring to be turned up now and then to mix the ingredients; becauſe as the liquids in the inner veſſel can never come into ebullition, unleſs the ſteam from the boiler be made of a dangerous heat, and every thing be cloſe confined, there cannot be any of that tumbling motion that we obſerve in a boiling pot.

The performance of this apparatus is far beyond any expectation we had formed of it. In one which we examined, ſix pans were ſtewing together by means of a boiler 10¾ inches in diameter, ſtanding on a briſk open fire. It boiled very briſkly, and the ſteam puffed frequently through the chinks between the ſtew-pans and their covers. In one of them was a piece of meat conſiderably above 30 pounds weight. This required above four hours ſtewing, and was then very thoroughly and equally cooked; the outſide being no more done than the heart, and it was near two pounds heavier than when put in, and greatly ſwelled. In the mean time, ſeveral diſhes had been dreſſed in the other pans. As far

far as we could judge, this cooking did not conſume one-third part of the fuel which an open fire would have required for the ſame effect.

When we conſider this apparatus with a little more knowledge of the mode of operation of fire than falls to the ſhare of the cooks (we ſpeak with deference), and conſider the very injudicious manner in which the ſteam is applied, we think that it may be improved ſo as to ſurpaſs any thing that the cook can have a notion of.

When the ſteam enters the ſtew-pan, it is condenſed on the meat and on the veſſel; but we do not want it to be condenſed on the veſſel. And the ſurface of the veſſel is much greater than that of the meat, and continues much colder; for the meat grows hot, and continues ſo, while the veſſel, made of metal, which is a very perfect conductor of heat, is continually robbed of its heat by the air of the kitchen, and carried off by it. If the meat touch the ſide of the pan in any part, no ſteam can be applied to that part of the meat, while it is continually imparting heat to the air by the intermedium of the veſſel. Nay, the meat can hardly be dreſſed unleſs there be a current of ſteam through it; and we think this confirmed by what is obſerved above, that when another ſtew-pan is ſet over the firſt, and thus gives occaſion to a current of ſteam through its cullender bottom to be condenſed by its ſides and contents, the lower diſh is more expeditiouſly dreſſed. We imagine, therefore, that not leſs than half of the ſteam is waſted on the ſides of the different ſtew-pans. Our firſt attention is therefore called to this circumſtance, and we wiſh to apply the ſteam more economically and effectually.

We would therefore conſtruct the ſteam-kitchen in the following manner:

Fig. 2.

We would make a wooden cheſt (which we ſhall call the Stew-chest) ABCD (fig. 2.). This ſhould be made of deal, in very narrow ſlips, not exceeding an inch, that it may not ſhrink This ſhould be lined with very thin copper, lead, or even ſtrong tinfoil. This will prevent it from becoming a conductor of heat by ſoaking with ſteam. For further ſecurity it might be ſet in another cheſt, with a ſpace of an inch or two all round, and this ſpace filled with a compoſition of powdered charcoal and clay. This ſhould be made by firſt making a mixture of fine potter's clay and water about as thick as poor cream: then as much powdered charcoal muſt be beat up with this as can be made to ſtick together. When this is rammed in and dry, it may be hot enough on one ſide to melt glaſs, and will not diſcolour white paper on the other.

This cheſt muſt have a cover LMNO, alſo of wood, having holes in it to receive the ſtew-pans P, Q, R. Between each pan is a wooden partition, covered on both ſides with milled lead or tinfoil. The whole top muſt be covered with very ſpongy leather or felt, and made very flat. Each ſtew-pan muſt have a bearing or ſhoulder all round it, by which it is ſupported, reſting on the felt, and lying ſo true and cloſe that no ſteam can eſcape. Some of the pans ſhould be ſimple, like the pan F, for dreſſing broths and other liquid diſhes. Others ſhould be like E and G, having in the bottom a pretty wide hole H, K, which has a pipe in its upper ſide, riſing about an inch or an inch and half into the ſtew-pan. The meat is laid on a cullender plate, as in the common way; only there muſt be no holes in the cullender immediately above the pipe.—Theſe ſtew-pans muſt be fitted with covers, or they may have others fitted to their mouths, for warming ſauces or other diſhes, or ſtewing greens, and many other ſubordinate purpoſes for which they may be fitted.

The main-pipe from the boiler muſt have branches, (each furniſhed with a cock), which admit the ſteam into theſe diviſions. At its firſt entry ſome will be condenſed on the bottom and ſides; but we imagine that theſe will in two minutes be heated ſo as to condenſe no more, or almoſt nothing. The ſteam will alſo quickly condenſe on the ſtew-pan, and in half a minute make it boiling hot, ſo that it will condenſe no more; all the reſt will now apply itſelf to the meat and to the cover. It may perhaps be adviſable to allow the cover to condenſe ſteam, and even to waſte it. This may be promoted by laying on it flannel ſoaked in water. Our view in this is to create a demand for ſteam, and thus produce a current through the ſtew-pan, which will be applied in its paſſage to the victuals. But we are not certain of the neceſſity of this. Steam is not like common air of the ſame temperature, which would glide along the ſurfaces of bodies, and impart to them a ſmall portion of its heat, and eſcape with the reſt. To produce this effect there *muſt* be a current; for air hot enough to melt lead, will not boil water, if it be kept ſtagnant round the veſſel. But ſteam imparts the *whole* of its latent heat to any body colder than boiling water, and goes no farther till this body be made boiling hot. It is a moſt faithful carrier of heat, and will deliver its whole charge to any body that can take it. Therefore, although there were no partitions in the ſtew-cheſt, and the ſteam were admitted at the end next the boiler, if the pan at the farther end be colder than the reſt, it will all go thither; and will, in ſhort, communicate to every thing impartially according to the demand. If any perſon has not the confidence in the ſteam which we expreſs, he may ſtill be certain that there muſt be a prodigious ſaving of heat by confining the whole in the ſtew-cheſt; and he may make the pans with entire bottoms, and admit the ſteam into them in the common way, by pipes which come through the ſides of the cheſt and then go into the pan. There will be none loſt by condenſation on the ſides of the cheſt; and the pans will ſoon be heated up to the boiling temperature; and hardly any of their heat will be waſted, becauſe the air in the cheſt will be ſtagnant. The chief reaſon for recommending our method is the much greater eaſe with which the ſtew-pans can be ſhifted and cleaned. There will be little difference in the performance.

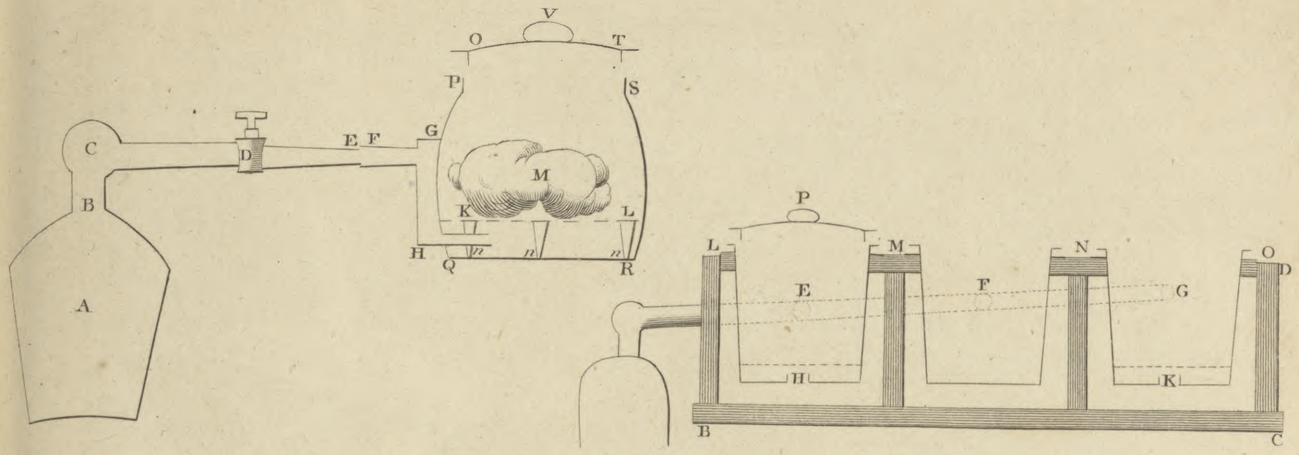
Nay, even the common ſteam-kitchen may be prodigiouſly improved by merely wrapping each pan in three or four folds of coarſe dry flannel, or making flannel bags of three or four folds fitted to their ſhape, which can be put on or removed in a minute. It will alſo greatly conduce to the good performance to wrap the main ſteam pipe in the ſame manner in flannel.

We ſaid that this main-pipe is conducted from the boiler with a gentle aſcent. The intention of this is, that the water produced by the unavoidable condenſation of the ſteam may run back into the boiler. But the rapid motion of the ſteam generally ſweeps it up hill, and it runs into the branch-pipes and deſcends into the ſtew-pans. Perhaps it would be as well to give the

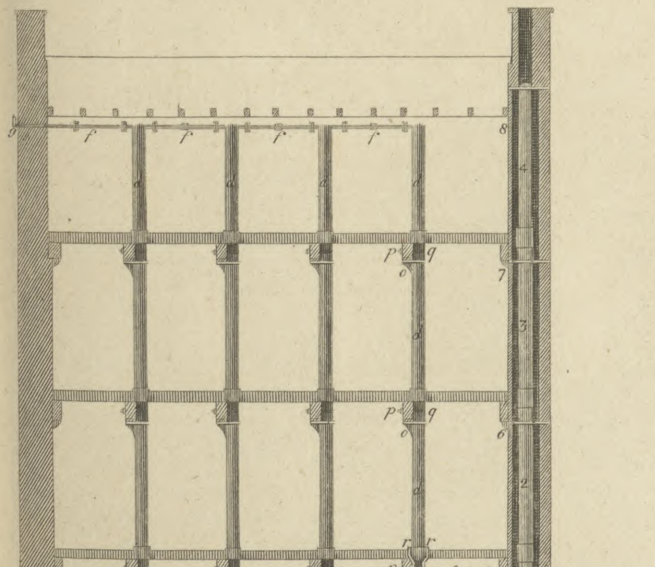
main-

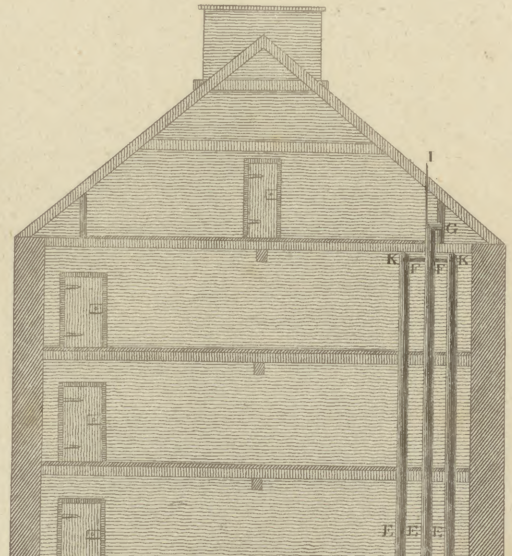
STEAM KITCHEN.

PLATE DV.



ROOMS *HEATED BY* STEAM.





W. Archibald sculpt.

main-pipe a declivity the other way, and allow all the water to collect in a hot well at the farther end, by means of a deſcending pipe, having a loaded valve at the end. This may be ſo contrived as to be cloſe by the fire, where it would be ſo warm that it would not check the boiling if again poured into the boiler. But the utmoſt attention muſt be paid to cleanlineſs in the whole of this paſſage, becauſe this water is boiled again, and its ſteam paſſes through the heart of every diſh. This circumſtance forbids us to return into the boiler what is condenſed in the ſtew-pans. This would mix the taſtes and flavours of every diſh, and be very diſagreeable. All this muſt remain in the bottom of each ſtew-pan; for which reaſon we put in the pipe riſing up in the middle of the bottom. It might indeed be allowed to fall down into the ſtew-cheſt, and to be collected in a common receptacle, while the fat would float at top, and the clear gravy be obtained below, perhaps fit for many ſauces.

The completeſt method for getting rid of this condenſed ſteam would be to have a ſmall pipe running along the under ſide of the main conductor, and communicating with it at different places, in a manner ſimilar to the air diſcharger on the mains of water-pipes. In the paper manufactory mentioned above, each ſteam-box has a pipe in its bottom, with a float-cock, by which the water is diſcharged; and the main pipe being of great diameter, and laid with a proper acclivity, the water runs back into the boiler.

But theſe precautions are of little moment in a ſteam-kitchen even for a great table; and for the general uſe of private families, would hurt the apparatus, by making it complex and of nice management. For a ſmall family, the whole apparatus may be ſet on a table four feet long and two broad, which may be placed on caſters, ſo as to be wheeled out of the way when not in uſe. If the main conductor be made of wood, or properly caſed in flannel, it will condenſe ſo little ſteam that the cooking table may ſtand in the remoteſt corner of the kitchen without ſenſibly impairing its performance; and if the boiler be properly ſet up in a ſmall furnace, and the flue made ſo that the flame may be applied to a great part of its ſurface, we are perſuaded that three-fourths of the fuel uſed in common cookery will be ſaved. Its only inconvenience ſeems to be the indiſpenſable neceſſity of the moſt anxious cleanlineſs in the whole apparatus. The moſt trifling neglect in this will deſtroy a whole dinner.

We had almoſt forgotten to obſerve, that the boiler muſt be furniſhed with a funnel for ſupplying it with water. This ſhould paſs through the top, and its pipe reach near to the bottom. It will be proper to have a cock on this funnel. There ſhould alſo be another pipe in the top of the boiler, having a valve on the top. If this be loaded with a pound on every ſquare inch, and the fire ſo regulated that ſteam may be obſerved to puff ſometimes from this valve, we may be certain that it is paſſing through our diſhes with ſufficient rapidity; and if we ſhut the cock on the funnel, and load the valve a little more, we ſhall cauſe the ſteam to blow at the covers of the ſtew-pans. If one of theſe be made very tight, and have a hole alſo furniſhed with a loaded valve, this pan becomes a digeſter, and will diſſolve bones, and do many things which are impracticable in the ordinary cookery.

STEAM applied to Heating Rooms. Steam has been ſucceſsfully applied as a ſubſtitute for open fires in heating manufactories, and promiſes to be highly beneficial, not only in point of economy in ſaving fuel, but alſo in leſſening the danger of accidental fire. The following mode of heating a cotton mill by ſteam was propoſed and practiſed in 1799 by Mr Niel Snodgraſs of Paiſley. We ſhall give an account of it in his own words *.

"Fig. 1. preſents a view of an inner gable, which is at one extremity of the preparation and ſpinning rooms of the mill. On the other ſide of this gable there is a ſpace of 17 feet, encloſed by an outer gable, and containing the water-wheel, the ſtaircaſe, and ſmall rooms for the accommodation of the work. In this ſpace the furnace and boiler are placed on the ground. The boiler cannot be ſhown here, as it lies behind the gable exhibited; nor is it of any conſequence, as there is nothing peculiar in it. It may be of any convenient form. The feeding apparatus, &c. are in every reſpect the ſame as in the boiler of a common ſteam-engine. A circular copper boiler, two feet diameter by two feet deep, containing 30 gallons of water, with a large copper head as a reſervoir for the ſteam, was found to anſwer in the preſent inſtance. The ſteam is conveyed from the boiler through the gable, by the copper pipe B, into the tin pipe, C, C. From C it paſſes into the centres of the perpendicular pipes E, E, E, by the ſmall bent copper tubes D, D, D. The pipes E, E, E, are connected under the garret floor by the tubes F, F, for the more eaſy circulation of the ſteam. The middle pipe, E, is carried through the garret floor, and communicates with a lying pipe, 36 feet in length (the end of which is ſeen at G), for heating the garret. At the further extremity of the pipe G, there is a valve falling inwards to prevent a vacuum being formed on the cooling of the apparatus; the conſequence of which would be the cruſhing of the pipes by the preſſure of the atmoſphere. Similar valves K, K, are placed near the top of the perpendicular pipes, E, E; and from the middle one E, the ſmall pipe paſſes through the roof, and is furniſhed with a valve at I, opening outwards, to ſuffer the air to eſcape while the pipes are filling with ſteam, or the ſteam itſelf to eſcape when the charge is too high.

Plate DV. fig. 1.

"The water condenſed in the perpendicular pipes E, E, E, trickles down their ſides into the three funnels L, L, L, the necks of which may either paſs through or round the pipe C, into the copper tube M, M, which alſo receives the water condenſed in C, C, by means of the ſhort tubes N, N. The pipe C, C, is itſelf ſo much inclined as to cauſe the water to run along it to the tubes N, N, and the pipe G in the garret has an inclination of 18 inches in its length, to bring the water condenſed in it back to the middle pipe E. The tube M, M, carries back the water through the gable to the boiler, which ſtands five feet lower than this tube. It is material to return the water to the boiler, as, being nearly at a boiling heat, a conſiderable expence of fuel is thereby ſaved.

"The large pipes are ten inches in diameter, and are made of the ſecond kind of tinned iron plates. The dimenſions of the ſmaller tubes may be ſeen by their comparative ſize in the engraving, and perhaps they might be varied without inconvenience.

"The apparatus erected as here deſcribed, has been found ſufficiently ſtrong, and has required no material repairs

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* *Phil. Mag.* xxvii. 174.

repairs ſince the firſt alterations were made. The leading object in the inſtance under conſideration being to ſave fuel, in order to derive as much heat as poſſible from a given quantity of fuel, the flue from the furnace, which heats the boiler, is conveyed into common ſtone pipes placed in the gable. Theſe are erected ſo as to prevent any danger of fire, in the manner ſhown in the engraving, fig. 2. The ſteam with this auxiliary communicates a heat of about 70° to the mill, the rooms of which are 50 feet long, 32½ feet wide, and 8½ feet high, except the lower ſtory and garret; the former of which is 11, and the latter ſeven feet high. The rooms warmed in this manner are much more wholeſome and agreeable than thoſe heated by the beſt conſtructed ſtoves, being perfectly free from vapour or contaminated air.

“ The application of the principle to buildings already conſtructed, it is preſumed, will be ſufficiently obvious from the foregoing details. In new manufactories, where the mode of heating may be made a part of the original plan, a more convenient apparatus may be introduced. This will be beſt explained by a deſcription of fig. 2. which gives a ſection of a cotton-mill conſtructed ſo as to apply the ſteam apparatus to a new building.

Fig. 2.

“ The furnace for the boiler is ſhown at *a* (fig. 2). The flue of the furnace conveys the ſmoke into the caſt iron ſtove pipes, 1, 2, 3, 4. Theſe pipes are placed in a ſpace in the gable, entirely incloſed with brick, except at the ſmall apertures, 5, 6, 7, 8. A current of air is admitted below at 9, and thrown into the rooms by thoſe openings, after being heated by contact with the pipes. This part of the plan is adopted with a view to prevent, as much as poſſible, any of the heat, produced by the fuel uſed, from being thrown away. It may be omitted where any danger of fire is apprehended from it, and the ſmoke may be carried off in any way that is conſidered abſolutely ſecure. So far, however, as appears from experience, there ſeems to be little or no danger of fire from a ſtove of this conſtruction. The greateſt inconvenience of a common ſtove is, that the cockle or metal furnace is liable to crack from the intenſity of the heat. By the continuity of the metal from the fireplace, an intenſe heat is alſo conducted along the pipes, which expoſes them to the ſame accident. Here the ſmoke being previouſly conveyed through a brick flue, can never communicate to the pipes a degree of heat ſufficient to crack them. In like manner the pipes, having no communication with the rooms but by the ſmall apertures, cannot come in contact with any combuſtible ſubſtance; and from being ſurrounded with air, which is conſtantly changing, can impart only a very moderate degree of heat to the walls. The iron ſupporters of the pipes may be imbedded in ſome ſubſtance which is a bad conductor of heat, as furnace aſhes and lime, &c. The emiſſion of heated air into the rooms may be regulated by valves. As the pipes are not expoſed to cracking, there is no riſk of their throwing ſmoke or vapour into the rooms.

“ The boiler *b*, *b*, is ſix feet long, three and a half broad, and three feet deep. As there is nothing peculiar in the feeding apparatus, it is omitted. The boiler may be placed in any convenient ſituation. Where a ſteam engine is uſed for other purpoſes, the ſteam may be taken from its boiler. The pipe *c*, *c*, conveys the ſteam from the boiler to the firſt perpendicular pipe *d*, *d*, *d*, *d*. There is an expanding joint at *e*, ſtuffed, to make it ſteam-tight. The ſteam aſcending in the firſt pipe *d*, *d*, *d*, enters the horizontal pipe *f*, *f*, *f*, *f*, (which is ſlightly inclined) expelling the air, which partly eſcapes by the valve *g*, and is partly forced into the other pipes. The valve *g* being conſiderably loaded, forces the accumulating ſteam down into the reſt of the pipes *d*, *d*, *d*. The air in theſe pipes recedes before the ſteam, and is forced through the tubes *h*, *h*, *h*, into the pipe *m*, *m*, *m*, whence it eſcapes at the valve *i*, and the ſyphon *k*. The water, condenſed in the whole of the pipes, paſſes alſo through the tubes *h*, *h*, *h*, *h*, into the pipe *m*, *m*, *m*, which has ſuch a declivity as to diſcharge the water at the ſyphon *k*, into the hot well *n*, whence it is pumped back into the boiler.

“ The whole of the pipes are of caſt iron, except *m*, *m*, *m*, which is of copper. The perpendicular pipes ſerve as pillars for ſupporting the beams of the houſe, by means of the projecting pieces *o*, *o*, *o*, which may be raiſed or lowered at pleaſure by the wedges *p*, *p*, *p*. The pipes are ſunk in the beams about an inch, and are made faſt to them by the iron ſtraps *q*, *q*. Thoſe in the lower ſtory reſt on the ſtones *s*, *s*, *s*, *s*, and are made tight at the junction with ſtuffing. The pipe in each ſtory ſupports the one in the ſtory above by a ſtuffed joint as ſhown at *r*. The pipes in the lower ſtory are ſeven inches in diameter; thoſe in the higher ſix inches; thoſe in the other two are of intermediate diameters. The thickneſs of the metal is three-eighths of an inch. The lower pipes are made larger than the upper, in order to expoſe a greater heated ſurface in the lower rooms, becauſe the ſteam being thrown from above into all the pipes, except the firſt, would otherwiſe become incapable of imparting an equal heat as it deſcends. There is no neceſſity for valves opening inwards in this apparatus, the pipes being ſtrong enough to reſiſt the preſſure of the atmoſphere.

“ The cotton mill is 60 feet long, 33 wide, and four ſtories high, the upper being a garret ſtory. In the engraving, five parts out of nine in the length of the building are only ſhown. The apparatus will heat the rooms to 85° in the coldeſt ſeaſon. It is evident that, by increaſing the ſize, or the number of the pipes, and the ſupply of ſteam, any degree of heat up to 212° may be eaſily produced. It may even be carried beyond that point by an apparatus ſtrong enough to compreſs the ſteam: this, however, can ſeldom be wanted. At firſt it was objected to this conſtruction, that the expanſion of the pipes, when heated, might damage the building: but experience has proved, that the expanſion occaſioned by the heat of ſteam is quite inſenſible.”

Steam has alſo been advantageouſly employed in drying muſlin goods, when the ſtate of the weather interrupts this proceſs out of doors. This application of ſteam, we underſtand, was the invention of an ingenious mechanic in Paiſley, who never derived the ſmalleſt benefit from the diſcovery. It was adopted immediately by ſome bleachers in the neighbourhood, and has now come into very general uſe. The ſteam is introduced into cylinders of tin plate, and the goods to be dried are wrapped round the cylinders which communicate to them a heat equal at leaſt to the temperature of boiling water, and in this way the proceſs of drying is expeditiouſly accompliſhed.

STEATITES, or *Soap earth*, a ſpecies of mineral belonging to the magneſian genus. See MINERALOGY *Index.*

STEATOMA, a kind of encyſted tumor, conſiſting of a matter like ſuet or lard, ſoft, without pain, and without diſcolouring the ſkin.

STEEL, iron united with carbone, from which it poſſeſſes properties diſtinct from thoſe of iron, and which render it of ſuperior value. From its higher degree of hardneſs, it admits a finer poliſh and aſſumes a brighter colour. When tempered, it poſſeſſes a higher degree of elaſticity, and is alſo more ſonorous. It is more weakly attracted by the loadſtone, it receives more ſlowly the magnetic power, but it preſerves it longer. When expoſed to a moiſt air, it does not contract ruſt ſo eaſily as iron. See IRON, CHEMISTRY *Index.*

STEEL-Bow Tenants. See TENURE.

STEEL-Yard, is one of the moſt ancient preſents which ſcience has made to ſociety; and though long in deſuetude in this country, is in moſt nations of the world the only inſtrument for aſcertaining the weight of bodies. What is tranſlated *balance* in the Pentateuch, is in fact ſteelyard, being the word uſed by the Arabs to this day for their inſtrument, which is a ſteelyard. It is in common uſe in all the Aſiatic nations. It was the *ſtatera* of the Greeks and Romans, and ſeems to have been more confided in by them than the balance; for which reaſon it was uſed by the goldſmiths, while the balance was the inſtrument of the people.—*Non aurificis ſtatera ſed populari trutina examinare.* Cic. de Orat. 238.

Plate DVI. fig. 1.

The ſteelyard is a lever of unequal arms, and, in its moſt perfect form, is conſtructed much like a common balance. It hangs in ſheers E (fig. 1.) reſting on the nail C, and the ſcale L for holding the goods hangs by a nail D on the ſhort arm BC. The counter weight P hangs by a ring of tempered ſteel, made ſharp in the inſide, that it may bear by an edge on the long arm CA of the ſteelyard. The under edge of the centre nail C, and the upper edge of the nail D, are in the ſtraight line formed by the upper edge of the long arm. Thus the three points of ſuſpenſion are in one ſtraight line. The needle or index of the ſteelyard is perpendicular to the line of the arms, and plays between the ſheers. The ſhort arm may be made ſo maſſive, that, together with the ſcale, it will balance the long arm unloaded. When no goods are in the ſcale, and the counter weight with its hook are removed, the ſteelyard acquires a horizontal poſition, in conſequence of its centre of gravity being below the axis of ſuſpenſion. The rules for its accurate conſtruction are the ſame as for a common balance.

The inſtrument indicates different weights in the following manner: The diſtance CD of the two nails is conſidered as an unit, and the long arm is divided into a number of parts equal to it; and theſe are ſubdivided as low as is thought proper; or in general, the long arm is made a ſcale of equal parts, commencing at the edge of the nail C; and the ſhort arm contains ſome determined number of thoſe equal parts. Suppoſe, then, that a weight A of 10 pounds is put into the ſcale L. The counterpoiſe P muſt be of ſuch a weight, that, when hanging at the diviſion 10, it ſhall balance this weight A. Now let any unknown weight W be put into the ſcale. Slide the hook of the counterpoiſe along the long arm till it balances this weight. Suppoſe it then hanging at the diviſion 38. We conclude that there is 38 pounds in the ſcale. This we do on the authority of the fundamental property of the lever, that forces acting on it, and balancing each other, are in the inverſe proportion of the diſtances from the fulcrum to their lines of direction. Whatever weight the counterpoiſe is, it is to A as CD to 10, and it is to the weight W as CD to 38; therefore A is to the weight W as 10 to 38, and W is 38 pounds: and thus the weight in the ſcale will always be indicated by the diviſion at which it is balanced by the counterpoiſe.

Our well-informed readers know that this fundamental property of the lever was diſcovered by the renowned Archimedes, or at leaſt firſt demonſtrated by him; and that his demonſtration, beſides the defect of being applicable only to commenſurable lengths of the arms, has been thought by metaphyſicians of the firſt note to proceed on a poſtulate which ſeems equally to need a demonſtration. It has accordingly employed the utmoſt refinement of the firſt mathematicians of Europe to furniſh a demonſtration free from objection. Mr D'Alembert has given two, remarkable for their ingenuity and ſubtlety; Foncenex has done the ſame; and Profeſſor Hamilton of Trinity college, Dublin, has given one which is thought the leaſt exceptionable. But critics have even objected to this, as depending on a poſtulate which ſhould have been demonſtrated.

Phil Tranſ 1794.

The following demonſtration by Mr Vince, we think unexceptionable, and of ſuch ſimplicity that it is aſtoniſhing that it has not occurred to any perſon who thinks on the ſubject.

Fig. 2.

Let AE (fig. 2.) be a mathematical lever, or inflexible ſtraight line, reſting on the prop A, and ſupported at D by a force acting upwards. Let two equal weights *b* and *d* be hung on at B and D, equidiſtant from A and E. Preſſures are now exerted at A and E; and becauſe every circumſtance of weight and diſtance is the ſame, the preſſure at E, ariſing from the action of the weight *b* on the point B, muſt be the ſame with the preſſure at A, ariſing from the action of the weight *d* on the point D; and the preſſure at E, occaſioned by the weight *d*, muſt be the ſame with the preſſure at A, occaſioned by the weight *b*. This muſt be the caſe wherever the weights are hung, provided that the diſtance AB and DE are equal. Moreover, the ſum of the preſſures at A and E is unqueſtionably equal to the ſum of the weights, becauſe the weights are ſupported ſolely at A and E. Let the two weights be hung on at C the middle point; the preſſure at E is ſtill the ſame. Therefore, in general, the preſſure excited at the point E, by two equal weights hanging at any points B and D, is the ſame as if they were hung on at the middle point between them; but the preſſure excited at E is a juſt meaſure of the effort or energy of the weights *b* and *d* to urge the lever round the point A. It is, at leaſt, a meaſure of the oppoſite force which muſt be applied at E to ſuſtain or balance this preſſure. A very faſtidious metaphyſician may ſtill ſay, that the demonſtration is limited to a point E, whoſe diſtance from A is twice AC, or = AB + AD. But it extends to any other point, on the authority of a poſtulate which cannot be refuſed, viz. that in whatever proportion the preſſure at E is augmented or diminiſhed, the preſſure at this other point muſt augment or diminiſh in the ſame proportion. This being proved, the general theorem may be demonſtrted in all proportions of diſtance, in the manner of Archimedes, at once the moſt ſimple, perſpicuous, and elegant of all.

We cannot help obſerving, that all this difficulty (and it is a real one to the philoſopher who aims at rendering mechanics a demonſtrative ſcience) has ariſen from an improper ſearch after ſimplicity. Had Archimedes taken a lever as it really exiſts in nature, and conſidered it as *material*, conſiſting of atoms united by coheſion; and had he traced the intermediate preſſures by whoſe means the two external weights are put in oppoſition to each other, or rather to the ſupport given to the fulcrum; all difficulty would have vaniſhed. (See what is ſaid on this ſubject in the article *STRENGTH of Timber*, &c.).

The quantity of goods which may be weighed by this inſtrument depends on the weight of the counterpoiſe, and on the diſtance CD from the fulcrum at which the goods are ſuſpended. A double counterpoiſe hanging at the ſame diviſion will balance or indicate a double quantity of goods hanging at D; and any counterpoiſe will balance and indicate a double quantity of goods, if the diſtance CD be reduced to one half. And it ſometimes occurs that ſteelyards are ſo conſtructed that they have two or more points of ſuſpenſion D, to which the ſcale may occaſionally be attached. It is evident, that in this caſe the value or indication of the diviſions of the long arm will be different, according to the point from which the ſcale is ſuſpended. The ſame diviſion which would indicate 20 pounds when CD is three inches, will indicate 30 pounds when it is two inches. As it would expoſe to chance of miſtakes, and be otherwiſe troubleſome to make this reduction, it is uſual to make as many divided ſcales on the long arm as there are points of ſuſpenſion D on the ſhort arm: and each ſcale having its own numbers, all trouble and all chance of miſtake is avoided.

But the range of this inſtrument is not altogether at the pleaſure of the maker. Beſides the inability of a ſlender beam to carry a great load, the diviſions of the ſcale anſwering to pounds or half-pounds become very minute when the diſtance CD is very ſhort; and the balance becomes leſs delicate, that is, leſs ſenſibly affected by ſmall differences of weight. This is becauſe in ſuch caſes the thickneſs which it is neceſſary to give the edges of the nails does then bear a ſenſible proportion to the diſtance CD between them; ſo that when the balance inclines to one ſide, that arm is ſenſibly ſhortened, and therefore the energy of the preponderating weight is leſſened.

We have hitherto ſuppoſed the ſteelyard to be in equilibrio when not loaded. But this is not neceſſary, nor is it uſual in thoſe which are commonly made. The long arm commonly preponderates conſiderably. This makes no difference, except in the beginning of the ſcale. The preponderancy of the long arm is equivalent to ſome goods already in the ſcale, ſuppoſe four pounds. Therefore when there are really 10 pounds in the ſcale, the counterpoiſe will balance it when hanging at the diviſion 6. This diviſion is therefore reckoned 10, and the reſt of the diviſions are numbered accordingly.

A ſcientific examination of the ſteelyard will convince us that it is inferior to the balance of equal arms in point of ſenſibility: But it is extremely compendious and convenient; and when accurately made and attentively uſed, it is abundantly exact for moſt commercial purpoſes. We have ſeen one at Leipzig which has been in uſe ſince the year 1718, which is very ſenſible to a difference of one pound, when loaded with nearly three tons on the ſhort arm; and we ſaw a waggon loaded with more than two tons weighed by it in about ſix minutes.

The ſteelyard in common uſe in the different countries of Europe is of a conſtruction ſtill ſimpler than what we have deſcribed. It conſiſts of a batten of hard wood, having a heavy lump A (*fig.* 3.) at one end, and Fig. 3.
a ſwivel-hook B at the other. The goods to be weighed are ſuſpended on the hook, and the whole is carried in a loop of whip-cord C, in which it is ſlid backward and forward, till the goods are balanced by the weight of the other end. The weight of the goods is eſtimated by the place of the loop on a ſcale of diviſions in harmonic progreſſion. They are marked (we preſume) by trial with known weights.

The chief uſe that is now made of the ſteelyard in theſe kingdoms is for the weighing of loaded waggons and carts. For this it is extremely convenient, and more than ſufficiently exact for the purpoſe in view. We ſhall deſcribe one or two of the moſt remarkable; and we ſhall begin with that at Leipzig already mentioned.

This ſteelyard is repreſented in fig. 4. as run out, Fig. 4.
and juſt about to be hooked for lifting up the load. The ſteelyard itſelf is OPQ, and is about 12 feet long. The ſhort arm PQ has two points of ſuſpenſion *c* and *b*; and the ſtirrup which carries the chains for holding the load is made with a double hook, inſtead of a double eye, that it may be eaſily removed from the one pin to the other. For this purpoſe the two hooks are connected above an haſp or ſtaple, which goes over the arm of the ſteelyard like an arch. This is repreſented in the little figure above the ſteelyard. The ſuſpenſion is ſhifted when the ſteelyard is run in under cover, by hooking to this ſtaple the running block of a ſmall tackle which hangs in the door through which the ſteelyard is run out and in. This operation is eaſy, but neceſſary, becauſe the ſtirrup, chains, and the ſtage on which the load is placed, weigh ſome hundreds.

The outer pin *b* is 14 inches, and the inner one *c* is ſeven inches, diſtant from the great nail which reſts in the ſheers. The other arm is about 10½ feet long, formed with an obtuſe edge above. On the inclined plane on each ſide of the ridge is drawn the ſcale of weights adapted to the inner pin *c*. The ſcales correſponding to the outer pin *b* are drawn on the upright ſides. The counterpoiſe ſlides along this arm, hanging from a ſaddle-piece made of braſs, that it may not contract ruſt. The motion is made eaſy by means of rollers. This is neceſſary, becauſe the counterpoiſe is greatly above a hundred weight. This ſaddle-piece has like two laps on each ſide, on which are engraved vernier ſcales, which divide their reſpective ſcales on the arm to quarters of a pound. Above the ſaddle is an arch, from the ſummit of which hangs a little plummet, which ſhows the equilibrium of the ſteelyard to the weigher, becauſe the ſheers are four feet out of the houſe, and he cannot ſee their coincidence with the needle of the ſteelyard. Laſtly, near the end of the long arm

STEELYARD.

PLATE DVI.

Fig. 4.

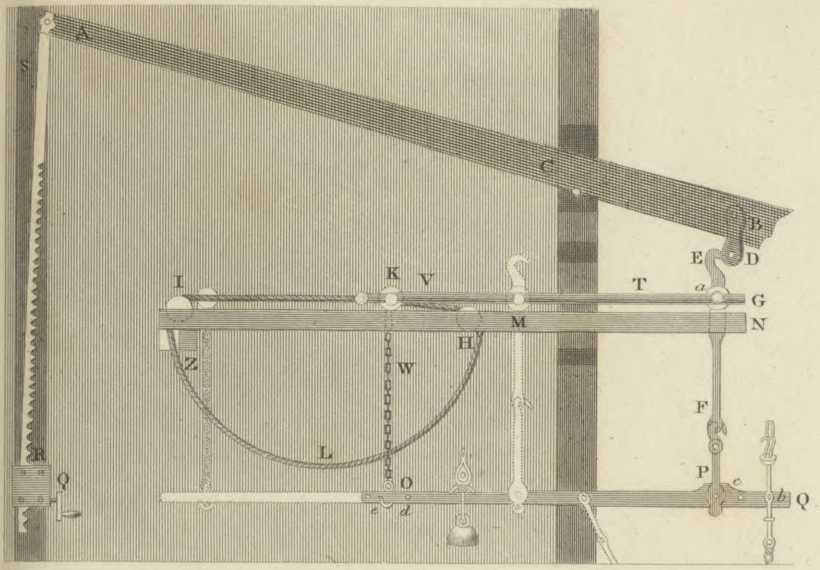


Fig. 2.

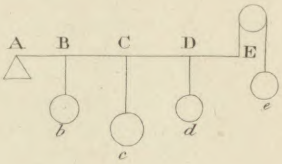


Fig. 1.

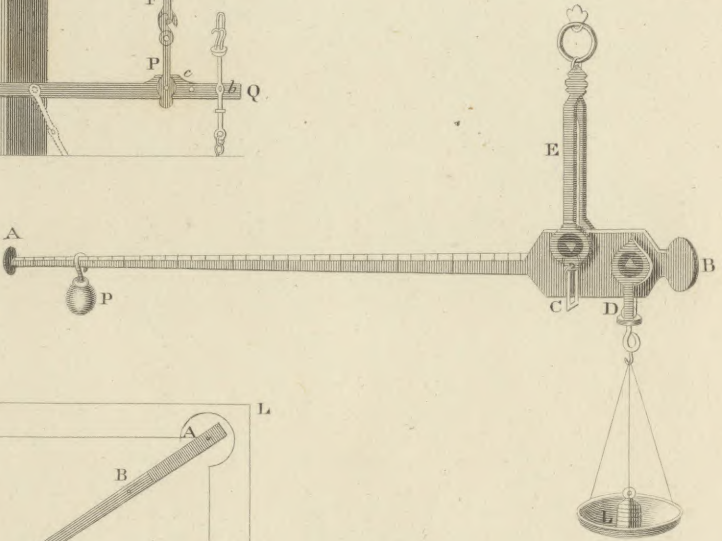


Fig. 5.

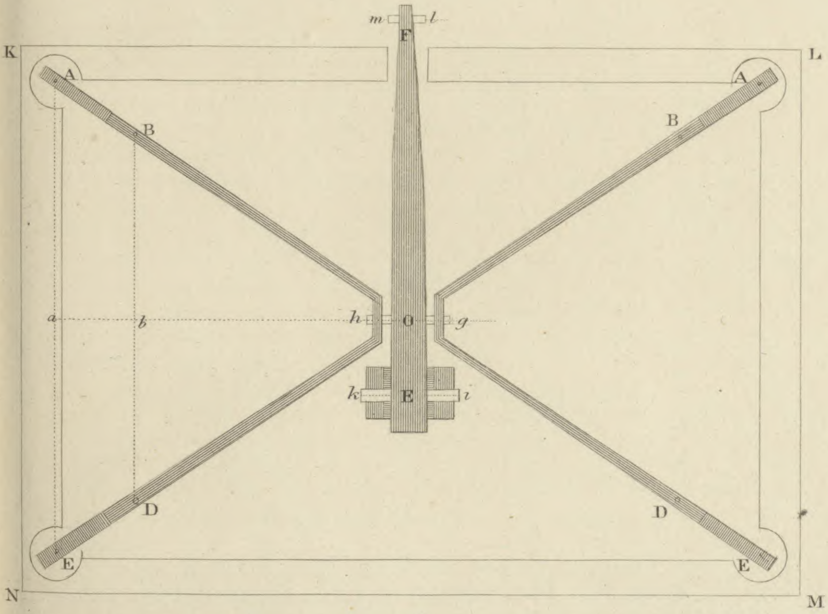
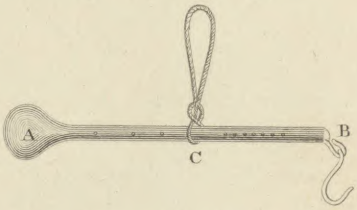


Fig. 3.



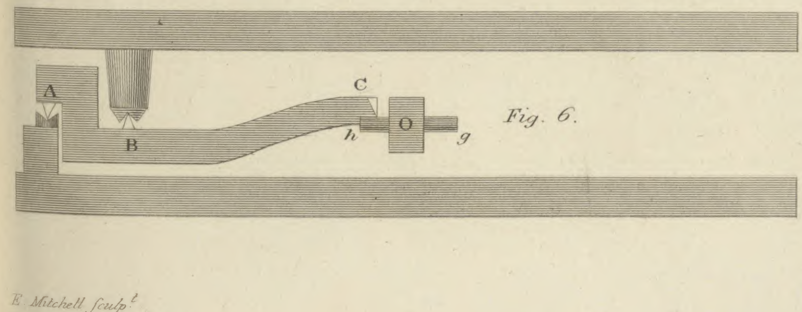


Fig. 6.

E. Mitchell ſculp^{t}

are two pins *d* and *e*, for ſuſpending occaſionally two eke weights for continuing the ſcale. Theſe are kept hanging on adjoining hooks, ready to be lifted on by a little tackle, which is alſo hooked immediately above the pins *d* and *e*.

The ſcales of weights are laid down on the arm as follows. Let the eke-weights appropriated to the pins *d* and *e* be called D and E, and call the counterpoiſe C. Although the ſtirrup with its chains and ſtage weigh ſome hundreds, yet the length and ſize of the arm OP gives it a preponderancy of 300 pounds. Here, then, the ſcale of weights muſt commence. The counterpoiſe weighs about 125 pounds. Therefore,

1. When the load hangs by the pin *b*, 14 inches from the centre, the diſtance from one hundred to another on the ſcale is about 11 inches, and the firſt ſcale (on the ſide of the arm) reaches from 300 to 1200. In order to repeat or continue this, the eke-weight E is hung on the pin *e*, and the counterpoiſe C is brought back to the mark 300; and the two together balance 1100 pounds hanging at *b*. Therefore a ſecond ſcale is begun on the ſide of the arm, and continued as far out as the firſt, and therefore its extremity marks 2000; that is, the counterpoiſe C at 2000 and the eke-weight E at *e* balance 2000 hanging at *b*.

2. To continue the ſcale beyond 2000, the load muſt be hung on the inner pin *c*. The eke-weight E is taken off, and the eke-weight D is hung on its pin *d*. The general counterpoiſe being now brought cloſe to the ſheers, it, together with the weight D at *d*, balance 2000 pounds hanging at *c*. A ſcale is therefore begun on one of the inclined planes a-top, and continued out to 4000, which falls very near to the pin *d*, each hundred pounds occupying about five inches on the arm. To complete the ſcale, hang on the eke-weight E on its pin *e*, and bring back the counterpoiſe to the ſheers, and the three together balance 3800 hanging at *c*. Therefore when the counterpoiſe is now ſlid out to 4000, it muſt complete the balance with 5800 hanging at *c*.

It required a little conſideration to find out what proportion of the three weights C, D, and E, would make the repetitions of the ſcale extend as far as poſſible, having very little of it expreſſed twice, or upon two ſcales, as is the caſe here. We ſee that the ſpace correſponding to a ſingle pound is a very ſenſible quantity on both ſcales, being one-ninth of an inch on the firſt two ſcales, and one-twentieth on the laſt two.

This very ponderous machine, with its maſſy weights, cannot be eaſily managed without ſome aſſiſtance from mechanics. It is extremely proper to have it ſuſceptible of motion out and in, that it may be protected from the weather, which would ſoon deſtroy it by ruſt. The contrivance here is very effectual, and abundantly ſimple.

When the ſteel-yard is not in uſe, it is ſupported at one end by the iron rod F, into which the upper end of the ſheers is hooked. The upper end of this rod has a ſtrong hook E, and a little below at *a* it is pierced with a hole, in which is a very ſtrong bolt or pin of tempered ſteel, having a roller on each end cloſe to the rod on each ſide. Theſe rollers reſt on two joiſts, one of which is repreſented by MN, which traverſe the building, with juſt room enough between them to allow the rod F to hang freely down. The other end O of the ſteel-yard reſts in the bight of a large flat hook at the end of a chain W, which hangs down between the joiſts, and is ſupported on them by a frame with rollers H. This is connected with the rollers at G, which carry the ſheers by means of two iron-rods, of which one only can be ſeen. Theſe connect the two ſets of rollers in ſuch a manner that they muſt always move together, and keep their diſtance invariable. This motion is produced by means of an endleſs rope HI ZLKVH paſſing over the pulleys I and K, which turn between the joiſts, and hanging down in a bight between them. It is evident that by pulling on the part LZ we pull the frame of rollers in the direction GH, and thus bring the whole into the houſe in the poſition marked by the dotted figure. It is alſo plain, that by pulling on the part LK we force the roller frame and the whole apparatus out again.

It remains to ſhow how the load is raiſed from the ground and weighed. When the ſteelyard is run out for uſe, the upper hook E juſt enters into the ring D, which hangs from the end of the great oaken lever BCA about 22 feet long, turning on gudgeons at C about 5 feet from this end. From the other end A deſcends a long iron-rod SR, which has one ſide formed into a toothed rack that is acted on by a frame of wheel-work turned by an endleſs ſcrew and winch Q. Therefore when the hook E is well engaged in the ring D, a man turns the winch, and thus brings down the end A of the great lever, and raiſes the load two or three inches from the ground. Every thing is now at liberty, and the weigher now manages his weights on the arm of the ſteelyard till he has made an equilibrium.

We need not deſcribe the operation of letting down the load, diſengaging the ſteelyard from the great lever, and bringing it again under cover. The whole of this ſervice is performed by two men, and may be done in ſucceſſion by one, and is over in five or ſix minutes.

The moſt compendious and economical machine of this kind that we have ſeen is one, firſt uſed (we have heard) for weighing the riders of race-horſes, and afterwards applied to the more reputable ſervice of weighing loaded carriages.

Fig. 5.

Fig. 5. is a plan of the machine. KLMN is the plan of a rectangular box, which has a platform lid or cover, of ſize ſufficient for placing the wheels of a cart or waggon. The box is about a foot deep, and is ſunk into the ground till the platform cover is even with the ſurface. In the middle of the box is an iron lever ſupported on the fulcrum pin *i k*, formed like the nail of a balance, which reſts with its edge on arches of hardened ſteel firmly faſtened to the bottom of the box. This lever goes through one ſide of the box, and is furniſhed at its extremity with a hard ſteel pin *l m*, alſo formed to an edge below. In the very middle of the box it is croſſed by a third nail of hardened ſteel *g h*, alſo formed to an edge, but on the upper ſide. Theſe three edges are in one horizontal plane, as in a well made balance.

In the four corners A, A′, E′, E, of the box are firmly fixed four blocks of tempered ſteel, having their upper ſurfaces formed into ſpherical cavities, well poliſhed and hard tempered. ABCDE repreſents the upper edge of an iron bar of conſiderable ſtrength, which reſts on the cavities of the ſteel blocks in A and E, by means of of two hard ſteel ſtuds projecting from its under edge, and formed into obtuſe angled points or cones. Theſe points are in a ſtraight line parallel to the ſide KN of the box. The middle part C of this crooked bar is faced with hard-tempered ſteel below, and is there formed into an edge parallel to AE and KN, by which it reſts on the upper edge of the ſteel pin *g h* which is in the lever. In a line parallel to AE, and on the upper ſide of the crooked bar ACE, are fixed two ſtuds or points of hardened ſteel B and D projecting upwards above half an inch. The platform-cover has four ſhort feet like a ſtool, terminated by hard ſteel ſtuds, which are ſhaped into ſpherical cavities and well poliſhed. With theſe it reſts on the four ſteel points B, B′, D′, D. The bar ACE is kneed in ſuch a manner vertically, that the points A, B, D, E and the edge C are all in a horizontal plane. Theſe particulars will be better underſtood by looking at the elevation in fig. 6. What has been ſaid of the bar ACE, muſt be underſtood as alſo ſaid of the bar A′ C′ E′.

Draw through the centre of the box the line *a b c* perpendicular to the line AE, BD. It is evident that the bar ACE is equivalent to a lever *a b c*, having the fulcrum or axis AE reſting with its extremity C on the pin *h g* and loaded at *b*. It is alſo evident that *a* C is to *a b* as the load on this lever to the preſſure which it exerts on the pin *g h*, and that the ſame proportion ſubſiſts between the whole load on the platform and the preſſure which it exerts on the pin *g h*. It will alſo appear, on an attentive conſideration, that this proportion is nowiſe deranged in whatever manner the load is placed on the platform. If very unequably, the two ends of the pin *g h* may be unequally preſſed, and the lever wrenched and ſtrained a little; but the total preſſure is not changed.

If there be now placed a balance or ſteelyard at the ſide LK, in ſuch a manner that one end of it may be directly above the pin *l m* in the end of the lever EOF, they may be connected by a wire or ſlender rod, and a weight on the other arm of the balance or ſteelyard may be put in equilibrio with any load that can be laid on the platform. A ſmall counterpoiſe being firſt hung on to balance the apparatus when unloaded, any additional weight will meaſure the load really laid on the platform. If *a b* be to *a c* as 1 to 8, and EO to EF, alſo as 1 to 8, and if a common balance be uſed above, 64 pounds on the platform will be balanced by one pound in the ſcale, and every pound will be balanced by $\frac{1}{4}$th of an ounce. This would be a very convenient partition for moſt purpoſes, as it would enable us to uſe a common balance and common weights to complete the machine: Or it may be made with a balance of unequal arms, or with a ſteelyard.

Some have thought to improve this inſtrument by uſing edges like thoſe of the nails of a balance, inſtead of points. But unleſs made with uncommon accuracy, they will render the balance very dull. The ſmall deviation of the two edges A and E, or of B and D, from perfect paralleliſm to KN, is equivalent to a broad ſurface equal to the whole deviation. We imagine that, with no extraordinary care, the machine may be made to weigh within $\frac{1}{2000}$ of the truth, which is exact enough for any purpoſe in commerce.

It is neceſſary that the points be attached to the bars. Some have put the points at A and E in the blocks of ſteel faſtened to the bottom, becauſe the cavity there lodged water or dirt, which ſoon deſtroyed the inſtrument with ruſt. But this occaſions a change of proportion in the firſt lever by any ſhifting of the crooked bars; and this will frequently happen when the wheels of a loaded cart are puſhed on the platform. The cavity in the ſteel ſtud ſhould have a little rim round it, and it ſhould be kept full of oil. In a nice machine a quarter of an inch of quickſilver would effectually prevent all theſe inconveniences.

The ſimpleſt and moſt economical form of this machine is to have no balance or ſecond ſteelyard; but to make the firſt ſteelyard EOF a lever of the firſt kind, viz. having the fulcrum between O and F, and allow it to project far beyond the box. The long or outward arm of this lever is then divided into a ſcale of weights, commencing at the ſide of the box. A counterpoiſe muſt be choſen, ſuch as will, when at the beginning of the ſcale, balance the ſmalleſt load that will probably be examined. It will be convenient to carry on this ſcale by means of eke-weights hung on at the *extremity* of the lever, and to uſe but one moveable weight. By this method the diviſions of the ſcale will always have one value. The beſt arrangement is as follows: Place the mark O at the beginning of the ſcale, and let it extend only to 100, if for pounds; or to 112, if for cwts.; or to 10, if for ſtones; and let the eke-weight be numbered 1, 2, 3, &c. Let the loweſt weight be marked on the beam. This is always to be added to the weight ſhown by the operation. Let the eke-weights ſtand at the end of the beam, and let the general counterpoiſe always hang at O. When the cart is put on the platform, the end of the beam tilts up. Hang on the heavieſt eke-weight that is not ſufficient to preſs it down. Now complete the balance by ſliding out the counterpoiſe. Suppoſe the conſtant load to be 312lb. and that the counterpoiſe ſtands at 86, and that the eke-weight is 9; we have the load =986+312,=1298lbs.

STEELE, Sir Richard, was born about the year 1676 in Dublin; in which kingdom one branch of the family was poſſeſſed of a conſiderable eſtate in the county of Wexford. His father, a counſellor at law in Dublin, was private ſecretary to James duke of Ormond; but he was of Engliſh extraction: and his ſon, while very young, being carried to London, he put him to ſchool at the Charter-houſe, whence he was removed to Merton College in Oxford. Our author left the univerſity, which he did without taking any degree, in the full reſolution to enter into the army. This ſtep was highly diſpleaſing to his friends; but the ardour of his paſſion for a military life rendered him deaf to any other propoſal. Not being able to procure a better ſtation, he entered as a private gentleman in the horſe guards, notwithſtanding he thereby loſt the ſucceſſion to his Iriſh eſtate. However, as he had a flow of good nature, a generous openneſs and frankneſs of ſpirit, and a ſparkling vivacity of wit, theſe qualities rendered him the delight of the ſoldiery, and procured him an enſign's commiſſion in the guards. In the mean time, as he had made choice of a profeſſion which ſet him free from all the ordinary reſtraints in youth, he ſpared not to indulge his inclinations in the wildeſt exceſſes. Yet his gaieties and revels did not paſs without ſome cool hours of reflection; it was in theſe that he drew up his little treatiſe intitled

The Chriſtian Hero, with a deſign, if we may believe himſelf, to be a check upon his paſſions. For this purpoſe it had lain ſome time by him, when he printed it in 1701, with a dedication to Lord Cutts, who had not only appointed him his private ſecretary, but procured for him a company in Lord Lucas's regiment of fuſileers.

The ſame year he brought out his comedy called *The Funeral*, or *Grief à la Mode*. This play procured him the regard of King William, who reſolved to give him ſome eſſential marks of his favour; and though, upon that prince's death, his hopes were diſappointed, yet, in the beginning of Queen Anne's reign, he was appointed to the profitable place of gazetteer. He owed this poſt to the friendſhip of Lord Halifax and the earl of Sunderland, to whom he had been recommended by his ſchoolfellow Mr Addiſon. That gentleman alſo lent him a helping hand in promoting the comedy called *The Tender Huſband*, which was acted in 1704 with great ſucceſs. But his next play, The Lying Lover, had a very different fate. Upon this rebuff from the ſtage, he turned the ſame humorous current into another channel; and early in the year 1709, he began to publiſh the Tatler: which admirable paper was undertaken in concert with Dr Swift. His reputation was perfectly eſtabliſhed by this work; and, during the courſe of it, he was made a commiſſioner of the ſtamp-duties in 1710. Upon the change of the miniſtry the ſame year, he joined the duke of Marlborough, who had ſeveral years entertained a friendſhip for him; and upon his Grace's diſmiſſion from all employments in 1711, Mr Steele addreſſed a letter of thanks to him for the ſervices which he had done to his country. However, as our author ſtill continued to hold his place in the ſtamp-office under the new adminiſtration, he wiſely declined the diſcuſſion of political ſubjects; and, adhering more cloſely to Mr Addiſon, he dropt the Tatler, and afterwards, by the aſſiſtance chiefly of that ſteady friend, he carried on the ſame plan, much improved, under the title of *The Spectator*. The ſucceſs of this paper was equal to that of the former; which encouraged him, before the cloſe of it, to proceed upon the ſame deſign in the character of the Guardian. This was opened in the beginning of the year 1713, and was laid down in October the ſame year. But in the courſe of it his thoughts took a ſtronger turn to politics: he engaged with great warmth againſt the miniſtry; and being determined to proſecute his views that way by procuring a ſeat in the houſe of commons, he immediately removed all obſtacles thereto. For that purpoſe he took care to prevent a forcible diſmiſſion from his poſt in the ſtamp-office, by a timely reſignation of it to the earl of Oxford; and at the ſame time gave up a penſion, which had been till this time paid him by the queen as a ſervant to the late Prince George of Denmark. This done, he wrote the famous Guardian upon the demolition of Dunkirk, which was publiſhed Auguſt 7. 1713; and the parliament being diſſolved next day, the Guardian was ſoon followed by ſeveral other warm political tracts againſt the adminiſtration. Upon the meeting of the new parliament, Mr Steele having been returned a member for the borough of Stockbridge in Hampſhire, took his ſeat accordingly in the houſe of commons; but was expelled thence in a few days after, for writing the cloſe of the paper called the *Engliſhman*, and one of his political pieces intitled the *Criſis*. Preſently after his expulſion, he publiſhed propoſals for writing the hiſtory of the duke of Marlborough; at the ſame time he alſo wrote the *Spinſter*; and, in oppoſition to the *Examiner*, he ſet up a paper called the *Reader*, and continued publiſhing ſeveral other things in the ſame ſpirit till the death of the queen. Immediately after which, as a reward for theſe ſervices, he was taken into favour by her ſucceſſor to the throne, King George I. He was appointed ſurveyor of the royal ſtables at Hampton-Court, governor of the royal company of comedians, put into the commiſſion of the peace for the county of Middleſex, and in 1715 received the honour of knighthood. In the firſt parliament of that king, he was choſen member for Boroughbridge in Yorkſhire; and, after the ſuppreſſion of the rebellion in the north, was appointed one of the commiſſioners of the forfeited eſtates in Scotland. In 1718, he buried his ſecond wife, who had brought him a handſome fortune and a good eſtate in Wales; but neither this, nor the ample additions lately made to his income, were ſufficient to anſwer his demands. The thoughtleſs vivacity of his ſpirit often reduced him to little ſhifts of wit for its ſupport; and the project of the fiſh-pool this year owed its birth chiefly to the projector's neceſſities. This veſſel was intended to carry fiſh alive, and without waſting, to any part of the kingdom: but notwithſtanding all his towering hopes, the ſcheme proved very ruinous to him; for after he had been at an immenſe expence in contriving and building his veſſel, beſides the charge of the patent, which he had procured, it turned out upon trial to be a mere project. His plan was to bring ſalmon alive from the coaſt of Ireland; but theſe fiſh, though ſupplied by this contrivance with a continual ſtream of water while at ſea, yet uneaſy at their confinement, ſhattered themſelves to pieces againſt the ſides of the pool; ſo that when they were brought to market they were worth very little.

The following year he oppoſed the remarkable peerage bill in the houſe of commons; and, during the courſe of this oppoſition to the court, his licence for acting plays was revoked, and his patent rendered ineffectual, at the inſtance of the lord chamberlain. He did his utmoſt to prevent ſo great a loſs; and finding every direct avenue of approach to his royal maſter effectually barred againſt him by his powerful adverſary, he had recourſe to the method of applying to the public, in hopes that his complaints would reach the ears of his ſovereign, though in an indirect courſe, by that canal. In this ſpirit he formed the plan of a periodical paper, to be publiſhed twice a week, under the title of the *Theatre*; the firſt number of which came out on the 2d of January 1719-20. In the mean time, the miſfortune of being out of favour at court, like other miſfortunes, drew after it a train of more. During the courſe of this paper, in which he had aſſumed the feigned name of *Sir John Edgar*, he was outrageouſly attacked by Mr Dennis, the noted critic, in a very abuſive pamphlet, entitled *The Character and Conduct of Sir John Edgar*. To this inſult our author made a proper reply in the Theatre.

While he was ſtruggling with all his might to ſave himſelf from ruin, he found time to turn his pen againſt the miſchievous South ſea ſcheme, which had nearly

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brought the nation to ruin in 1720; and the next year he was reſtored to his office and authority in the play-houſe in Drury Lane. Of this it was not long before he made an additional advantage, by bringing his celebrated comedy called the *Conſcious Lovers* upon that ſtage, where it was acted with prodigious ſucceſs; ſo that the receipt there muſt have been very conſiderable, beſides the profits accruing by the ſale of the copy, and a purſe of 500l. given to him by the king, to whom he dedicated it. Yet notwithſtanding theſe ample ſupplies, about the year following being reduced to the utmoſt extremity, he ſold his ſhare in the play-houſe; and ſoon after commenced a law-ſuit with the managers, which in 1726 was decided againſt him. Having now again, for the laſt time, brought his fortune by the moſt heedleſs profuſion, into a deſperate condition, he was rendered altogether incapable of retrieving the loſs, by being ſeized with a paralytic diſorder, which greatly impaired his underſtanding. In theſe unhappy circumſtances, he retired to his ſeat at Languanor near Caermarthen in Wales, where he died on the 21ſt of September 1729, and was privately interred, according to his own deſire, in the church of Caermarthen. Among his papers were found the manuſcripts of two plays, one called *The Gentlemen*, founded upon the Eunuch of Terence, and the other intitled *The School of Action*, both nearly finiſhed.

Sir Richard was a man of undiſſembled and extenſive benevolence, a friend to the friendleſs, and, as far as his circumſtances would permit, the father of every orphan. His works are chaſte and manly. He was a ſtranger to the moſt diſtant appearance of envy or malevolence; never jealous of any man's growing reputation; and ſo far from arrogating any praiſe to himſelf from his conjunction with Mr Addiſon, that he was the firſt who deſired him to diſtinguiſh his papers. His great fault was want of economy; and it has been ſaid of him, he was certainly the moſt agreeable and the moſt innocent rake that ever trod the rounds of diſſipation.

STEEPLE, an appendage erected generally on the weſtern end of churches, to hold the bells. Steeples are denominated from their form, either ſpires or towers: the firſt are ſuch as aſcend continually diminiſhing either conically or pyramidally; the latter are mere parallelopipeds, and are covered a-top platform-like.

STEERAGE, on board a ſhip, that part of the ſhip next below the quarter-deck, before the bulk-head of the great cabin, where the ſteerſman ſtands, in moſt ſhips of war. See STEERING.

STEERING, in *Navigation*, the art of directing the ſhip's way by the movements of the helm; or of applying its efforts to regulate her courſe when ſhe advances.

The perfection of ſteering conſiſts in a vigilant attention to the motion of the ſhip's head, ſo as to check every deviation from the line of her courſe in the firſt inſtant of its motion; and in applying as little of the power of the helm as poſſible. By this ſhe will run more uniformly in a ſtraight path, as declining leſs to the right and left; whereas, if a greater effort of the helm is employed, it will produce a greater declination from the courſe, and not only increaſe the difficulty of ſteering, but alſo make a crooked and irregular track through the water. See HELM.—The helmſman ſhould diligently watch the movements of the head by the land, clouds, moon, or ſtars; becauſe, although the courſe is in general regulated by the compaſs, yet the vibrations of the needle are not ſo quickly perceived as the ſallies of the ſhip's head to the right or left, which, if not immediately reſtrained, will acquire additional velocity in every inſtant of their motion, and demand a more powerful impulſe of the helm to reduce them; the application of which will operate to turn her head as far on the contrary ſide of her courſe.—The phraſes uſed in ſteering a ſhip vary according to the relation of the wind to her courſe. Thus, if the wind is fair or large, the phraſes uſed by the pilot or officer who ſuperintends the ſteerage are, *port*, *ſtarboard*, and *ſteady*. The firſt is intended to direct the ſhip's courſe farther to the right; the ſecond is to guide her farther to the left; and the laſt is deſigned to keep her exactly in the line whereon ſhe advances, according to the courſe preſcribed. The exceſs of the firſt and ſecond movements is called *hard-a-port*, and *hard-a-ſtarboard;* the former of which gives her the greateſt poſſible inclination to the right, and the latter an equal tendency to the left.—If, on the contrary, the wind is foul or ſcant, the phraſes are *luff*, *thus*, and *no nearer;* the firſt of which is the order to keep her cloſe to the wind; the ſecond, to retain her in her preſent ſituation; and the third to keep her ſails full.

In a ſhip of war, the exerciſe of ſteering the ſhip is uſually divided amongſt a number of the moſt expert ſailors, who attend the helm in their turns; and are accordingly called *timoneers*, from the French term *timonier*, which ſignifies "helmſman." The ſteerage is conſtantly ſuperintended by the quarter-maſters, who alſo attend the helm by rotation. In merchant ſhips every ſeaman takes his turn in this ſervice, being directed therein by the mate of the watch, or ſome other officer. As the ſafety of a ſhip, and all contained therein, depends in a great meaſure on the ſteerage or effects of the helm, the apparatus by which it is managed ſhould often be diligently examined by the proper officers. Indeed, a negligence in this important duty appears almoſt unpardonable, when the fatal effects which may reſult from it are duly conſidered.

STEEVENS, GEORGE, the moſt ſucceſsful of all the editors and commentators of Shakeſpeare, was born in the year 1735. We know nothing reſpecting his parents, but they appear to have been in affluent circumſtances. Our author received the rudiments of his education at Kingſton-upon-Thames, and had Gibbon the hiſtorian for a companion at that ſchool. From hence he went to Eton, and in a few years was admitted a fellow commoner of King's college, Cambridge; but no mention is made of his peculiar courſe of ſtudies. It appears, however, that he had little reliſh for the mathematics, which lead at Cambridge to academical honours. On the firſt eſtabliſhment of the Eſſex militia, he accepted of a commiſſion; but he ſpent the concluding years of his life in almoſt total ſecluſion from the world, ſeldom mingling with ſociety, but in the ſhops of bookſellers, in the Shakeſpeare gallery, or in the morning converſations of Sir Joſeph Banks.

Although not an original writer, we cannot in juſtice refuſe him a place among the firſt literary characters of the age, when we conſider the works he illuſtrated, and the learning, ſagacity, taſte, and general knowledge which he brought to the taſk. With a verſatility of talents,

lents, he was eminent both by his pen and his pencil, but his chief excellence lay in his critical knowledge of an author's text; and the beſt ſpecimen of his great abilities is his edition of Shakeſpeare, in which he has left every competitor far behind him. He had ſtudied the age of Shakeſpeare, and employed his perſevering induſtry in becoming acquainted with the writings, manners, and laws of that period, as well as the provincial peculiarities, whether of language or cuſtoms, which prevailed in different parts of the kingdom, but more particularly in thoſe where Shakeſpeare paſſed the early years of his life. He was continually increaſing this ſtore of knowledge, by the acquiſition of the obſolete publications of a former age, which he ſpared no expence to obtain. His critical ſagacity and obſervation were conſtantly employed in calling forth the hidden meanings of the dramatic bard, and of courſe enlarging the diſplay of his beauties. This advantage is apparent from his laſt edition of Shakeſpeare, which contains ſo large a portion of new, intereſting, and accumulated inſtruction. In preparing it for the preſs, he gave an inſtance of activity and perſeverance without example. To this work he excluſively devoted a period of 18 months, during which he left his houſe every morning at one o'clock, going to his friend Mr Iſaac Read's chambers in Barnard's-inn, without any conſideration of the weather or the ſeaſon, and there he found a ſheet of the Shakeſpeare letter-preſs ready for correction. Thus, while the printers ſlept the editor was awake, by which means he completed, in leſs than 20 months, his ſplendid edition of Shakeſpeare in 15 vols octavo; a labour almoſt incredible, and by which the energy and perſevering powers of his mind were fully proved.

He probably reſted ſatisfied with being a commentator from the particular habits of his life, and his devotion to the name of Shakeſpeare. But at the ſame time he was a claſſical ſcholar of the firſt order, and well acquainted with the belles lettres of Europe. He ſtudied ancient and modern hiſtory; and particularly that of his own country. His genius was ſtrong and original; his wit abundant; his imagination of every colour; and his ſentiments enlivened with the moſt brilliant expreſſions. His eloquence was logical and animated; his deſcriptions were ſo true to nature, his figures ſo curiouſly ſelected, and ſo happily grouped, that he might be regarded as a ſpeaking Hogarth. He ſcattered his wit and his humour too freely around him, and they were not loſt for want of gathering.

Mr Steevens had a very handſome fortune, which he managed with diſcretion. His generoſity was equal to his fortune; and though not profuſe of his money to ſturdy beggars, few perſons diſtributed with more liberality to truly deſerving objects. He poſſeſſed all the graces of outward accompliſhment, at a period when civility and politeneſs were characteriſtics of a gentleman.

He bequeathed his valuable Shakeſpeare, illuſtrated with about 1500 prints, to Lord Spencer; his Hogarth perfect, with the exception of one or two pieces, to Mr Windham; and his corrected copy of Shakeſpeare, with 200 guineas, to his friend Mr Read. He died in the month of January 1800, about 65 years of age.

STEGANOGRAPHY, the art of ſecret writing, or of writing in ciphers, known only to the perſons correſponding. See CIPHER.

STELLARIA, a genus of plants belonging to the claſs decandria, and in the natural ſyſtem arranged under the 22d order, *Caryophylleæ*. See BOTANY *Index*.

STELLATE, in *Botany*, a term applied to leaves which grow not leſs than ſix at a joint, and are arranged like the rays of a ſtar.

STELLERA, GERMAN GROUNDSEL, a genus of plants belonging to the claſs octandria; and in the natural ſyſtem arranged under the 31ſt order, *Vepreculæ*. See BOTANY *Index*.

STELLIONATE, in the civil law, a kind of crime committed by a fraudulent bargain, where one of the parties ſells a thing for what it is not; as if I ſell an eſtate for my own which belongs to another, or convey a thing as free and clear which is already engaged to another, or put off copper for gold, &c.

STEM, in *Botany*, that part of a plant ariſing out of the root, and which ſuſtains the leaves, flowers, fruits, &c. By waſhing and rubbing the ſtems of trees, their annual increaſe is promoted; for the method of doing which, ſee the article TREE.

STEM of a Ship, a circular piece of timber into which the two ſides of a ſhip are united at the fore-end: the lower end of it is ſcarfed to the keel, and the bowſprit reſts upon its upper end. The ſtem is formed of one or two pieces, according to the ſize of the veſſel; and as it terminates the ſhip forward, the ends of the wales and planks of the ſides and bottom are let into a groove or channel, in the midſt of its ſurface, from the top to the bottom; which operation is called *rabiting*. The outſide of the ſtem is uſually marked with a ſcale, or diviſion of feet, according to its perpendicular height from the keel. The intention of this is to aſcertain the draught of water at the forepart, when the ſhip is in preparation for a ſea-voyage, &c. The ſtem at its lower end is of equal breadth and thickneſs with the keel, but it grows proportionally broader and thicker towards its upper extremity. See *SHIP-Building*.

STEMMATA, in the hiſtory of inſects, are three ſmooth hemiſpheric dots, placed generally on the top of the head, as in moſt of the hymenoptera and other claſſes. The name was firſt introduced by Linnæus.

STEMODIA, a genus of plants belonging to the claſs didynamia; and in the natural ſyſtem ranging under the 40th order, *Perſonatæ*. See BOTANY *Index*.

STEMPHYLA, a word uſed by the ancients to expreſs the huſks of grapes, or the remains of the preſſings of wine. The ſame word is alſo uſed by ſome to expreſs the remaining maſs of the olives, after the oil is preſſed out.

STEMPHYLITES, a name given by the ancients to a ſort of wine preſſed hard from the huſks.

STEMPLES, in mining, croſs bars of wood in the ſhafts which are ſunk to mines.

In many places the way is to ſink a perpendicular hole, or ſhaft, the ſides of which are ſtrengthened from top to bottom with wood-work, to prevent the earth from falling in; the tranſverſe pieces of wood are called *ſtemples*, and by means of theſe the miners in ſome places deſcend, without uſing any rope.

STEMSON, in a ſhip, an arching piece of timber fixed within the apron, to reinforce the ſcarf thereof, in the ſame manner as the apron ſupports the ſcarf of the ſtern. In large ſhips it is uſually formed of two pieces.

STENOGRAPHY (A).

CHAP. I.

THE art of ſtenography, or ſhort writing, was known and practiſed by moſt of the ancient civilized nations. The Egyptians, who were diſtinguiſhed for learning at an early period, at firſt expreſſed their words by a delineation of figures called *hieroglyphics*. A more conciſe mode of writing ſeems to have been afterwards introduced, in which only a part of the ſymbol or picture was drawn. This anſwered the purpoſe of ſhort-hand in ſome degree. After them the Hebrews, the Greeks, and the Romans *, adopted different methods of abbreviating their words and ſentences, ſuited to their reſpective languages. The initials, the finals, or radicals, often ſerved for whole words; and various combinations of theſe ſometimes formed a ſentence. Arbitrary marks were likewiſe employed to determine the meaning, and to aſſiſt legibility; and it ſeems probable that every writer, and every author of antiquity, had ſome peculiar method of abbreviation, calculated to facilitate the expreſſion of his own ſentiments, and intelligible only to himſelf.

* Vide *Buxtorf*, *Diog. Laetius*, *Plutarch*, &c.

It is alſo probable, that ſome might by theſe means take down the heads of a diſcourſe or oration; but few, very few, it is preſumed, could have followed a ſpeaker through all the meanders of rhetoric, and noted with preciſion every ſyllable, as it dropt from his mouth, in a manner legible even to themſelves.

To arrive at ſuch conſummate perfection in the art was reſerved for more modern times, and is ſtill an acquiſition by no means general.

In every language of Europe, till about the cloſe of the 16th century, the Roman plan of abbreviating (viz. ſubſtituting the initials or radicals, with the help of arbitraries, for words) appears to have been employed. Till then no regular alphabet had been invented expreſsly for ſtenography, when an Engliſh gentleman of the name of *Willis* invented and publiſhed one (B). His plan was ſoon altered and improved, or at leaſt pretended to be ſo. One alteration ſucceeded another; and at intervals, for a ſeries of years paſt, ſome men of ingenuity and application have compoſed and publiſhed ſyſtems of ſtenography, and doubtleſs have themſelves reaped all the advantages that attend it. But among the various methods that have been propoſed, and the different plans that have been adopted by individuals, none has yet appeared fortunate enough to gain general approbation; or proved ſufficiently ſimple, clear, and conciſe, to be univerſally ſtudied and practiſed.

Some ſyſtems are replete with unmeaning ſymbols, perplexing arbitraries, and ill-judged contractions; which render them ſo difficult to be attained by a common capacity, or ordinary application, that it is not to be wondered at if they have ſunk into neglect, and are now no longer known (C). Other ſyſtems, by being too prolix, by containing a multiplicity of characters, and thoſe characters not ſimple or eaſily remembered, become ineffectual to the purpoſe of expedition, and are only ſuperior in obſcurity to a common hand. Some, again, not only reject all arbitraries and contractions, but even prepoſitions and terminations; which laſt, if not too laviſhly employed and badly deviſed, highly contribute to promote both expedition and legibility; and though they reduce their characters to fewer than can poſſibly expreſs the various modifications of ſound, yet they make nearly one half of them complex. In the diſpoſition of the vowels there is the greateſt perplexity in moſt ſyſtems. A dot is ſometimes ſubſtituted for all the vowels indiſcriminately, and the judgment is left to determine which letter out of ſix any dot is intended to expreſs; or a minute ſpace is allotted them; ſo that unleſs they be arranged with mathematical preciſion they cannot be diſtinguiſhed from one another; but ſuch a minute attention is inconſiſtent with the nature of ſhort-hand, which ſhould teach us to write down in a ſhort time, as well as in ſmall bounds, what we wiſh to preſerve of what we hear. Nor is the plan of lifting the pen and putting the next conſonant in the vowel's place, in the middle of words, leſs liable to objections; or that of repreſenting all the vowels by diſtinct characters, being obviouſly ill calculated for facility and diſpatch,

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(A) The value of ſtenography is not unknown to the learned; and the care and ſucceſs with which it has been lately cultivated in theſe kingdoms will, in all probability, ſoon render it an object of general attention. No one, however, appears to us to have ſimplified and improved the art ſo much as Dr Mavor, author of *Univerſal Stenography*, who has liberally permitted us to preſent our readers with a complete view of his ſcheme. To thoſe who wiſh to become proficients in SHORT-WRITING, we earneſtly recommend his entire publication (printed for Cadell and Davis, Strand, London), which in many ſchools of the firſt reputation now forms a deſerved claſs-book.

(B) Mr Locke ſays, a regular method of ſhort-writing ſeems to be known and practiſed only in Britain. This is not now the caſe; and indeed there is no reaſon to doubt whether characters may not be invented to expreſs the various ſounds, or letters, employed in any language, either ancient or modern.

(C) A liſt of writers on ſtenography. Mr Addy, Alridge, Angell, Annet, Blandemore, Bloſſet, Botley, Bridges, Byrom, Coles, Croſs, Dix, Everardt, Ewen, Facey, Farthing, Gibbs, Græme, Gurney, Heath, Holdſworth, Hopkins, Jeake, Labourer, Lane, Lyle, Macauley, Maſon, Mavor, Metcalfe, Nicholas, Palmer, Rich, Ridpath, Shelton, Steele, Tanner, Taylor, Thickneſſe, Tiffen, Webſter, Weſton, Williamſon, Willis, B. D. and Willis, &c.

diſpatch, and conſequently inadmiſſible into any uſeful ſyſtem.

It is to be confeſſed, that the perſon who firſt propoſed the omiſſion of vowels in the middle of words (D), which it is obvious are not wanted, and invented letters, which could be connected as in a running hand without lifting the pen in the middle of the word, made a real improvement on the works of his predeceſſors. But, in fine, moſt ſyſtems, either in their plan or execution, labour under ſome capital defect, attended with circumſtances highly diſcouraging to the learner, and which in a great meaſure defeat the end of their invention, by being too complicated to be learned with eaſe and remembered with accuracy, or to be practiſed with the expedition which is requiſite; and ſo difficult to be deciphered, that a man can ſcarcely read what he has juſt written.

To obviate theſe defects; to provide againſt prolixity and conciſeneſs, which might occaſion obſcurity; to exhibit a ſyſtem founded on the ſimpleſt principles, which might be eaſily learned and read, and yet be capable of the utmoſt expedition—were the motives that gave riſe to the preſent attempt.

This method will be found different from any yet publiſhed, and ſuperior to all in the diſpoſition of the vowels and the facility of arranging them; the confuſion in placing which ſeems to detract from the merit of the beſt performances on the ſubject; and it may be affirmed, without oſtentation, that characters ſimpler in their form, and more perfect in their union, have not been applied to the art of ſtenography.

As well as it could be determined, the ſimpleſt characters are appropriated to the letters moſt uſually employed: indeed, as far as poſſible, thoſe which are complex have been rejected; but as it was an object always kept in view that the writing ſhould be on a line, a few are admitted into the alphabet for that reaſon.

The characters for the double and triple conſonants are the eaſieſt that could be invented, conſiſtent with perſpicuity (E); for care has been taken to provide againſt all obſcurity which might ariſe by adopting letters too ſimilar in their formation; and with reſpect to the prepoſitions and terminations, thoſe which occur moſt frequently are expreſſed by the ſimpleſt characters, which will be found perfectly eaſy in their application.

The arbitraries are few in number (F), and the arbitrary abbreviations, as they are entirely from the letters of the alphabet, and choſen from ſome thouſands of words in common uſe, will well repay the learner for an hour's trouble in committing them to memory.

The laſt chapter lays down a ſcheme of abbreviation, compriſed in a few rules, perfectly eaſy to be underſtood and practiſed by proficients in this art, which we hope will anſwer the expectation of the author, and will be found free from the perplexity complained of in many ſyſtems where abbreviation is admitted. The principal rules are new, are ſo eaſy, ſo extenſive in their uſe, and ſo conſiſtent with expedition and legibility, if applied with judgment, that they alone might ſuffice. The learner is, however, adviſed by no means to adopt any of them, till experience has convinced him that they may be uſed without error or injury to legibility. All abbreviating rules are ſuited to thoſe only who have made ſome progreſs in the ſtenographic art; for although they certainly promote expedition in a wonderful manner, and afford the greateſt eaſe to a proficient, yet a learner, as expedition is not his firſt, though his ultimate view, ſhould admit of nothing that in the leaſt renders the reading difficult.

CHAP. II.

The general principles of ſtenography.

THE Engliſh alphabet conſiſts of twenty-ſix letters; ſix of which are vowels, *a, e, i, o, u,* and *y*; and the other twenty conſonants, *b, c, d, f, g, h, k, l, m, n, p, q, r, s, t, v, x,* and *z*.

This alphabet, as is obſerved by the beſt grammarians that have written on the language, is both defective and redundant in expreſſing the various modifications of ſound *.

Cuſtom or prejudice has aſſigned ſome letters a place, when others would with much more propriety expreſs the ſame ſound: and to this may be added, that ſeveral letters, ſometimes in one word, ſeem to be admitted for no other reaſon than to perplex a young beginner or a foreigner, as an obſtruction to true pronunciation, and to add to the apparent length of the word, when they are entirely quieſcent and uſeleſs. That this is the genius of the orthography of our language muſt be perceived by the moſt ſuperficial obſerver; but no modern tongue is abſolutely free from the ſame exceptions. In particular, the French has a great number of dormant letters, which, it is obvious, render the pronunciation more difficult and perplexing to learners (G).

But as it is neither our buſineſs nor our intention to propoſe a mode of ſpelling different from that in common uſe, when applied to printing or long-hand writing (ſince ſeveral innovators in orthography have fallen into contempt, and their plans have been only preſerved as beacons to warn others of the folly of endeavouring to ſubvert eſtabliſhed principles †); we ſhall only obſerve, that in ſtenography, where the moſt expeditious and conciſe

* *Lowth's Gram. Prieſtley's Gram. Sheridan's Lectures on Elocution.*

† *Preface to Johnſon's Dictionary.*

(D) Mr Byrom rejected vowels entirely in the middle of words, as others before him had only done partially. Without critically examining the executive part of his performance, which is very defective, it muſt be owned, that it is above the reach of human ingenuity to exceed his general plan; which for ever muſt be the baſis of every future rational ſyſtem.

(E) Thoſe for *th* and *ch* may be either made upright or ſloping to the right.

(F) Theſe are not by any means preſcribed; they may be employed or not according to the fancy of the learner.

(G) The Latin and Greek claim a juſt ſuperiority over the modern tongues in this reſpect. In them no confuſion or doubt can ariſe from the manner of ſpelling; and the reader can ſcarcely be wrong (unleſs in quantity) in ſounding all the letters he ſees.

conciſe method is the beſt, if conſiſtent with perſpicuity, the following ſimple rules are ſtudiouſly to be regarded and practiſed.

2 Rules for the conſonants. RULE I. All quieſcent conſonants in words are to be dropped; and the orthography to be directed only by the pronunciation; which being known to all, will render this art attainable by thoſe who cannot ſpell with preciſion in long hand.

RULE II. When the abſence of conſonants, not entirely dormant, can be eaſily known, they may often be omitted without the leaſt obſcurity.

RULE III. Two or ſometimes more conſonants may, to promote greater expedition, be exchanged for a ſingle one of nearly ſimilar ſound; and no ambiguity as to the meaning enſue (H).

RULE IV. When two conſonants of the ſame kind or ſame ſound come together, without any vowel between them, only one is to be expreſſed; but if a vowel or vowels intervene, both are to be written: only obſerve, if they are perpendicular, horizontal, or oblique lines, they muſt only be drawn a ſize longer than uſual; and characters with loops muſt have the ſize of their heads doubled *.

* See Plate DVII.

3 Firſt rule exemplified. Might is to be written *mit*, fight *fit*, machine *maſhin*, enough, *enuf*, laugh *laf*, prophet *profet*, phyſics *fiſiks*, through *thro'*, foreign *foren*, ſovereign *ſoveren*, pſalm *ſam*, receipt *reſet*, write *rite*, wright *rit*, iſland *iland*, knavery *navery*, temptation *temtation*, knife *nife*, ſtick *ſtik*, thigh *thi*, honour *onour*, indictment *inditement*, acquaint *aquaint*, chaos *kaos*, &c.

4 Second rule exemplified. Strength *ſtrenth*, length *lenth*, friendſhip *frenſhip*, connect *conek*, commandment *comanment*, conjunct *conjunt*, humble *humle*, lumber *lumer*, ſlumber *ſlumer*, number *numer*, exemplary *exemlary*, &c.

5 Third rule exemplified. Rocks *rox*, acts *aks* or *ax*, facts *faks* or *fax*, diſtricts *diſtriks* or *diſtrix*, affects *afeks* or *afex*, afflicts *afliks* or *aflix*. conquer *konkr*, &c.

6 Fourth rule exemplified. Letter *leter*, little *litle*, command *comand*, error *eror*, terror *teror*, &c. But in *remember*, *moment*, *ſiſter*, and ſuch like words, where two conſonants of the ſame name have an intervening vowel, both of them muſt be written.

Theſe four rules, with their examples, being carefully conſidered by the learner, will leave him in no doubt concerning the diſpoſition and management of the conſonants in this ſcheme of ſhort-writing; we ſhall therefore proceed to lay down rules for the application of the vowels with eaſe and expedition.

7 Rules for the vowels. RULE I. Vowels, being only ſimple articulate ſounds, though they are the connectives of conſonants, and employed in every word and every ſyllable, are not neceſſary to be inſerted in the middle of words; becauſe the conſonants, if fully pronounced, with the aſſiſtance of connection, will always diſcover the meaning of a word, and make the writing perfectly legible.

RULE II. If a vowel is not ſtrongly accented in the incipient ſyllable of a word, or if it is mute in the final, it is likewiſe to be omitted; becauſe the ſound of the incipient vowel is often implied in that of the firſt conſonant, which will conſequently ſupply its place.

RULE III. But if the vowel conſtitutes the firſt or laſt ſyllable of a word, or is ſtrongly accented at its beginning or end, that vowel is continually to be written.

RULE IV. If a word begins or ends with two or more vowels though ſeparated, or when there is a coalition of vowels, as in diphthongs and triphthongs; only one of them is to be expreſſed, which muſt be that which agrees beſt with the pronunciation.

RULE V. In monoſyllables, if they begin or end with a vowel, it is always to be inſerted, unleſs the vowel be *e* mute at the end of a word.

Such are the general principles of this art; in vindication and ſupport of which it will be needleſs to offer any arguments, when it is conſidered that brevity and expedition are the chief objects, if conſiſtent with legibility; and the ſubſequent ſpecimens in the orthography recommended will, we hope, be ſufficient to ſhow that there is no real deficiency in the laſt mentioned particular.

8 Specimen of the mode of ſpelling in ſtenography. He who md us mſt be etrnl, grt, nd mnptnt. It is or dty, as rſnl bngs, to ſrv, lv, nd oby hm.—A mn tht wd avd blm, ſhd be ſrkmſpk in al hs axns, nd ndvr wth al hs mt to pls evry bdy.—I wd nt frm any knxns wth a mn who hd no rgrd fr hmslf; nthr wd I blv a mn who hd ons tld me a li.—Onr is of al thngs the mſt dfklt to prſrv ntrnſhd; nd whn ons mpchd, lk the chaſtty of a wmn, nvr ſhns wth its wntd lſtr.—Wth gd mnrs, kmplſms nd an eſy plt adrs, mny mk a fgr in the wrl, whs mnl ablts wd ſkrſly hv rsd thm aby the rnk of a ſtmn.—Idlns is the prnt of a thſnd msfrtns, wch ar nvr flt by the ndſtrs: it is a pn nd a pnſhmnt of itslf, nd brngs wnt nd bgry in its trn.—Vrtu is the frſt thng tht ſhd be rgrdd; it is a rwrd of itslf; mks a mn rſpktbl hr, nd wl mk hm etrnly hpy hrftr.—Prd is a mſt prnſs pſn, wch yt ws plntd by hvn in ur ntr, to rs ur emlsn to imtt grt nd wrthy krktrs or axns, to xt in us a sl fr wht is rt nd gſt, nd a ldbl ndgnſn gnſt oprſrs nd wrkrs of any knd of nkyty; in ſhrt, to mk us st a prpr vlu upn urvſls, nd dſps a wrthls flo, hu evr xltd. Ths fr prd is a vrtu, nd my gſtly be kld a grtns of ſl. Bt prd, lk othr pſns, gnrly fxs upn rng obgks, or is apld in rng prprſns. Hu kmn is it to ſe a rtch whm evry vs hs rndrd mſrbl, nd evry fly kntmbl, vlng hmſlf on hs hi brth, nd bſtng ths ilſtrs nſttrs, of whm he nhrts nthng bt the nm or ttl! nſtrs who if thy nu hm, wd dſn thr dſndnt wth kntmt. But al prd of ths ſrt is fly, nd evr to be avdd.

CHAP. III.

As the whole of this art depends upon a regular method and a ſimple alphabet, we have not only endeavoured to eſtabliſh the former on ſatisfactory principles, but have been careful to appropriate, according to the comparative frequency of their occurrence, ſuch characters

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(H) By this rule likewiſe *q* and *v* in the middle of words, but never in the beginning, may be exchanged for *k* and *f*, when they admit of an eaſier connecting with the following character, or will make the writing appear neater.

ters for the letters as, after repeated trials and alterations, were conceived to be the beſt adapted for diſpatch.

9 tenogra- hic alpha- et. Plate DVII.

The ſtenographic alphabet conſiſts of 18 diſtinct characters (viz. two for the vowels and the reſt for the conſonants), taken from lines and ſemicircular curves; the formation and application of which we ſhall now explain, beginning with the vowels.

For the three firſt vowels, *a*, *e*, and *i*, a comma is appropriated in different poſitions; and for the other three, *o*, *u*, and *y*, a point. The comma and point, when applied to *a*, and *o*, is to be placed, as in the Plate DVII. at the top of the next character; when for *e* and *u*, oppoſite to the middle; and when for *i* and *y*, at the bottom.

This arrangement of the vowels is the moſt ſimple and diſtinct that can eaſily be imagined. Places at the top, the middle, and the bottom of characters, which make three different poſitions, are as eaſily diſtinguiſhed from one another as any three ſeparate characters could be; and a comma is made with the ſame facility as a point.

10 ines.

Simple lines may be drawn four different ways; perpendicular, horizontal, and with an angle of about 45 degrees to the right and left. An aſcending oblique line to the right, which will be perfectly diſtinct from the reſt when joined to any other character, may likewiſe be admitted. Theſe characters being the ſimpleſt in nature, are aſſigned to thoſe five conſonants which moſt frequently occur, viz. *l*, *r*, *t*, *c* hard or *k*, and *c* ſoft or *s*.

11 rcles.

Every circle may be divided with a perpendicular and horizontal line, ſo as to form likewiſe four diſtinct characters. Theſe being the next to lines in the ſimplicity of their formation, we have appropriated them for *b*, *d*, *n*, and *m*.

12 rves and es.

The characters expreſſing nine of the conſonants are all perfectly diſtinct from one another; eight only remain which are needful, viz. *f*, *g* or *j*, *h*, *p*, *q*, *v*, *w*, and *x*; to find characters for which we muſt have recourſe to mixed curves and lines. The characters which we have adopted are the ſimpleſt in nature after thoſe already applied, admit of the eaſieſt joining, and tend to preſerve lineality and beauty in the writing.

It muſt be obſerved that we have no character for *c* when it has a hard ſound, as in *caſtle*; or ſoft, as in *city*; for it naturally takes the ſound of *k* or *s*, which in all caſes will be ſufficient to ſupply its place.

R likewiſe is repreſented by the ſame character as *l*; only with this difference, *r* is written with an aſcending ſtroke (I), and *l* with a deſcending; which is always to be known from the manner of its union with the following character; but in a few monoſyllables where *r* is the only conſonant in the word, and conſequently ſtands alone, it is to be made as is ſhown in the alphabet for diſtinction's ſake.

Z, as it is a letter ſeldom employed in the Engliſh language, and only a coarſer and harder expreſſion of *s*, muſt be ſupplied by *s* whenever it occurs; as for *Zedekiah* write *Sedekiah*, &c.

CHAP. IV.

13 Rules for prepoſitions and terminations.

THE prepoſitions and terminations in this ſcheme are ſo ſimple, that the greateſt benefit may be reaped from them, and very little trouble required to attain them; as the incipient letter or the incipient conſonant of all the prepoſitions and of ſeveral of the terminations is uſed to expreſs the whole. But although in Plate DVII ſufficient ſpecimens are given of the manner of their application, that the learner of leſs ingenuity or more ſlow perception may have every aſſiſtance, we have ſubjoined the following directions.

RULE I The prepoſition is always to be written without joining, yet ſo near as plainly to ſhow what word it belongs to; and the beſt way is to obſerve the ſame order as if the whole was to be connected.

RULE II. A prepoſition, though the ſame letters that conſtitute it may be met with in the middle or end of a word, is never to be uſed, becauſe it would expoſe to obſcurity.

RULE III. Obſerve that the prepoſition *omni* is expreſſed by the vowel *o* in its proper poſition; and for *anti*, *anta*, *ante*, by the vowel *a*, which the radical part of the word will eaſily diſtinguiſh from being only ſimple vowels.

The firſt rule for the prepoſitions is (allowing ſuch exceptions as may be ſeen in the Plate) to be obſerved for the terminations; and alſo the ſecond, *mutatis mutandis*; except that whenever *ſis*, *ſus*, *ſys*, *cious*, *tious*, and *ces* occur, they are to be expreſſed as directed in the fourth rule for the conſonants, whether in the beginning, middle, or end of words (K).

RULE IV. The terminative character for *tion*, *ſion*, *cion*, *cian*, *tian*, is to be expreſſed by a ſmall circle joined to the neareſt letter, and turned to the right; and the plurals *tions*, *ſions*, *cions*, *cians*, *tians*, *tience*, by a dot on the ſame ſide.

RULE V. The terminative character for *ing*, is to be expreſſed likewiſe by a ſmall circle, but drawn to the left hand; and its plural *ings* by a dot (L).

RULE VI. The plural ſign *s* is to be added to the terminative characters when neceſſary.

RULE VII. The ſeparated terminations are never to be uſed but in polyſyllables or words of more ſyllables than one.

Theſe rules duly obſerved will point out a method as conciſe and elegant as can be deſired, for expreſſing the moſt

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(I) The character for *h*, when lineality requires it, may be made from the bottom and inverted (ſee Plate DVII.). And often *h* may be omitted entirely, or a vowel may be ſubſtituted in its ſtead, without any injury to legibility, it being rather a breathing than letter.

(K) But in a few words where three horizontal characters meet, it will be better to expreſs the *ſis*, &c. by the ſemielliptical character in Plate DVII. oppoſite *tious*.

(L) In horizontal characters, by the left hand is meant the top, and by the right the ſpace below the letter (ſee *ing* joined, Plate DVII.). In all other characters the right and left poſitions will naturally be known.

moſt frequent and longeſt prepoſitions and terminations in the Engliſh language. If it ſhould be thought neceſſary to increaſe their number by the addition of others, it will be an eaſy matter for any one of the leaſt diſcernment to do ſo, by proceeding on the principles before laid down.

CHAP. V.

14
Rules for abbreviation.

THOUGH a more conciſe method of writing, or more numerous abbreviations, may not be indiſpenſably neceſſary, if the foregoing directions be practiſed for a conſiderable time, yet contractions will be found extremely uſeful and convenient to thoſe who have attained a proper knowledge of the ſubject, and lead to a greater degree of expedition, at the ſame time that they diminiſh the labour of writing. It has been obſerved in the introduction, that abbreviations are only to be employed by proficients in this art; becauſe expedition is not the firſt, though the ultimate, object in view; and that an eaſy legibility is of the utmoſt conſequence to the learner; which, however, cannot be preſerved, if he adopts too ſoon thoſe very rules which in time will afford him the greateſt eaſe when applied with judgement.

The following ſhort and practical rules will be found, we hope, fully adequate to every purpoſe for which they were intended, and are far ſuperior in the facility of their application to any which we have ſeen.

RULE I. The uſual abbreviations in long hand are always to be followed; as Mr for Maſter, M. D. for Doctor of Phyſic, and Abp. for Archbiſhop, &c.

RULE II. Subſtantives, adjectives, verbs, and participles, when the ſenſe will direct to the meaning, are to be expreſſed by their initial conſonant with the diſtinguiſhing marks exhibited in Plate DVII. viz. a ſubſtantive muſt have the dot exactly over its initial conſonant; an adjective muſt have a dot under it; a verb is to be expreſſed by a comma over its initial conſonant; and a participle by a comma under (M). Theſe being the four principal parts of ſpeech will be ſufficient; and an adept will never be at a loſs to know when he can with ſafety apply this rule to them.

RULE III. To render the writing more legible, the laſt letter of the word may be joined to the firſt, and the proper mark applied.

RULE IV. The conſtituent or radical part of words, eſpecially if they are long, will often ſerve for the whole or ſometimes the firſt ſyllable: as, we ought to moderate our *ex.* by our *circum.*; a man's *man.* commonly ſhape his *for.*

RULE V. All long words without exception may have their prepoſitions or terminations expreſſed by the incipient conſonant of ſuch prepoſition or termination.

RULE VI. When there is a great dependence between the parts of a ſentence, the initial letter will often ſuffice; as *L.* is the capital of Great *B.*; the eldeſt *S.* of the king of Great *B.* is ſtyled prince of *W.* Every one, it is preſumed, will allow this to be perfectly legible in long-hand, then why may it not in ſtenography?

RULE VII. The terminations *neſs* and *leſs* may be omitted; as *faithfulneſs* is only to be written *faithful*; *forwardneſs*, *forward*; *heedleſs*, *heed*; *ſtubbornneſs*, *ſtubborn*, &c.

RULE VIII. The ſecond and third perſons of verbs, ending in *eth* and *eſt*, may be expreſſed by *s*; as, he *loves*, thou *teaches*; inſtead of he *loveth*, thou *teacheſt*: or even without *s*; as, he *love*, &c.

RULE IX. Words may often be entirely omitted, and yet no ambiguity enſue; as, *In beginning God created heaven and earth*, for In *the* beginning God created *the* heaven and *the* earth.

RULE X. When there is an immediate repetition of a ſentence or word, a line is to be drawn under the ſentence or word to be repeated; as, Amen, Amen, is to be written *Amen*; but if any words intervene before a word or ſentence is to be repeated the line muſt be drawn as before, and a ʌ or mark of omiſſion placed where the repetition ſhould begin; as, *Is it juſt the innocents ſhould be* condemned ʌ reviled?

The CONTENTS *of the* STENOGRAPHIC PLATES.

Fabricius's Reply to Pyrrhus.

Plate DVIII.

As to my poverty, you have indeed, Sir, been rightly informed. My whole eſtate conſiſts in a houſe of but mean appearance, and a little ſpot of ground, from which by my own labour I draw my ſupport. But if by any means you have been perſuaded to think, that this poverty makes me leſs conſidered in my country, or in any degree unhappy, you are extremely deceived. I have no reaſon to complain of fortune, ſhe ſupplies me with all that nature requires; and if I am without ſuperfluities, I am alſo free from the deſire of them. With theſe I confeſs I ſhould be more able to ſuccour the neceſſitous, the only advantage for which the wealthy are to be envied; but as ſmall as my poſſeſſions are, I can ſtill contribute ſomething to the ſupport of the ſtate and the aſſiſtance of my friends. With regard to honours, my country places me, poor as I am, upon a level with the richeſt: for Rome knows no qualifications for great employments but virtue and ability. She appoints me to officiate in the moſt auguſt ceremonies of religion; ſhe entruſts me with the command of her armies; ſhe confides to my care the moſt important negociations. My poverty does not leſſen the weight and influence of my counſels in the ſenate; the Roman people honour me for that very poverty which you conſider as a diſgrace; they know the many opportunities I have had in war to enrich myſelf without incurring cenſure; they are convinced of my diſintereſted zeal for their proſperity; and if I have any thing to complain of in the return they make, it is only the exceſs of their applauſe. What value then can I ſet upon your gold and ſilver! What king can add any thing to my fortune! Always attentive to diſcharge the duties incumbent

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(M) The dot or comma being placed thus will never occaſion them to be miſtaken for vowels, becauſe they ſhould always be on one ſide or other; whereas the mark for parts of ſpeech may conſtantly be placed exactly over or under.

incumbent on me, I have a mind free from ſelf-reproach, and I have an honeſt fame. *Dodſley's Preceptor.*

Letter to a Friend againſt waſte of Time.

Converſe often with yourſelf, and neither laviſh your time, nor ſuffer others to rob you of it. Many of our hours are ſtolen from us, and others paſs inſenſibly away; but of both theſe loſſes the moſt ſhameful is that which happens through our own neglect. If we take the trouble to obſerve, we ſhall find that one conſiderable part of our life is ſpent in doing evil, and the other in doing nothing, or in doing what we ſhould not do. We don't ſeem to know the value of time, nor how precious a day is; nor do we conſider that every moment brings us nearer our end. Reflect upon this, I entreat you, and keep a ſtrict account of time. Procraſtination is the moſt dangerous thing in life. Nothing is properly ours but the inſtant we breathe in, and all the reſt is nothing; it is the only good we poſſeſs; but then it is fleeting, and the firſt comer robs us of it. Men are ſo weak, that they think they oblige by giving of trifles, and yet reckon that time as nothing for which the moſt grateful perſon in the world can never make amends. Let us therefore conſider time as the moſt valuable of all things; and every moment ſpent, without ſome improvement in virtue or ſome advancement in goodneſs, as the greateſt ſublunary loſs.

St Paul's Speech before Agrippa and Feſtus.

I think myſelf happy, King Agrippa, that I ſhall anſwer for myſelf this day before thee, touching all things whereof I am accuſed of the Jews: eſpecially becauſe I know thee to be expert in all cuſtoms and queſtions which are among the Jews, wherefore I beſeech thee to hear me patiently. My manner of life from my youth, which was at firſt among mine own nation at Jeruſalem, know all the Jews, which knew me from the beginning (if they would teſtify), that, after the ſtraiteſt ſect of our religion, I lived a Phariſee. And now I ſtand and am judged for the hope of the promiſe made by God unto our fathers; unto which promiſe our twelve tribes inſtantly ſerving God day and night hope to come; for which hope's ſake, King Agrippa, I am accuſed of the Jews. Why ſhould it be thought a thing incredible with you, that God ſhould raiſe the dead, when God himſelf has given aſſurance of it unto all men, in that he hath raiſed Chriſt from the dead? As for my own part, moſt noble Feſtus, I own I once verily thought that even I myſelf ought to do many things contrary to the name of Jeſus of Nazareth. Which thing I alſo did in Jeruſalem. I puniſhed the ſaints oft in every ſynagogue, and compelled them to blaſpheme; and being exceedingly mad againſt them, I perſecuted them even unto ſtrange cities. In purſuit of which, as I went to Damaſcus, with authority and commiſſion from the chief prieſts: At mid-day, O king, I ſaw in the way a light from heaven, above the brightneſs of the ſun, ſhining about me, and them which journeyed with me. And when we were all fallen to the earth, I heard a voice ſpeaking unto me, and ſaying in the Hebrew tongue, Saul, Saul, why perſecuteſt thou me? It is hard for thee to kick againſt the pricks. And I ſaid, Who art thou, Lord? And he ſaid, I am Jeſus whom thou perſecuteſt. But riſe, and ſtand upon thy feet: for I have appeared unto thee for this purpoſe, to make thee a miniſter and a witneſs both of theſe things which thou haſt ſeen, and of thoſe things in which I will appear unto thee. Whereupon, O king Agrippa, I was not diſobedient to the heavenly viſion: but ſhewed firſt unto them of Damaſcus, and at Jeruſalem, and throughout all the coaſts of Judea, and then to the Gentiles, that they ſhould repent and turn to God. For theſe cauſes the Jews caught me in the temple, and went about to kill me. Having therefore obtained help of God, I continued unto this day, witneſſing both to ſmall and great, ſaying none other things than thoſe which the prophets and Moſes did ſay ſhould come: That Chriſt ſhould ſuffer, and that he ſhould be the firſt that ſhould riſe from the dead, and ſhould ſhow light unto the people, and to the Gentiles. This is the real truth: Believe me, I am no peſtilent fellow, nor mover of ſedition; but always endeavour all that lies in me to preſerve a conſcience void of offence towards God and towards man: nor can the Jews prove the things whereof they now accuſe me. Neither am I, Feſtus, beſides myſelf; but ſpeak thus freely before the king, becauſe he knows theſe things to be fact; yea, I am fully perſuaded the king knows them all to be fact; for they were not done in a corner. King Agrippa, believeſt thou the prophets? I know that thou believeſt. And would to God that not only thou, but alſo all that hear me this day, were altogether ſuch as I am except theſe bonds. *Holmes's Rhetoric.*

Pope to Atterbury.

Once more I write to you as I promiſed, and this once I fear will be the laſt; the curtain will ſoon be drawn between my friend and me, and nothing left but to wiſh you a long good night; may you enjoy a ſtate of repoſe in this life not unlike that ſleep of the ſoul which ſome have believed is to ſucceed it, where we lie utterly forgetful of that world from which we are gone, and ripening for that to which we are to go. If you retain any memory of the paſt, let it only image to you what has pleaſed you beſt; ſometimes preſent a dream of an abſent friend, or bring you back an agreeable converſation. But, upon the whole, I hope you will think leſs of the time paſt than the future; as the former has been leſs kind to you than the latter infallibly will be. Do not envy the world your ſtudies: They will tend to the benefit of men, againſt whom you can have no complaint; I mean, of all poſterity: and, perhaps, at your time of life, nothing elſe is worth your care. What is every year of a wiſe man's life but a cenſure or critic on the paſt? Thoſe whoſe date is the ſhorteſt, live long enough to laugh at one half of it: The boy deſpiſes the infant, the man the boy, the philoſopher both, and the Chriſtian all. You may now begin to think your manhood was too much a puerility; and you will never ſuffer your age to be but a ſecond infancy. The toys and baubles of your childhood are hardly now more below you than thoſe toys of our riper and our declining years; the drums and rattles of ambition, and the dirt and bubbles of avarice. At this time, when you are cut off from a little ſociety, and made a citizen of the world at large, you ſhould bend your talents not to ſerve a party, or a few, but all mankind. Your genius ſhould mount above that miſt, in which its participation and neighbourhood with earth hath long involved it: To ſhine abroad, and to heaven, ought to be the buſineſs and the glory of your preſent ſituation. Remember it was at ſuch a time that the greateſt lights of antiquity dazzled and blazed the moſt; in their retreat, in their exile, or in their death. But why do I talk of dazzling or blazing? it was then that they did good, that they gave light, and that they became guides to mankind. Thoſe aims alone are worthy of ſpirits truly great, and ſuch I therefore hope will be yours. Reſentment indeed may remain, perhaps cannot be quite extinguiſhed, in the nobleſt minds; but revenge will never harbour there: Higher principles than thoſe of the firſt, and better principles than thoſe of the latter, will infallibly influence men whoſe thoughts and whoſe hearts are enlarged, and cauſe them to prefer the whole to any part of mankind, eſpecially to ſo ſmall a part as one's ſingle ſelf. Believe me, my Lord, I look upon you as a ſpirit entered into another life, as one juſt upon the edge of immortality, where the paſſions and affections muſt be much more exalted, and where you ought to deſpiſe all little views and all mean retroſpects. Nothing is worth your looking back: and therefore look forward, and make (as you can) the world look after you; but take care it be not with pity, but with eſteem and admiration. I am, with the greateſt ſincerity and paſſion for your fame as well as happineſs, your, &c.

The above moſt charming and moſt affectionate letter was written about a month before Atterbury biſhop of Rocheſter was ſent into baniſhment, and is univerſally admired.

STENTOROPHONIC TUBE, a ſpeaking trumpet; thus called from Stentor, a perſon mentioned by Homer. See TRUMPET.

STEP, in a ſhip, a block of wood fixed on the decks or bottom of a ſhip, and having a hole in its upper ſide, fitted to receive the heel of a maſt or capſtern. The ſteps of the main and foremaſts of every ſhip reſt upon the kelſon, to which they are firmly ſecured by knees, bolts, or ſpike-nails. The ſtep of the mizen-maſt uſually reſts upon the lower deck.

STEPHANIUM, a genus of plants belonging to the pentandria claſs; and in the natural method ranking under the 47th order, *Stellatæ*. See BOTANY *Index*.

STEPHANOPHORUS, in antiquity, the chief prieſt of Pallas, who preſided over the reſt. It was uſual for every god to have a chief prieſt; that of Pallas was the Stephanophorus juſt mentioned, and that of Hercules was called Dadouchus.—Stephanophorus was alſo a prieſt who aſſiſted the women in the celebration of the feſtival Theſmophoria.

STEPHANUS BYZANTINUS, an able grammarian, who lived in the fifth or ſixth century. He wrote a Dictionary, in which he made a great number of obſervations, borrowed from mythology and hiſtory, which ſhowed the origin of cities and colonies, of which we have nothing remaining but a mean abridgement by Hermolaus the grammarian; but from that work the learned have received great light; and Sigonius, Caſaubon, Scaliger, Salmaſius, &c. have employed themſelves in illuſtrating it.

STEPHEN, king of England. See ENGLAND, N° 108, &c.

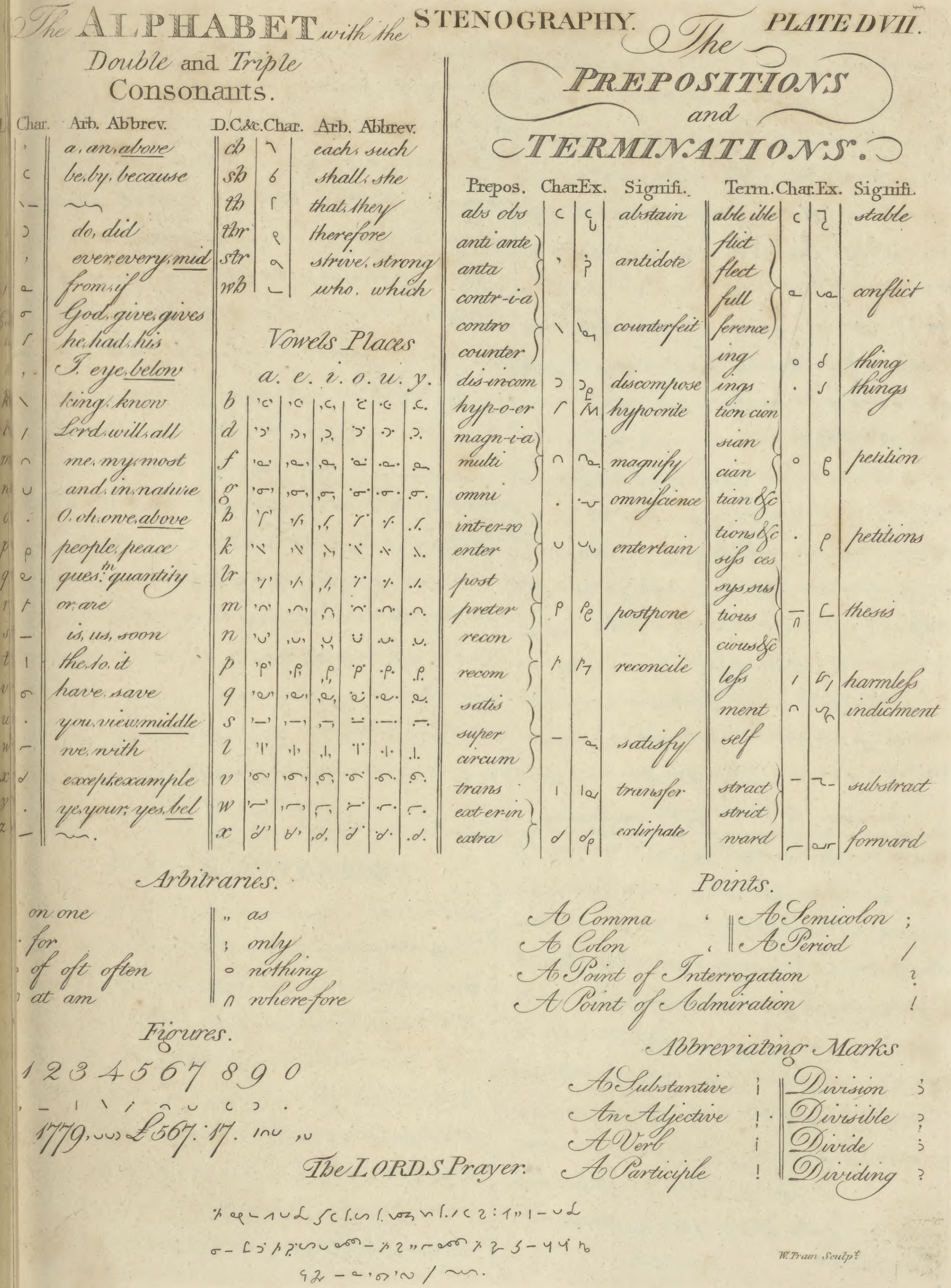
STEPHEN, or *St Stephen's Day*, a feſtival of the Chriſtian church, obſerved on the 26th of December, in memory of the firſt martyr St Stephen.

STEPHENS, a family of printers deſervedly celebrated. They flouriſhed at the time of the revival of learning, and contributed a great deal towards diſpelling the cloud of ignorance which had ſo long overſhadowed Europe. Some of the claſſics before the 16th century were in a great meaſure loſt, and all of them were exceedingly corrupted. By their abilities and indefatigable induſtry theſe defects were ſupplied, and the learned were furniſhed with beautiful and correct editions of the Greek and Roman authors. Thus the world was not only ſupplied with an inexhauſtible fund of amuſement and inſtruction in theſe ancient writings; but it is to the ardour which they inſpired, and to the model of elegance which they diſplayed, that the preſent advanced ſtate of literature is in a great meaſure owing.

HENRY STEPHENS, the firſt of theſe illuſtrious men, was born in France, ſoon after the diſcovery of printing, perhaps about the year 1465. He ſettled as a printer at Paris, and was probably patronized by Louis XII. A great proportion of the books which he publiſhed were Latin: They are printed in the Roman letter, and are not inelegant, though ſome of them abound rather too much in contractions. He died about the year 1520, and left behind him three ſons, Francis, Robert, and Charles. His widow married Simeon de Colines (*Colinæus* in Latin), who thus got poſſeſſion of Henry's printing-office, and continued the profeſſion till his death.

Of FRANCIS, the eldeſt ſon, little more is known than that he carried on buſineſs along with his father-in-law Colinæus, and that he died at Paris in 1550.

ROBERT STEPHENS, the ſecond ſon, was born in 1503. In his youth he made great proficiency in the Roman, Greek, and Hebrew languages, and at the age of 19 had acquired ſo much knowledge, that his father-in-law entruſted him with the management of his preſs. An edition of the New Teſtament was publiſhed under his inſpection, which gave great offence to the Paris divines, who accuſed him of hereſy, and threatened to prevent the ſale of the book. Soon after he began buſineſs himſelf, and married Perrete the daughter of Jodocus Badius, a printer and an author. She was a woman of learning, and underſtood Latin, which indeed was the neceſſary conſequence of her ſituation. Her huſband always entertained a number of learned men as correctors of the preſs: Being foreigners, and of different nations, they made uſe of no other language but Latin; which Perrete being accuſtomed to hear, was able in a ſhort time



The ALPHABET with the Double and Triple Consonants.

Char.	Arb. Abbrev.
	a, an, above
	be, by, because
	do, did
	ever, every, mid
	from, if
	God, give, gives
	he, had, his
	I, eye, below
	king, know
	Lord, will, all
	me, my, most
	and, in, nature
	O, oh, owe, above
	people, peace
	ques.^tn quantity
	or, are
	is, us, soon
	the, to, it
	have, save
	you, view, middle
	we, with
	except, example
	ye, your, yes, bel

D.C.&c.	Char.	Arb. Abbrev.
ch		each, such
sh		shall, she
th		that, they
thr		therefore
str		strive, strong
wh		who, which

Vowels Places

	a.	e.	i.	o.	u.	y.
b						
d						
f						
g						
h						
k						
lr						
m						
n						
p						
q						
s						
l						
v						
w						
x						

Arbitraries.

on one	as
for	only
of oft often	nothing
at am	where-fore

Figures.

1 2 3 4 5 6 7 8 9 0

1779, £567. 17.

The PREPOSITIONS and TERMINATIONS.

Prepos.	Char.	Ex.	Signifi.
abs obs			abstain
anti ante anta			antidote
contr-i-a contro counter			counterfeit
dis-in-com			discompose
hyp-o-er			hypocrite
magn-i-a multi			magnify
omni			omniſcience
int-er-ro enter			entertain
post preter			postpone
recon recom			reconcile
satis super circum			satisfy
trans			transfer
ext-er-in extra			extirpate

Term.	Char.	Ex.	Signifi.
able ible			stable
flict flect full ference			conflict
ing			thing
ings			things
tion cion sian cian tian &c			petition
tions &c siſs ces			petitions
sys sus tious cious &c			thesis
leſs			harmleſs
ment			indictment
self			
stract strict			substract
ward			forward

Points.

A Comma	‘	A Semicolon	;
A Colon	‚	A Period	/

A Point of Interrogation ?

A Point of Admiration !

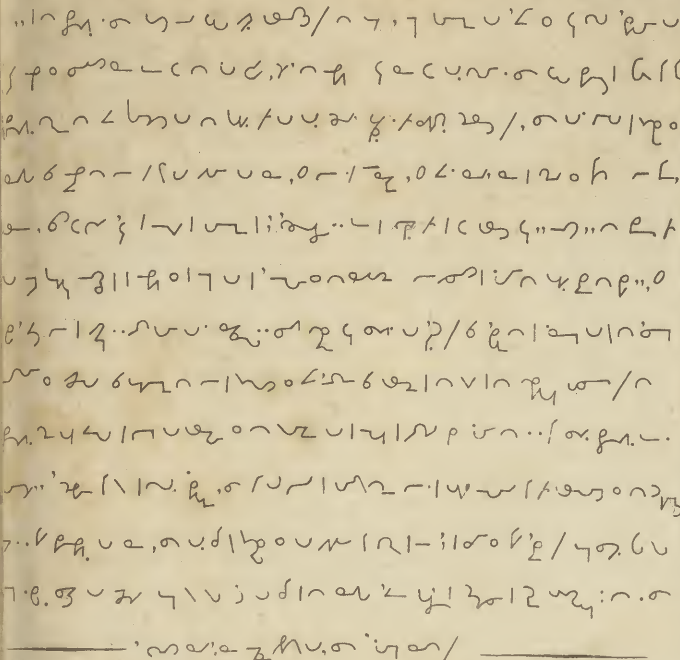
Abbreviating Marks

A Substantive	Division
An Adjective	Divisible
A Verb	Divide
A Participle	Dividing

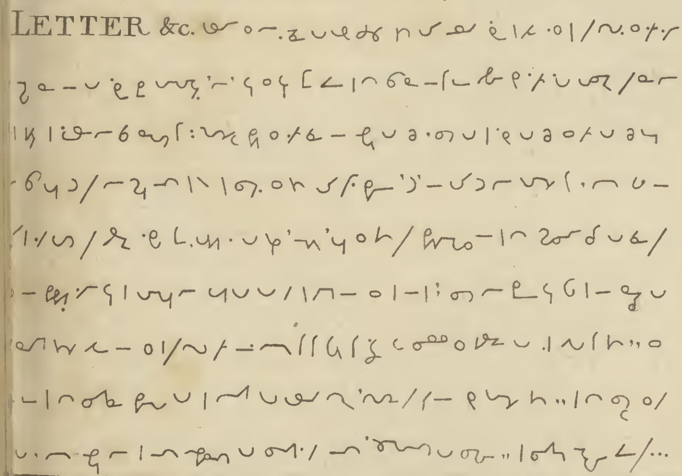
The LORDS Prayer.

W. Tram Sculp^t.

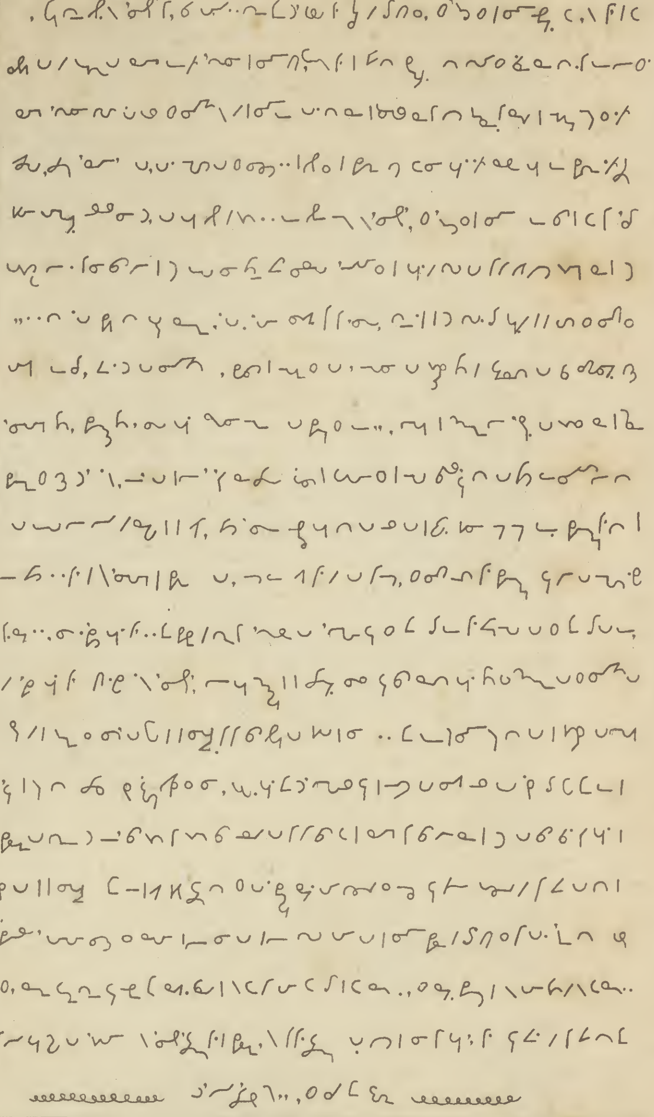
FABRICIUS' Reply to PYRRHUS.



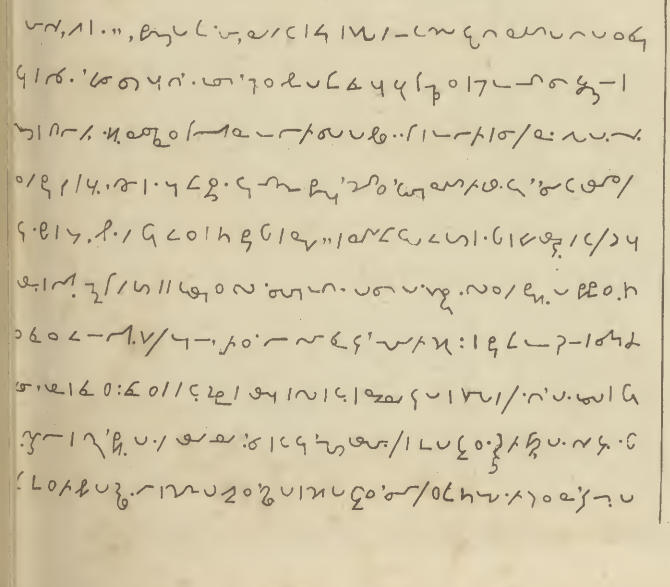
LETTER &c.

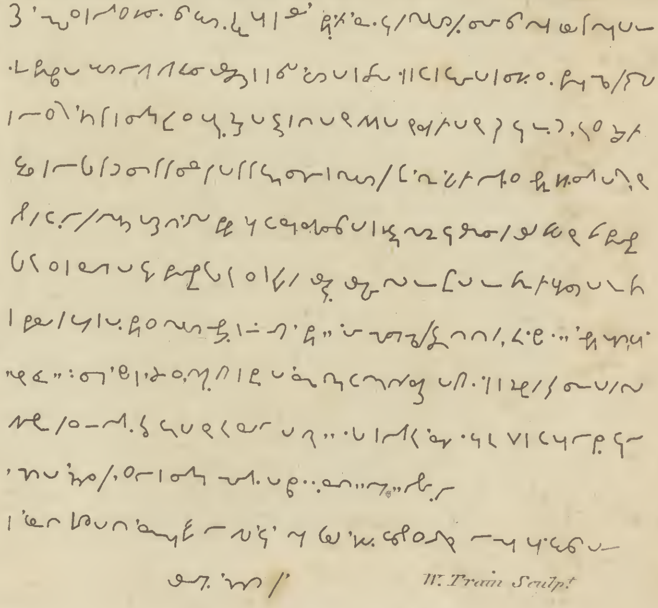


St PAUL'S SPEECH.



POPE *to* ATTERBURY.





W. Train Sculpt.

not only to underſtand, but even to ſpeak with tolerable eaſe.

In 1531 he publiſhed his Latin "Theſaurus;" a work of great importance, which he laboured at for two years. The mark which he put upon all his books was a tree branched, with a man looking upon it, and theſe words *noli altum ſapere*, to which he ſometimes added *ſed time*. In 1539, Francis I. made him his printer, and ordered a new ſet of elegant types to be founded for him. His frequent editions of the New Teſtament gave great offence to the doctors of the Sorbonne, who accuſed him of hereſy for his annotations, and inſiſted upon the ſuppreſſion of ſome of his books. Although Henry the French king in ſome meaſure protected him, the perſecution of theſe divines rendered him ſo unhappy, not to mention the expence and loſs of time which an almoſt conſtant attendance at court unavoidably occaſioned, that in 1552 he abandoned his country and went to Geneva. Here he embraced the Proteſtant religion, and thus juſtified in ſome meaſure the ſuſpicions of his theological enemies. It has been affirmed by ſeveral writers that he carried along with him the royal types, and the moulds alſo in which they were caſt; but it is certain that he never afterwards made uſe of thoſe types. Beſides, is it poſſible that the author of ſo daring a theft could have been not only protected in Geneva, but even courted and honoured by the moſt eminent men of the age? Is it credible that ſuch a crime could have been concealed for 60 years; or that Henry, the ſon and heir of the perpetrator, would have enjoyed the favour of the French king, if Robert Stephens had acted ſuch a ſhameful part? If he was burnt in effigy at Paris, it was not for theft, but for having changed his religion. After his arrival at Geneva, he publiſhed an account of the diſpute between him and the Paris divines, which does as much honour to his abilities as his *Theſaurus* does to his learning. He died in 1559, after a life of the moſt extraordinary induſtry. The books of which he was the editor were not fewer than 360. Many of them were ancient claſſics in different languages. Several were accompanied with annotations which he collected, and all of them were corrected by collating manuſcripts. He was ſo anxious to obtain perfect accuracy, that he uſed to expoſe his proofs in public, and reward thoſe who diſcovered a miſtake. His books conſequently were very correct. It is ſaid that his New Teſtament, called *O Mirificam* (becauſe the preface begins with theſe words), has not a ſingle fault.

It was Robert Stephens who firſt divided the New Teſtament into verſes during a journey between Paris and Lyons. The advantages of this improvement are fully counterbalanced by its defects. It has deſtroyed the unity of the books, and induced many commentators to conſider every verſe as a diſtinct and independent aphoriſm. To this in ſome meaſure is to be aſcribed the many abſurd interpretations and creeds that have been forced out of that book.

By his laſt will his eſtate was left excluſively to ſuch of his children as ſhould ſettle at Geneva. He left behind him three ſons, Henry, Robert, and Francis.

CHARLES STEPHENS, the third ſon of Henry, was, like the reſt of his family, familiarly acquainted with the learned languages. This recommended him to Lazarus de Baif, who made him tutor to his ſon, and in 1540 carried him along with him to Germany. He ſtudied medicine, and practiſed it with ſucceſs in France. He did not, however, forſake the profeſſion of his family, but exerciſed it in Paris, where he became the editor of many books remarkable for neatneſs and elegance. He wrote above thirty treatiſes on different ſubjects, particularly on botany, anatomy, and hiſtory. He died in 1564.

ROBERT STEPHENS, the ſon of Robert the firſt of that name, did not accompany his father to Geneva, but continued to profeſs the Catholic religion, and to reſide at Paris. His letter was remarkably beautiful.—He was made king's printer, and died about 1589.

His brother FRANCIS was alſo a printer. He embraced the Proteſtant religion, and reſided at Geneva.

HENRY STEPHENS, the remaining ſon of Robert, was born at Paris in 1528. He became the moſt learned and moſt celebrated of all his family. From his very birth almoſt he gave proofs of uncommon abilities, and diſplayed an ardent paſſion for knowledge. The Medea of Euripides, which he ſaw acted while at ſchool, firſt kindled his love for poetry, and inſpired him with the deſire of acquiring the language in which that tragedy is written. He intreated his father not to condemn him to ſtudy Latin, which he already underſtood from converſation, but to initiate him at once into the knowledge of Greek. His father willingly granted his requeſt; and Henry applied with ſuch vigour, that in a ſhort time he could repeat the Medea by heart. He afterwards ſtudied Greek under Peter Daneſius, who was tutor to the Dauphin, and finally heard the lectures of Tuſanus and Turnebus. He became eager at an early age to underſtand aſtrology, and accordingly attended a profeſſor of that myſterious art; but he was not long in diſcovering its abſurdity. At 19 he began his travels, which he undertook in order to examine foreign libraries, and to become acquainted with learned men. He ſpent two years in Italy, and returned into France completely maſter of Italian, and bringing along with him copies of ſeveral ſcarce authors, particularly a part of Anacreon, which before was thought loſt.

He found his father publiſhing an edition of the New Teſtament, to which he prefixed ſome Greek verſes.—Soon after, he viſited England and the Netherlands, where he met with John Clement, an Engliſhman, to whom he was indebted for the remaining odes of Anacreon. During this journey he learned the Spaniſh language, which was very much ſpoken at that time in the Low Countries.

Whether Henry accompanied his father to Geneva or not is uncertain; at leaſt he muſt have returned immediately to France, for we find him ſoon after eſtabliſhed at Paris, and publiſhing the odes of Anacreon. In 1554 he went to Rome, and thence to Naples. This journey was undertaken at the requeſt, and in the ſervice, of the French government. He was diſcovered, and would have been arreſted as a ſpy, had he not by his addreſs and ſkill in the language of the country been able to paſs himſelf for a native of Italy. On his return to France he aſſumed the title of printer to Ulric Fugger, a very rich and learned German nobleman, who allowed him a conſiderable penſion.

In 1560 he married a relation, as is generally ſuppoſed, of Henry Scrimgeour, a Scotch nobleman, with whom he was intimately acquainted. She was a woman, as he himſelf informs us, endowed with the nobleſt ſpirit and the moſt amiable diſpoſitions. Her death, which happened in 1586, brought on a diſeaſe that had twice attacked him before. It was a diſguſt at all thoſe purſuits which had formerly charmed him, an averſion to reading and the ſight of books. It was probably occaſioned by too conſtant and ſevere an application to literary purſuits. In 1572 he publiſhed his *Theſaurus Linguæ Græcæ*, one of the greateſt works, perhaps, that ever was executed by one man, if we conſider the wretched materials which more ancient dictionaries could furniſh, if we conſider the ſize and perfection of the work, and the immenſe labour and learning which muſt have been employed in the compilation. This work had been carried on at a greater expence than he could well bear. He expected to be reimburſed by the ſale of the book, but he was unfortunately diſappointed. John Scapula, one of his own ſervants, extracted from it whatever he thought would be moſt ſerviceable to ſtudents, and publiſhed it beforehand in 4to. By this act of treachery Henry was reduced to poverty.

See *Scapula.*

About this time he was much beloved by Henry III. of France, who treated him ſo kindly, and made him ſuch flattering promiſes, that he reſided frequently at court. But theſe promiſes were never fulfilled, owing to the civil wars which ſoon after diſtracted France, and the unfortunate death of King Henry himſelf. During the remainder of his life his ſituation was very unſettled. We find him ſometimes at Paris, ſometimes in Geneva, in Germany, and even in Hungary. He died at Lyons in 1598, at the age of 70. He was fond of poetry from his very infancy. It was a cuſtom of his to compoſe verſes on horſeback, and even to write them, though he generally rode a very mettleſome ſteed. His *Theſaurus* was his great work, but he was alſo the author of ſeveral other treatiſes. His poems are numerous: His Apology for Herodotus is a witty ſatire on the Roman Catholics. His Concordance to the New Teſtament muſt have been a laborious work, and has deſervedly endeared him to every Chriſtian who wiſhes to acquire a rational and critical knowledge of the Scriptures. The number of books which he publiſhed, though fewer than his father, was great, and ſuperior in elegance to any thing which the world had then ſeen. A great proportion of them were Greek; he was the editor, however, of many Roman and even of ſome eaſtern writings. His Greek claſſics are remarkably correct; the principal of them are Homer, Anacreon, Æſchylus, Maximus Tyrius, Diodorus Siculus, Pindar, Xenophon, Thucydides, Herodotus, Sophocles, Diogenes Laertius, Plutarch, Plato, Apollonius Rhodius, Æſchines, Lyſias, Callimachus, Theocritus, Herodian, Dionyſius Halicarnaſſenſis, Dion Caſſius, Iſocrates, Appian, Xiphilin, &c. His temper in the latter part of his life is repreſented as haughty and ſevere, owing probably to his diſappointments. He left behind him a ſon and two daughters, one of whom was married to the learned Iſaac Caſaubon.

PAUL STEPHENS, the ſon of Henry, continued his father's profeſſion at Geneva. He was a man of learning, and wrote tranſlations of ſeveral books, and publiſhed a conſiderable number of the ancient claſſics; but his editions poſſeſs little of his father's elegance. He died in 1627, at the age of 60, after ſelling his types to one Chouet a printer.—His ſon ANTONY, the laſt printer of the family, abandoned the Proteſtant religion, and returned to France, the country of his anceſtors. He received letters of naturalization in 1612, and was made printer to the king; but managing his affairs ill, he was reduced to poverty, and obliged to retire into an hoſpital, where he died in 1674, miſerable and blind, at the age of 80.

STERCORARIANS, or **STERCORANISTÆ**, formed from *ſtercus*, "dung," a name which thoſe of the Romiſh church anciently gave to ſuch as held that the hoſt was liable to digeſtion, and all its conſequences, like other food.

STERCULIA, a genus of plants belonging to the claſs monœcia; and in the natural ſyſtem ranging under the 38th order, *Tricoccæ*. See BOTANY *Index*.

STEREOGRAPHIC PROJECTION, is the projection of the circles of the ſphere on the plane of ſome one great circle, the eye being placed in the pole of that circle. See *PROJECTION of the Sphere*.

STEREOMETER, an inſtrument invented in France for meaſuring the volume of a body, however irregular, without plunging it in any liquid. If the volume of air contained in a veſſel be meaſured, when the veſſel contains air only, and alſo when it contains a body whoſe volume is required to be known, the volume of air aſcertained by the firſt meaſurement, deducting the volume aſcertained by the ſecond, will be the volume of the body itſelf. Again, if the volume of any maſs of air be inverſely as the preſſure to which it is ſubjected, the temperature being ſuppoſed conſtant, it will be eaſy to deduce, from the mathematical relations of quantity, the whole bulk if the difference between the two bulks under two known preſſures be obtained by experiment.

Suppoſe that the firſt preſſure is double the ſecond, or the ſecond volume of air double the firſt, and the difference equal to 50 cubic inches; the firſt volume of air will likewiſe be 50 cubic inches. The deſign of the ſtereometer is to aſcertain this difference at two known preſſures.

The inſtrument is a kind of funnel AB (fig. 1.) compoſed of a capſule A, in which the body is placed, and the tube B as uniform in the bore as can be procured. The upper edge of the capſule is ground with emery, that it may be hermetically cloſed with a glaſs cover M ſlightly greaſed. A double ſcale is paſted on the tube, having two ſets of graduations; one to denote the length, and the other the capacities, as determined by experiment.

Plate DIX. fig. 1.

When this inſtrument is uſed, it muſt be plunged into a veſſel of mercury, with the tube very upright, till the mercury riſe within and without to a point C of the ſcale. See fig. 2.

Fig. 2.

The capſule is then cloſed with the cover, which being greaſed will prevent its communication between the external air and that contained within the capſule and tube.

In this ſituation of the inſtrument, the internal air is compreſſed by the weight of the atmoſphere, expreſſed by the length of the mercury in the tube of the common barometer.

The inſtrument is then elevated, ſtill keeping the tube in the vertical poſition. It is thus repreſented, fig. 2. ſecond poſition. The mercury deſcends in the tube, but not to the level of the external ſurface, and a column of mercury DE remains ſuſpended in the tube, the height of which is known by the ſcale. The interior air is leſs compreſſed

STEREOMETER

PLATE DIX.

Fig. 1.

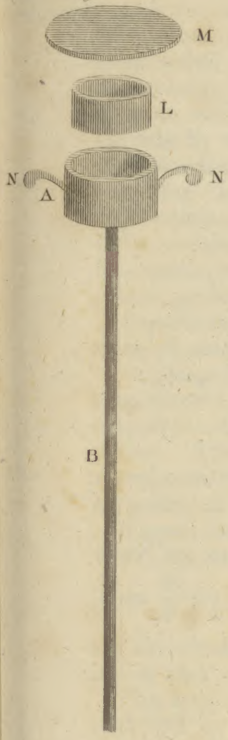


Fig. 2.

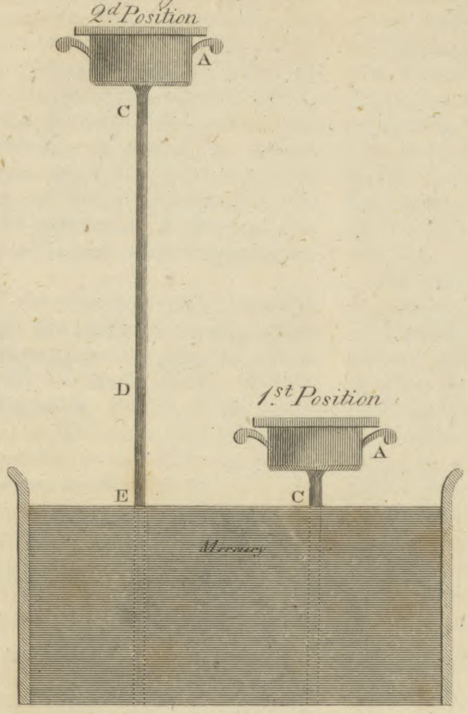
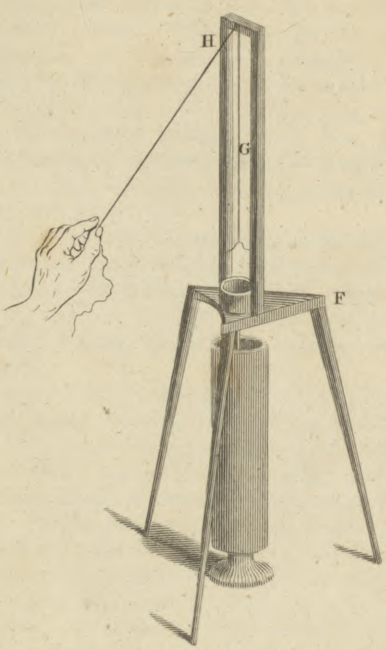
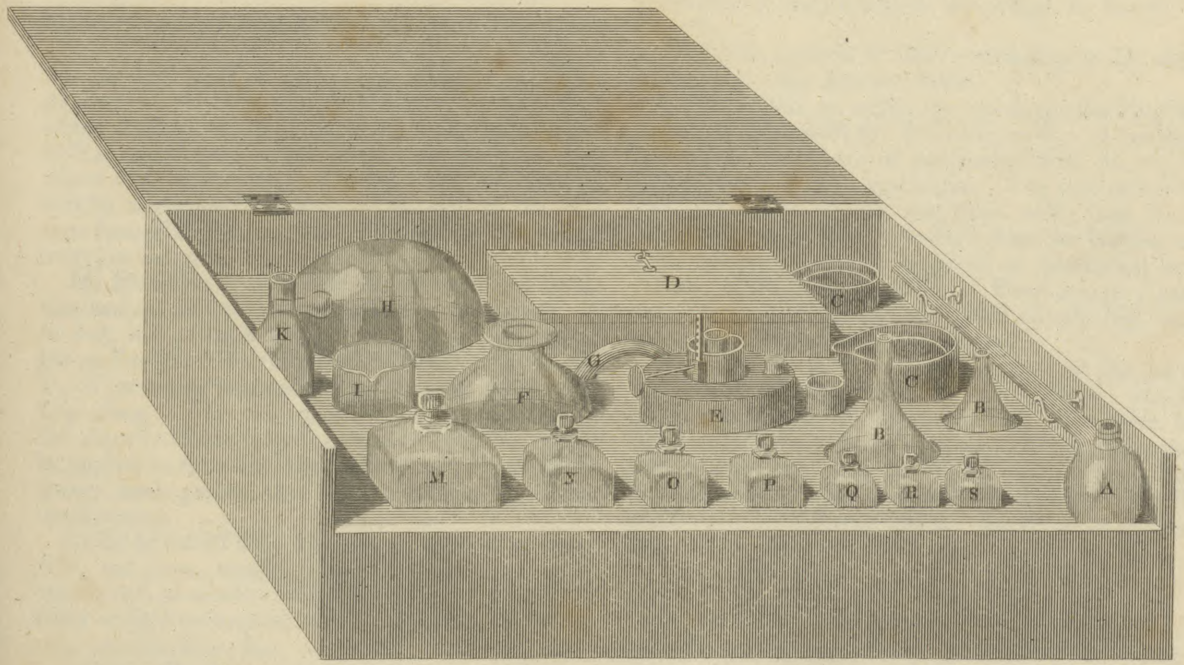


Fig. 3.



SOILS Analysis of



E. Mitchell Sculp!

compreſſed than before, the increaſe of its volume being equal to the whole capacity of the tube from C to D, indicated by the ſecond ſcale.

It is therefore known that the preſſures are in proportion to the barometrical column, and to the ſame column —DE. The bulks of the air in theſe two ſtates are inverſely in the ſame proportion; and the difference between theſe bulks is the abſolute quantity left void in the tube by the fall of the mercury; from which data the following rule is deduced. Multiply the number expreſſing the leſs preſſure by that which denotes the augmentation of capacity, and divide the product by the number which denotes the difference of the preſſures. The quotient is the bulk of the air when ſubject to the greater preſſure.

Suppoſe the height of the mercury in the barometer to be 78 centimetres, and the inſtrument being empty to be plunged into the mercury to the point C. It is then covered and raiſed till the ſmall column of mercury DE is ſuſpended, ſay at the height of ſix centimetres. The internal air at firſt compreſſed by a force repreſented by 78 centimetres, is now only compreſſed by a force = 72 centimetres, or 78—6 = 72.

Suppoſe that the capacity of the part CD of the tube which the mercury has quitted is two cubic centimetres. Then $\frac{72}{6} \times 2 = 24$ cubical centimetres, the volume of the air included in the inſtrument when the mercury roſe as high as C in the tube.

The body of which the volume is to be aſcertained muſt then be placed in the capſule, and the operation repeated. Let the column of mercury ſuſpended be =8 centimetres, when the capacity of the part CD of the tube is = 2 centimetres cubic. Then the greateſt preſſure being denoted by 78 centimetres, the leaſt will be 70 centimetres, the difference of preſſure being 8, and difference of the volumes two cubic centimetres. Hence $\frac{70}{8} \times 2$ gives the bulk of the included air under the greateſt preſſure 17.5 cubic centimetres. Then 24—17.5 =6.5 the volume of the body introduced. If the abſolute weight of the body be multiplied by its bulk in centimetres, and divided by the abſolute weight of one cubic centimetre of diſtilled water, the quotient will be = the ſpecific gravity of the body in the common form of the tables, where diſtilled water is taken as unity, or the term of compariſon.

Mr Nicholſon ſuppoſes that the author of the invention had not finiſhed his meditations on the ſubject. If he had, it is probable that he would have determined his preſſures, as well as the meaſures of bulks, by weight. For if the whole inſtrument were ſet to its poſitions by 3. ſuſpending it from one arm of a balance at H (fig. 3.) the quantity of counterpoiſe, when in equilibrio, might be applied to determine the preſſures to a degree of accuracy much greater than can be obtained by linear meaſurement.

STEREOMETRY, Στερεομετρια, formed of στερεος, *ſolid*, and μετρον, *meaſure*, that part of geometry which teaches how to meaſure ſolid bodies, i. e. to find the ſolidity or ſolid contents of bodies; as globes, cylinders, cubes, veſſels, ſhips, &c.

STEREOTOMY, formed from στερεος, and τομη, *ſection*, the art or act of cutting ſolids, or making ſections thereof; as walls and other membranes in the profiles of architecture.

STEREOTYPE PRINTING, a method of printing, which was introduced into this country by William Ged of Edinburgh before the middle of the 18th century, and which has been revived of late, and greatly improved by the French. It has alſo been brought into practice in Britain by Earl Stanhope, who has produced ſome beautiful ſpecimens of it. Some perſons ſeem diſpoſed to diſpute the invention of Ged, ſeeing that the ſame method of printing by wooden blocks was practiſed by the Chineſe and Japaneſe many hundred years ago. See GED, *life of*, and PRINTING.

STERILITY, barreneſs, in oppoſition to fertility. It has been aſſerted by many authors, that all monſters produced by a mixture of different ſpecies of animals, ſuch as mules, are barren; but this does not hold univerſally, even with the mule, which is the inſtance moſt generally adduced.

Sterility in women ſometimes happens from a miſcarriage, or violent labour injuring ſome of the genital parts; but one of the moſt frequent cauſes is the ſuppreſſion of the menſtrual flux.—There are other cauſes ariſing from various diſeaſes incident to thoſe parts, by which the uterus may be unfit to receive or retain the male ſeed;—from the tubæ fallopianæ being too ſhort, or having loſt their erective power; in either of which caſes no conception can take place;—from univerſal debility and relaxation; or a local debility of the genital ſyſtem; by which means, the parts having loſt their tone or contractile power, the ſemen is thrown off immediately *poſt coitum*;—from imperforation of the vagina, the uterus, or the *tubæ*, or from diſeaſed ova, &c. Hence medical treatment can only avail in caſes ariſing from topical or univerſal debility; in correcting irregularities of the menſtrual flux, or in removing tumors, cicatrices, or conſtrictions of the paſſage, by the art of ſurgery.

STERIS, a genus of plants belonging to the claſs pentandria. See BOTANY *Index*.

STERLING, an epithet by which genuine Engliſh money is diſtinguiſhed. It is unneceſſary to mention the various conjectures of antiquaries about the origin and meaning of this appellation. The moſt probable opinion ſeems to be this, that ſome artiſts from Germany, who were called *Eſterlings*, from the ſituation of their country, had been employed in fabricating our money, which conſiſted chiefly of ſilver pennies; and that from them the penny was called an *eſterling*, and our money *eſterling* or *ſterling* money.

Henry's Hiſtory of Great Britain, vol. iii.

STERN, the poſterior face of a ſhip; or that part which is repreſented to the view of a ſpectator, placed on the continuation of the keel behind. The ſtern is terminated above by the taffarel, and below by the counters; it is limited on the ſides by the quarter-pieces, and the intermediate ſpace comprehends the galleries and windows of the different cabins. See *QUARTER of a Ship*, SHIP, and SHIP-BUILDING.

STERN-Faſt, a rope uſed to confine the ſtern of a ſhip or boat to any wharf or jetty head, &c.

STERN-Moſt, in ſea language, uſually denotes that part of a fleet of ſhips which is in the rear, or fartheſt a-ſtern, as oppoſed to head-moſt.

STERN-Poſt, a long ſtraight piece of timber erected on the extremity of the keel, to ſuſtain the rudder and terminate the ſhip behind.

This piece ought to be well ſecured and ſupported; becauſe the ends of all the lower planks of the ſhip's bottom are fixed in a channel, cut on its ſurface; and the whole weight of the rudder is ſuſtained by it.

STERN-Sheets, that part of a boat which is contained between the ſtern and the aftmoſt or hindmoſt ſeat of the rowers. It is generally furniſhed with benches to accommodate the paſſengers. See BOAT.

STERNA, the TERN; a genus of birds arranged under the order of *palmipedes*. See ORNITHOLOGY *Index*.

STERNE, LAURENCE, an Engliſh writer of a very peculiar caſt, was born at Clomwell, in the ſouth of Ireland, on 24th November 1713. His father Roger Sterne was the grandſon of Sterne archbiſhop of York, who has been ſuppoſed, we know not upon what grounds, to have been the author of the excellent book entitled "The Whole Duty of Man." Laurence inherited nothing of his anceſtor's manner of writing, but rather reſembled Rabelais, whoſe wit he carried with him even into the pulpit.

In 1722 he was ſent to ſchool at Halifax in Yorkſhire, where he continued till 1732, when he was removed to Jeſus College in Cambridge. How long he reſided in college, or what progreſs he made in literature or ſcience, is not known: his works diſplay rather native genius than profound erudition. Upon quitting the univerſity he went to York, and being in orders was preſented to the living of Sutton by the intereſt of his uncle Dr Sterne, a prebendary of that church. In 1741 he married, and was ſoon afterwards made a prebendary of York, by the intereſt alſo of his uncle, who was then upon very good terms with him; but "quickly quarrelled with him (he ſays), and became his bittereſt enemy, becauſe he would not be a party man, and write paragraphs in the newſpapers." By his wife's means he got the living of Stillington, but remained near 20 years at Sutton, doing duty at both places. He was then in very good health, which, however, ſoon after forſook him; and books, painting, fiddling, and ſhooting, were, as he tells us, his amuſements.

In 1760, he went to London to publiſh his two firſt volumes of "Triſtram Shandy;" and was that year preſented to the curacy of Coxwold. In 1762 he went to France, and two years after to Italy, for the recovery of his health; but his health never was recovered. He languiſhed under a conſumption of the lungs, without the ſlighteſt depreſſion of ſpirits, till 1768, when death put a period to his terreſtrial exiſtence.

The works of Sterne are very generally read. They conſiſt of, 1. The Life and Opinions of Triſtram Shandy; 2. Sermons; 3. A Sentimental Journey; 4. Letters, publiſhed ſince his death. In every ſerious page, and in many of much levity, the author writes in praiſe of benevolence, and declares that no one who knew him could ſuppoſe him one of thoſe wretches who heap miſfortune upon misfortune: But we have heard anecdotes of him extremely well authenticated, which proved that it was eaſier for him to praiſe this virtue than to practiſe it. His wit is univerſally allowed; but many readers have perſuaded themſelves that they found wit in his blank pages, while it is probable that he intended nothing but to amuſe himſelf with the idea of the ſage conjectures to which theſe pages would give occaſion. Even his originality is not ſuch as is generally ſuppoſed by thoſe fond admirers of the Shandean manner, who have preſumed to compare him with Swift, Arbuthnot, and Butler. He has borrowed both matter and manner from various authors, and in particular from an old work, "The Anatomy of Melancholy by Burton," as every reader may be convinced by the learned, elegant, and candid comments on his works publiſhed by Dr Ferriar, in the fourth volume of the Memoirs of the Literary and Philoſophical Society of Mancheſter.

STERNOCOSTALES, commonly called the *muſculi triangulares ſterni*, in *Anatomy*, are five pairs of fleſhy planes, diſpoſed more or leſs obliquely on each ſide the ſternum, on the inſides of the cartilages of the ſecond, third, fourth, fifth, and ſixth true ribs.

STERNO-HYOIDÆUS, in *Anatomy*. See *Table of the Muſcles*, under the article ANATOMY.

STERNOMANTIS, in antiquity, a deſignation given to the Delphian prieſteſs, more uſually called PYTHIA.—Sternomantis is alſo uſed for any one that had a propheſying demon within him.

STERNOMASTOIDÆUS, a muſcle. See *Table of the Muſcles*, under ANATOMY.

STERNOTHYROIDEUS, a muſcle. See *Table of the Muſcles*, under ANATOMY.

STERNUM. See ANATOMY *Index*.

STERNUTATIVE, or STERNUTATORY, a medicine proper to produce ſneezing. See SNEEZING.

STETIN, or STETTIN, a ſea-port town of Germany, in the circle of Upper Saxony, and capital of Hither Pomerania, with the title of a duchy, and a caſtle. It had long a famous ſchool, which the wars of Germany never diſturbed. The ancient dukes of Pomerania reſided here; and it was taken by the elector of Brandenburg in 1676, but given to Sweden by the treaty of Nimeguen. In 1713 it ſubmitted to the allies; and then the ſaid elector was put in poſſeſſion again of this important place, which is a bulwark to the marche of Brandenburg; and the fortifications have been greatly improved. It is now a flouriſhing place, and carries on a conſiderable trade. It is ſeated on the river Oder, 72 miles north of Francfort, and 70 north by eaſt of Berlin. E. Long. 14. 38. N. Lat. 53. 35. The duchy is 125 miles in length, and borders upon Mecklenburg, and partly upon Brandenburg. The breadth is from 17 to 25 miles, and it is divided by the river Oder into two parts.

STEW, a ſmall kind of fiſh-pond, the peculiar uſe of which is to maintain fiſh, and keep them in readineſs for the daily uſe of the family, &c.

STEWS (from the French *eſtuves*, i. e. *thermæ, balneum*), thoſe places which were permitted in England to women of profeſſed incontinency; ſo called, becauſe diſſolute perſons are wont to prepare themſelves for venereous acts by bathing; and hot baths were by Homer reckoned among the effeminate ſort of pleaſures. Theſe ſtews were ſuppreſſed by King Henry VIII. about the year 1546.

STEWARD (*ſeneſcallus*, compounded of the Saxon *ſteda*, i. e. "room" or "ſtead," and *weard*, "a ward" or "keeper"), an officer appointed in another's ſtead or place, and always taken for a principal officer within his juriſdiction.

juriſdiction. Of theſe there are various kinds. The greateſt officer under the crown is the lord high-ſteward of England, an office that was anciently the inheritance of the earls of Leiceſter, till forfeited by Simon de Mountfort to King Henry III. But the power of this officer is ſo very great, that it has not been judged ſafe to truſt it any longer in the hands of a ſubject, excepting only *pro hac vice*, occaſionally: as to officiate at a coronation, at the arraignment of a nobleman for high-treaſon, or the like. During his office, the ſteward bears a white ſtaff in his hand; and the trial, &c. ended, he breaks the ſtaff, and with it his commiſſion expires. There is likewiſe a lord-ſteward of the king's houſehold, who is the chief officer of the king's court, has the care of the king's houſe, and authority over all the officers and ſervants of the houſehold, except ſuch as belong to the chapel, chamber, and ſtable.

STEWARD, an officer in a ſhip of war, appointed by the purſer to diſtribute the different ſpecies of proviſions to the officers and crew; for which purpoſe he is furniſhed with a mate and proper aſſiſtants.

Court of the Lord High STEWARD of Great Britain, is a court inſtituted for the trial of peers indicted for treaſon or felony, or for miſpriſion of either. The office of this great magiſtrate is very ancient, and was formerly hereditary, or at leaſt held for life, or *dum bene ſe geſſerit*: but now it is uſually, and hath been for many centuries paſt, granted *pro hac vice* only; and it hath been the conſtant practice (and therefore ſeems now to have become neceſſary) to grant it to a lord of parliament, elſe he is incapable to try ſuch delinquent peer. When ſuch an indictment is therefore found by a grand jury of freeholders in the King's bench, or at the aſſizes before the juſtices of *oyer* and *terminer*, it is to be removed by a writ of *certiorari* into the court of the lord high-ſteward, which has the only power to determine it. A peer may plead a pardon before the court of King's bench, and the judges have power to allow it, in order to prevent the trouble of appointing an high-ſteward merely for the purpoſe of receiving ſuch plea: but he may not plead in that inferior court any other plea, as guilty or not guilty of the indictment, but only in this court; becauſe, in conſequence of ſuch plea, it is poſſible that judgment of death might be awarded againſt him. The king, therefore, in caſe a peer be indicted of treaſon, felony, or miſpriſion, creates a lord high-ſteward *pro hac vice* by commiſſion under the great ſeal; which recites the indictment ſo found, and gives his Grace power to receive and try it *ſecundum legem et conſuetudinem Angliæ*. Then when the indictment is regularly removed by writ of *certiorari*, commanding the inferior court to certify it up to him, the lord high-ſteward directs a precept to a ſerjeant at arms, to ſummon the lords to attend and try the indicted peer. This precept was formerly iſſued to ſummon only 18 or 20 ſelected from the body of the peers; then the number came to be indefinite; and the cuſtom was for the lord high-ſteward to ſummon as many as he thought proper (but of late years not leſs than 23); and that thoſe lords only ſhould ſit upon the trial; which threw a monſtrous weight of power into the hands of the crown, and this its great officer, of ſelecting only ſuch peers as the then predominant party ſhould moſt approve of. And accordingly, when the earl of Clarendon fell into diſgrace with Charles II. there was a deſign formed to prorogue the parliament, in order to try him by a ſelect number of peers; it being doubted whether the whole houſe could be induced to fall in with the views of the court. But now, by ſtatute 7 W. III. c. 3. upon all trials of peers for treaſon or miſpriſion, all the peers who have a right to ſit and vote in parliament ſhall be ſummoned at leaſt 20 days before ſuch trial, to appear and vote therein; and every lord appearing ſhall vote in the trial of ſuch peer, firſt taking the oaths of allegiance and ſupremacy, and ſubſcribing the declaration againſt popery.

lackſt.
omment.
ol. iv.

During the ſeſſion of parliament, the trial of an indicted peer is not properly in the court of the lord high-ſteward, but before the court laſt mentioned of our lord the king in parliament. It is true, a lord high-ſteward is always appointed in that caſe to regulate and add weight to the proceedings: but he is rather in the nature of a ſpeaker *pro tempore*, or chairman of the court, than the judge of it; for the collective body of the peers are therein the judges both of law and fact, and the high-ſteward has a vote with the reſt in right of his peerage. But in the court of the lord high-ſteward, which is held in the receſs of parliament, he is the ſole judge of matters of law, as the lords triors are in matters of fact; and as they may not interfere with him in regulating the proceedings of the court, ſo he has no right to intermix with them in giving any vote upon the trial. Therefore, upon the conviction and attainder of a peer for murder in full parliament, it hath been holden by the judges, that in caſe the day appointed in the judgment for execution ſhould lapſe before execution done, a new time of execution may be appointed by either the high court of parliament during its ſitting, though no high-ſteward be exiſting, or, in the receſs of parliament, by the court of King's-bench, the record being removed into that court.

It has been a point of ſome controverſy, whether the biſhops have now a right to ſit in the court of the lord high-ſteward to try indictments of treaſon and miſpriſion. Some incline to imagine them included under the general words of the ſtatute of King William "all peers who have a right to ſit and vote in parliament;" but the expreſſion had been much clearer, if it had been "all lords," and not "all peers;" for though biſhops, on account of the baronies annexed to their biſhoprics, are clearly lords of parliament, yet their blood not being ennobled, they are not univerſally allowed to be peers with the temporal nobility: and perhaps this word might be inſerted purpoſely with a view to exclude them. However, there is no inſtance of their ſitting on trials for capital offences, even upon impeachments or indictments in full parliament, much leſs in the court we are now treating of; for indeed they uſually withdraw voluntarily, but enter a proteſt, declaring their right to ſtay. It is obſervable, that in the 11th chapter of the conſtitutions of Clarendon, made in parliament 11th Henry II. they are expreſsly excuſed, rather than excluded, from ſitting and voting in trials, which concern life or limb: *epiſcopi, ſicut cæteri barones, debent intereſſe judiciis cum baronibus, quoſque perveniatur ad diminutionem membrorum vel ad mortem.* And Becket's quarrel with the king hereupon was not on account of the exception (which was agreeable to the canon law), but of the general rule, that compelled the biſhops to attend at all. And the determination of the houſe of lords in the earl of Danby's caſe, which hath ever ſince been adhered to, is conſonant to theſe conſtitutions; "that the lords ſpiritual have a right to ſtay and ſit in court in capital caſes, till the court proceeds to the vote of guilty or not guilty." It muſt be noted, that this reſolution extends only to trials in full parliament; for to the court of the lord high-ſteward (in which no vote can be given, but merely that of guilty or not guilty), no biſhop, as ſuch, ever was or could be ſummoned: and though the ſtatute of King William regulates the proceedings in that court, as well as in the court of parliament, yet it never intended to new-model or alter its conſtitution; and conſequently does not give the lords ſpiritual any right, in caſes of blood, which they had not before. And what makes their excluſion more reaſonable is, that they have no right to be tried themſelves in the court of the lord high-ſteward, and therefore ſurely ought not to be judges there. For the privilege of being thus tried depends upon nobility of blood rather than a ſeat in the houſe, as appears from the trials of the popiſh lords, of lords under age, and (ſince the union) of the Scotch nobility, though not in the number of the ſixteen; and from the trials of females, ſuch as the queen conſort or dowager, and of all peereſſes by birth; and peereſſes by marriage alſo, unleſs they have, when dowagers, diſparaged themſelves by taking a commoner to their ſecond huſband.

STEWARD of the Chiltern Hundreds. See *CHILTERN Hundreds*.

STEWART, Dr Matthew, an eminent mathematician, was in 1717 born at Rothſay in the iſle of Bute, of which pariſh his father was miniſter. Being intended for the church, he went through the uſual courſe of a grammar-ſchool education, and was in 1734 received as a ſtudent into the univerſity of Glaſgow. There he had the happineſs of having for his preceptors in moral ſcience and in mathematics the celebrated profeſſors Hutcheſon and Simſon; by the latter of whom he was inſtructed in what may not improperly be called the *arcana* of the ancient geometry.

Account of Dr Stewart in the Edinburgh Philoſophical Tranſactions, vol. i. *by Mr Playfair.*

Mr Stewart's views making it neceſſary for him to remove to Edinburgh, he was introduced by Dr Simſon to Mr Maclaurin, that his mathematical ſtudies might ſuffer no interruption; and he attended the lectures of that great maſter with ſuch advantage as might be expected from eminent abilities, directed by the judgement of him who made the philoſophy and geometry of Newton intelligible to ordinary capacities. Mr Stewart, however, had acquired, from his intimacy with Dr Simſon, ſuch a predilection for the ancient geometry, as the modern analyſis, however powerfully recommended, could not leſſen; and he kept up a regular correſpondence with his old maſter, giving him an account of his progreſs and his diſcoveries in geometry, and receiving in return many curious communications reſpecting the *Loci Plani* and the poriſms of Euclid. See Porism and Simson.

While the ſecond invention of poriſms, to which more genius was perhaps required than to the firſt diſcovery of them, employed Dr Simſon, Mr Stewart purſued the ſame ſubject in a different and new direction. In doing ſo, he was led to the diſcovery of thoſe curious and intereſting propoſitions which were publiſhed under the title of *General Theorems* in 1746. They were given without the demonſtrations; but did not fail to place their diſcoverer at once among the geometers of the firſt rank. They are for the moſt part poriſms, though Mr Stewart, careful not to anticipate the diſcoveries of his friend, gave them no other name than that of theorems.

Our author had before this period entered into the church; and obtained, through the patronage of the duke of Argyle and the earl of Bute, the living of Roſeneath, a retired country pariſh in the weſt of Scotland: but in 1747 he was elected to the mathematical chair in the univerſity of Edinburgh, which had become vacant the year before by the death of Mr Maclaurin. The duties of this office gave a turn ſomewhat different to his purſuits, and led him to think of the moſt ſimple and elegant means of explaining thoſe difficult propoſitions which were hitherto only acceſſible to men deeply verſed in the modern analyſis. In doing this, he was purſuing the object which of all others he moſt ardently wiſhed to attain, viz. the application of geometry to ſuch problems as the algebraic calculus alone had been thought able to reſolve. His ſolution of Kepler's problem was the firſt ſpecimen of this kind which he gave to the world; and it was impoſſible to have produced one more to the credit of the method he followed, or of the abilities with which he applied it. On this problem the utmoſt reſources of the integral calculus had been employed. But though many excellent ſolutions had been given, there was none of them at once direct in its method and ſimple in its principles. Mr Stewart was ſo happy as to attain both theſe objects; and his ſolution appeared in the ſecond volume of the Eſſays of the Philoſophical Society of Edinburgh for the year 1756. In the firſt volume of the ſame collection there are ſome other propoſitions of Mr Stewart's, which are an extenſion of a curious theorem in the fourth book of Pappus. They have a relation to the ſubject of poriſms, and one of them forms the 91ſt of Dr Simſon's Reſtoration. They are beſides very beautiful propoſitions, and are demonſtrated with all the elegance and ſimplicity of the ancient analyſis.

The proſecution of the plan which he had formed of introducing into the higher parts of mixed mathematics the ſtrict and ſimple form of ancient demonſtration, produced the Tracts Phyſical and Mathematical, which were publiſhed in 1761, and the Eſſay on the Sun's Diſtance, which was publiſhed in 1763. In this laſt work it is acknowledged that he employed geometry on a taſk which geometry cannot perform; but while it is granted that this determination of the ſun's diſtance is by no means free from error, it may ſafely be aſſerted that it contains a great deal which will always intereſt geometers, and will always be admired by them. Few errors in ſcience are redeemed by the diſplay of ſo much ingenuity, and what is more ſingular, of ſo much ſound reaſoning. The inveſtigation is everywhere elegant, and will probably be long regarded as a ſpecimen of the moſt arduous inquiry which has been attempted by mere geometry.

The Sun's Diſtance was the laſt work which Dr Stewart publiſhed; and though he lived to ſee ſeveral animadverſions on it made public, he declined entering into any controverſy. His diſpoſition was far from polemical; and he knew the value of that quiet which a literary man ſhould rarely ſuffer his antagoniſts to interrupt. He uſed to ſay, that the deciſion of the point in queſtion was now before the public; that if his inveſtigation was right it would never be overturned, and that if it was wrong it ought not to be defended. A few months before he publiſhed the eſſay juſt mentioned, he gave to the world another work, intitled *Propoſitiones Geometricæ More Veterum Demonſtratæ*. This title, it is ſaid, was given to it by Dr Simſon, who rejoiced in the publication of a work ſo well calculated to promote the ſtudy of the ancient geometry. It conſiſts of a ſeries of geometrical theorems, for the moſt part new; inveſtigated firſt by an analyſis, and afterwards ſynthetically demonſtrated by the inverſion of the ſame analyſis.

Dr Stewart's conſtant uſe of the geometrical analyſis had put him in poſſeſſion of many valuable propoſitions which did not enter into the plan of any of the works that have been enumerated. Of theſe not a few have found a place in the writings of Dr Simſon, where they will for ever remain to mark the friendſhip of theſe two mathematicians, and to evince the eſteem which Dr Simſon entertained for the abilities of his pupil.

Soon after the publication of the Sun's Diſtance, Dr Stewart's health began to decline, and the duties of his office became burdenſome to him. In the year 1772 he retired to the country, where he afterwards ſpent the greater part of his life, and never reſumed his labours in the univerſity. But though mathematics had now ceaſed to be his buſineſs, they continued to be his amuſement till a very few years before his death, which happened on the 23d of January 1785, at the age of 68.

The habits of ſtudy, in a man of original genius, are objects of curioſity, and deſerve to be remembered. Concerning thoſe of Dr Stewart, his writings have made it unneceſſary to remark, that from his youth he had been accuſtomed to the moſt intenſe and continued application. In conſequence of this application, added to the natural vigour of his mind, he retained the memory of his diſcoveries in a manner that will hardly be believed. He rarely wrote down any of his inveſtigations till it became neceſſary to do ſo for the purpoſe of publication. When he diſcovered any propoſition, he would put down the enunciation with great accuracy, and on the ſame piece of paper would conſtruct very neatly the figure to which it referred. To theſe he truſted for recalling to his mind at any future period the demonſtration or the analyſis, however complicated it might be. Experience had taught him, that he might place this confidence in himſelf without any danger of diſappointment; and for this ſingular power he was probably more indebted to the activity of his invention than the mere tenaciouſneſs of his memory. Though he was extremely ſtudious, he read few books, and verified the obſervation of M. D'Alembert, that of all men of letters, mathematicians read leaſt of the writings of one another. His own inveſtigations occupied him ſufficiently; and indeed the world would have had reaſon to regret the miſapplication of his talents, had he employed in the mere acquiſition of knowledge that time which he could dedicate to works of invention.

Stewart, in *Scots Law*. See Law *Index*.

STEWARTIA, a genus of plants belonging to the claſs monadelphia, and in the natural ſyſtem ranging under the 37th order, *Columniferæ*. See Botany *Index*.

STIBADIUM, among the Romans, a low kind of table couch or bed of a circular form, which ſucceeded to the triclinia, and was of different ſizes according to the number of gueſts for which it was deſigned. Tables of this kind were called *hexaclina*, *octaclina*, or *enneaclina*, according as they held ſix, eight, or nine gueſts, and ſo of any other number.

STIBIUM, a name for Antimony.

STICHOS, a name given by the old writers to a pectoral confection, the principal ingredient of which was the herb *marrubium* or horehound.

STICKLEBACK, a genus of fiſhes. See Gasterosteus, Ichthyology *Index*.

Foot-Sticks, in *Printing*, ſlips of wood that lie between the foot of the page and the cheſs, to which they are wedged faſt by the quoins, to keep the form firm, in conjunction with the ſide-ſticks, which are placed at the ſide of the page, and fixed in the ſame manner by means of quoins.

STIFFLE, or Great Muscle, in the manege, is the part of the hind-leg of a horſe which advances towards his belly. This is a moſt dangerous part to receive a blow upon.

STIGMA, a brand or impreſſion with a hot iron; a mark of infamy. See Stigmatizing.

Stigma, in *Botany*, the ſummit or top of the ſtyle, accounted by the ſexualiſts the female organ of generation in plants, which receives the fecundating duſt of the tops of the ſtamina, and tranſmits its vapour or effluvia through the ſtyle into the heart of the ſeed-bud, for the purpoſe of impregnating the ſeeds.

STIGMATA, in *Natural Hiſtory*, the apertures in different parts of the bodies of inſects communicating with the tracheæ or air-veſſels, and ſerving for the office of reſpiration.

Stigmata, in antiquity, certain marks impreſſed on the left ſhoulders of the ſoldiers when liſted.

Stigmata, were alſo a kind of notes or abbreviations, conſiſting only of points diſpoſed various ways; as in triangles, ſquares, croſſes, &c.

Stigmata, is alſo a term uſed among the Franciſcans, to expreſs the marks or prints of our Saviour's wounds, ſaid to have been miraculouſly impreſſed by him on the body of their ſeraphic father St Francis.

STIGMATIZING, among the ancients, was inflicted upon ſlaves as a puniſhment, but more frequently as a mark to know them by: in which caſe, it was done by applying a red-hot iron marked with certain letters to their foreheads, till a fair impreſſion was made; and then pouring ink into their furrows, that the inſcription might be the more conſpicuous.

Soldiers were branded in the hand with the name or character of their general.

After the ſame manner, it was cuſtomary to ſtigmatize the worſhippers and votaries of ſome of the gods. The marks uſed on theſe occaſions were various; ſometimes they contained the name of the god, ſometimes his particular enſign, as the thunderbolt of Jupiter, the trident of Neptune, the ivy of Bacchus, &c. or they marked themſelves with ſome myſtical number, whereby the god's name was deſcribed. To theſe three ways of ſtigmatizing St John is ſuppoſed to refer (Rev. chap. xiii. ver. 16, 17.). Theodoret is of opinion, that the

Jews were forbidden to brand themſelves with ſtigmata, becauſe the idolaters, by that ceremony, uſed to conſecrate themſelves to their falſe gods.

Among ſome nations, ſtigmatizing was conſidered as a diſtinguiſhing mark of honour and nobility. In Thrace, as Herodotus tells us *, it was practiſed by none but perſons of credit, nor omitted by any but perſons of the meaneſt rank. The ancient Britons are alſo ſaid to have imprinted on the bodies of their infants the figures of animals, and other marks, with hot irons.

STIL DE GRAIN, in the colour trade, the name of a compoſition uſed for painting in oil or water, and is made of a decoction of the lycium or Avignon berry, in alum-water, which is mixed with whiting into a paſte, and formed into twiſted ſticks. It ought to be choſen of a fine gold yellow, very fine, tender, and friable, and free from dirt.

STILAGO, a genus of plants belonging to the claſs gynandria. See BOTANY *Index*.

STILBE, a genus of plants belonging to the claſs polygamia, and order of diœcia. See BOTANY *Index*.

STILBITE, a ſpecies of mineral, or variety of zeolite. See ZEOLITE, MINERALOGY *Index*.

STILE. See STYLE.

STILL, the name of an apparatus uſed in chemiſtry for various purpoſes, and in the diſtillation of ardent ſpirits.

STILL-Bottoms, in the diſtillery, a name given by the traders to what remains in the ſtill after working the waſh into low wines. Theſe bottoms are procured in the greateſt quantity from the malt-waſh, and are of ſo much value to the diſtiller in the fattening of hogs, &c. that he often finds them one of the moſt valuable articles of the buſineſs.

STILLINGFLEET, EDWARD, biſhop of Worceſter, was the ſon of Samuel Stillingfleet, gentleman, and was born at Cranborn in Dorſetſhire in 1635. He was educated at St John's College, Cambridge; and having received holy orders, was, in 1657, preſented to the rectory of Sutton in Nottinghamſhire. By publiſhing his *Origines Sacræ*, one of the ableſt defences of revealed religion that has ever been written, he ſoon acquired ſuch reputation, that he was appointed preacher of the Rolls Chapel; and in January 1665 was preſented to the rectory of St Andrew's, Holborn. He was afterwards choſen lecturer at the Temple, and appointed chaplain in ordinary to King Charles II. In 1668 he took the degree of doctor of divinity; and was ſoon after engaged in a diſpute with thoſe of the Romiſh religion, by publiſhing his diſcourſe concerning the idolatry and fanaticiſm of the church of Rome, which he afterwards defended againſt ſeveral antagoniſts. In 1680 he preached at Guildhall chapel a ſermon on Phil. iii. 26. which he publiſhed under the title of *The Miſchief of Separation*; and this being immediately attacked by ſeveral writers, he in 1683 publiſhed his Unreaſonableneſs of Separation. In 1685 appeared his *Origines Britannicæ*, or the Antiquities of the Britiſh Church, in folio. During the reign of King James II. he wrote ſeveral tracts againſt popery, and was prolocutor of the convocation, as he had likewiſe been under Charles II. After the Revolution he was advanced to the biſhopric of Worceſter, and was engaged in a diſpute with the Socinians, and alſo with Mr Locke; in which laſt conteſt he is generally thought to have been unſucceſsful. He died at Weſtminſter in 1699, and was interred in the cathedral of Worceſter, where a monument was erected to his memory by his ſon. Dr Stillingfleet wrote other works beſides thoſe here mentioned, which, with the above, have been reprinted in 6 vols. folio.

STILLINGFLEET, *Benjamin*, an ingenious naturaliſt, was grandſon of the preceding. His father Edward was fellow of St John's College in Cambridge, F. R. S. M. D. and Greſham profeſſor of phyſic: but marrying in 1692, he loſt his lucrative offices and his father's favour; a misfortune that affected both himſelf and his poſterity. However, going into orders, he obtained, by his father's means, the living of Newington-Butts, which he immediately exchanged for thoſe of Wood-Norton and Swanton in Norfolk. He died in 1708.

Benjamin, his only ſon, was educated at Norwich ſchool, which he left in 1720, with the character of an excellent ſcholar. He then went to Trinity-College in Cambridge, at the requeſt of Dr Bentley, the maſter, who had been private tutor to his father, domeſtic chaplain to his grandfather, and much indebted to the family. Here he was a candidate for a fellowſhip, but was rejected by the maſter's influence. This was a ſevere and unexpected diſappointment, and but little alleviated afterwards by the Doctor's apology, that it was a pity that a gentleman of Mr Stillingfleet's parts ſhould be buried within the walls of a college.

Perhaps, however, this ingratitude of Dr Bentley was not of any real diſſervice to Mr Stillingfleet. By being thrown into the world, he formed many honourable and valuable connections. He dedicated ſome tranſlations of Linnæus to the late Lord Lyttleton, partly, he ſays, from motives of private reſpect and honour. Lord Barrington gave him, in a very polite manner, the place of the maſter of the barracks at Kenſington; a favour to which Mr Stillingfleet, in the dedication of his Calendar of Flora to that nobleman, alludes with equal politeneſs, as well as with the warmeſt gratitude. His Calendar of Flora was formed at Stratton in Norfolk in the year 1755, at the hoſpitable ſeat of his very worthy and ingenious friend Mr Marſham, who had made ſeveral obſervations of that kind, and had communicated to the public his curious obſervations on the growth of trees. But it was to Mr Wyndham of Felbrig in Norfolk that he appears to have had the greateſt obligations: he travelled abroad with him, ſpent much of his time at his houſe, and was appointed one of his executors (Mr Garrick was another), with a conſiderable addition to an annuity which that gentleman had ſettled upon him in his lifetime.

Mr Stillingfleet's genius ſeems, if we may judge from his works, to have led him principally to the ſtudy of natural hiſtory; which he proſecuted as an ingenious philoſopher, an uſeful citizen, and a good man. In this walk of learning he mentions, as his friends, Dr Watſon, Mr (afterwards Dr) Solander, Mr Hudſon, Mr Price of Foxley, and ſome others; to whom may be added the ingenious Mr Pennant. Nor can we omit the flattering mention which Mr Gray makes of him in one of his letters, dated from London in 1761: "I have lately made an acquaintance with this philoſopher, who lives in a garret here in the winter, that he may ſupport ſome near relations who depend upon him. He is always employed, conſequently (according to my old maxim)

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* Lib. v.

maxim) always happy, always cheerful, and ſeems to me a very worthy honeſt man. His preſent ſcheme is to ſend ſome perſons, properly qualified, to reſide a year or two in Attica, to make themſelves acquainted with the climate, productions, and natural hiſtory of the country, that we may underſtand Ariſtotle, Theophraſtus, &c. who have been heathen Greek to us for ſo many ages; and this he has got propoſed to Lord Bute, no unlikely perſon to put it in execution, as he is himſelf a botaniſt."

Mr Stillingfleet publiſhed a volume of miſcellaneous tracts, which is in much eſteem, and does great honour to his head and heart. They are chiefly tranſlations of ſome eſſays in the *Amœnitates Academicæ*, publiſhed by Linnæus, interſperſed with ſome obſervations and additions of his own. In this volume he ſhows alſo a taſte for claſſical learning, and entertains us with ſome elegant poetical effuſions of his own. But his Eſſay on Converſation, publiſhed in the firſt volume of Dodſley's Collection of Poems, entitles him to a diſtinguiſhed rank among our Engliſh poets. This poem is addreſſed to Mr Wyndham, with all that warmth of friendſhip which diſtinguiſhes Mr Stillingfleet. As it is chiefly didactic, it does not admit of ſo many ornaments as ſome compoſitions of other kinds. However, it contains much good ſenſe, ſhows a conſiderable knowledge of mankind, and has ſeveral paſſages that in point of harmony and eaſy verſification would not diſgrace the writings of our moſt admired poets. Here more than once Mr Stillingfleet ſhows himſelf ſtill ſore for Dr Bentley's cruel treatment of him; and towards the beautiful and moral cloſe of it (where it is ſuppoſed he gives us a ſketch of himſelf) ſeems to hint at a mortification of a more delicate nature, which he is ſaid to have ſuffered from the other ſex.

To theſe diſappointments it was perhaps owing that Mr Stillingfleet neither married nor went into orders. His London reſidence was at a ſaddler's in Piccadilly; where he died in 1771, aged above 70, leaving ſeveral valuable papers behind him. He was buried in St James's church, without the ſlighteſt monument to his memory.

STILLINGIA, a genus of plants belonging to the claſs monœcia, and to the order of *monadelphia*. See Botany *Index*.

STILYARD. See *Steel-Yard*.

STILPO, a celebrated philoſopher of Megara, flouriſhed under the reign of Ptolemy Euergetes. In his youth he had been addicted to licentious pleaſures, from which he religiouſly refrained from the moment that he ranked himſelf among philoſophers. When Ptolemy Soter, at the taking of Megara, offered him a large ſum of money, and requeſted that he would accompany him into Egypt, he accepted but a ſmall part of the offer, and retired to the iſland of Ægina, whence, on Ptolemy's departure, he returned to Megara. That city being again taken by Demetrius the ſon of Antigonus, and the philoſopher required to give an account of any effects which he had loſt during the hurry of the plunder, he replied, that he had loſt nothing; for no one could take from him his learning and eloquence. So great was the fame of Stilpo, that the moſt eminent philoſophers of Athens took pleaſure in attending upon his diſcourſes. His peculiar doctrines were, that ſpecies or univerſals have no real exiſtence, and that one thing cannot be predicated of another. With reſpect to the former of theſe opinions, he ſeems to have taught the ſame doctrine with the ſect afterwards known by the appellation of *Nominaliſts*. To prove that one thing cannot be predicated of another, he ſaid, that *goodneſs* and *man*, for inſtance, are different things, which cannot be confounded by aſſerting the one to be the other: he argued farther, that goodneſs is an univerſal, and univerſals have no real exiſtence; conſequently ſince nothing cannot be predicated of any thing, goodneſs cannot be predicated of man. Thus, whilſt this ſubtle logician was, through his whole argument, predicating one thing of another, he denied that any one thing could be the accident or predicate of another. If Stilpo was ſerious in this reaſoning; if he meant any thing more than to expoſe the ſophiſtry of the ſchools, he muſt be confeſſed to have been an eminent maſter of the art of wrangling; and it was not wholly without reaſon that Glycera, a celebrated courtezan, when ſhe was reproved by him as a corrupter of youth, replied, that the charge might be juſtly retorted upon himſelf, who ſpent his time in filling their heads with ſophiſtical quibbles and uſeleſs ſubtleties. In ethics he ſeems to have been a Stoic, and in religion he had a public and a private doctrine, the former for the multitude, and the latter for his friends. He admitted the exiſtence of a ſupreme divinity, but had no reverence for the Grecian ſuperſtitions.

Enfield's Hiſtory of Philoſophy, vol. i.

STILOBATUM, in *Architecture*, denotes the body of the pedeſtal of any column.

STILTON, a town of England, in Huntingdonſhire, 75 miles from London, ſouth-weſt of Yaxley, on the Roman highway from Caſtor to Huntingdon, called *Ermine-ſtreet*, ſome parts of which, in this neighbourhood, appear ſtill paved with ſtone. This place is famous for cheeſe called *Engliſh Parmeſan*, which is generally kept till it is old before it is brought to table, and even the proceſs of decay is accelerated by various means, to render it agreeable to a vitiated taſte. For making Stilton cheeſe, the following receipt is given in the firſt volume of the *Repoſitory of Arts and Manufactures*:

"Take the night's cream, and put it to the morning's new milk, with the rennet; when the curd is come, it is not to be broken, as is done with other cheeſes, but take it out with a ſoil-diſh altogether, and place it in a ſieve to drain gradually; and as it drains, keep gradually preſſing it till it becomes firm and dry; then place it in a wooden hoop; afterwards to be kept dry on boards, turned frequently, with cloth binders round it, which are to be tightened as occaſion requires, and changed every day until the cheeſe become firm enough to ſupport itſelf; after the cloth is taken off, the cheeſe is rubbed every day all over, for two or three months, with a bruſh; and if the weather be damp or moiſt twice a-day: and even before the cloth is taken off, the top and bottom are well rubbed every day."

STIMULANTS, in *Medicine*, ſubſtances which increaſe the action of certain parts of the body. In particular, they quicken the motion of the blood, increaſe the action of the muſcular fibres, and affect the nervous ſyſtem.

STIMULI, in *Botany*, a ſpecies of armature or offenſive weapon, with which ſome plants, as nettle, caſſada, acalypha, and tragia, are furniſhed. Their uſe, ſays Linnæus, is by their venomous punctures to keep off naked animals that would approach to hurt them.

STING, an apparatus in the bodies of certain inſects, in the form of a little ſpear, ſerving them as a weapon of offence.

STING-Ray. See RAIA, ICHTHYOLOGY *Index.*

Falconer's Marine Dictionary.

STINK-POT, an earthen jar or ſhell, charged with powder, grenadoes, and other materials of an offenſive and ſuffocating ſmell. It is frequently uſed by privateers, in the weſtern ocean, in the attack of an enemy whom he deſigns to board; for which purpoſe it is furniſhed with a light fuſe at the opening or touch-hole. See BOARDING.

STINT, a ſpecies of bird. See TRINGA, ORNITHOLOGY *Index.*

STIPA, FEATHER GRASS, a genus of plants belonging to the claſs triandria, and order of digynia; and in the natural ſyſtem ranging under the 4th order, *Gramina.* See BOTANY *Index.*

STIPEND, among the Romans, ſignifies the ſame with tribute; and hence *ſtipendarii* were the ſame with *tributarii.*

STIPEND, in *Scots Law.* See LAW, § clix. 12.

STIPULA, in *Botany*, one of the fulcra or props of plants, defined by Linnæus to be a ſcale, or ſmall leaf, ſtationed on each ſide the baſe of the footſtalks of the flower and leaves, at their firſt appearance, for the purpoſe of ſupport. Elmgren reſtricts it to the footſtalks of the leaves only.

STIPULATION, in the civil law, the act of ſtipulating, that is, of treating and concluding terms and conditions to be inſerted in a contract. Stipulations were anciently performed at Rome, with abundance of ceremonies; the firſt whereof was, that one party ſhould interrogate, and the other anſwer, to give his conſent, and oblige himſelf. By the ancient Roman law, nobody could ſtipulate but for himſelf; but as the tabelliones were public ſervants, they were allowed to ſtipulate for their maſters; and the notaries ſucceeding the tabelliones have inherited the ſame privilege.

STIRIA, a province of Germany, in the circle of Auſtria, with the title of a duchy. It is bounded on the north by the archduchy of Auſtria, on the eaſt by Hungary, on the ſouth by Carniola, and on the weſt by Carinthia and the archbiſhopric of Saltſburg; it is 125 miles in length and 17 in breadth, and is ſaid to contain 22 cities, 95 towns, 338 caſtles, 15 convents, and 200,000 inhabitants. Though it is a mountainous country, yet there is a great deal of land fit for tillage, and the ſoil is ſo good, that the inhabitants never were in want of corn. It contains mines of very good iron; whence the arms made there are in great eſteem. The women differ greatly from the Auſtrians, and are very plain and ingenious. They have all ſwellings on their throats, called *bronchoceles.* The men are alſo very ſimple, and are rather diſpoſed to indulge in indolence. The chief town is Gratz.

STIRLING, a town of Scotland, ſituated on the river Forth, 35 miles north-weſt of Edinburgh, in W. Long. 3. 59. N. Lat. 56. 6. It is alſo called *Sterling* and *Striveling;* from the former of which Boethius falſely derives the name *Sterling money;* becauſe, ſays he, Oſbert, a Saxon prince, after the overthrow of the Scots, eſtabliſhed a mint there. The name of *Striveling* is ſaid to have been derived from the frequency of ſtrifes or conflicts in the neighbourhood. The town contains about 4000 inhabitants. It has a manufacture of tartans and ſhalloons, and employs about 30 looms in that of carpets. The great ſtreet is very broad. In it is the tolbooth, where is kept the ſtandard for the wet meaſures of Scotland. The other ſtreets are narrow and irregular.—Stirling is in miniature a reſemblance of Edinburgh; being built on a rock of the ſame form, with a fortreſs on the ſummit. The origin of the caſtle is unknown. The rock of Stirling was ſtrongly fortified by the Picts, amongſt whom architecture and ſeveral other uſeful arts had made a conſiderable progreſs. As it lay in the extremities of their kingdom, the poſſeſſion of it was the occaſion of frequent conteſts betwixt them and their neighbours the Scots and Northumbrians; each of whoſe dominions did, for ſome time, terminate near it.

When the Scots, under Kenneth II. overthrew the Pictiſh empire near the middle of the ninth century, they endeavoured to obliterate every memorial of that people. They not only gave new names to provinces and towns, but, with all the rage of barbarians, demoliſhed many magnificent and uſeful edifices which had been reared up by them, and this fortreſs among the reſt. It was, however, ſoon rebuilt, though upon an occaſion not very honourable to the Scots.

Upon the death of Kenneth II. in 855, his brother Donald V. mounted the throne of Scotland. In the beginning of his reign the kingdom was invaded by Oſbrecht and Ella, two Northumbrian princes, who, uniting their forces with the Cumbrian Britons, and a number of Picts, who upon their expulſion from their native country had taken refuge in England, advanced to Jedburgh, where Donald encountered them; and, after a fierce and bloody battle, obtained a complete victory: but, having taken up his ſtation in Berwick, in ſupine ſecurity, the Northumbrians, informed of the careleſs poſture in which the Scottiſh army lay, ſurpriſed them by a haſty march, diſperſed them, and made a priſoner of the king. Purſuing the advantage they had gained, they marched northward, and ſubdued all before them to the frith of Forth and the town of Stirling. But the forlorn ſituation of the Scots, without a king and without an army, obliging them to ſue for peace, they obtained it, upon condition that they ſhould pay a ſum of money for the ranſom of the king, and yield up all their dominions upon the ſouth ſide of the Forth to the conquerors.

The Northumbrians taking poſſeſſion of the territories ceded to them by this treaty, rebuilt the caſtle of Stirling, and planted with a ſtrong garriſon, in order to preſerve their new conqueſts, upon the frontiers of which it was ſituated. Our authorities alſo inform us, that they erected a ſtone bridge over the Forth, upon the ſummit of which a croſs was raiſed, with the following inſcription in monkiſh rhyme.

Anglos a Scotis ſeparat crux iſta remotis;
Armis hic ſtant Bruti, Scoti ſtant hic, cruce tuti.

Which is thus tranſlated by Bellenden.

I am free marche, as paſſengeris may ken,
To Scottis, to Britonis, and to Ingliſmen.

None of the ancient Engliſh hiſtorians mentions this conqueſt. The whole ſtory, as well as the inſcription, wears

wears much of a monkiſh garb; yet its authenticity is not a little confirmed by the arms of the town of Stirling, upon which is a bridge, with a croſs, and the laſt line of the above Latin diſtich is the motto round it.

We muſt not, however, imagine, that in thoſe times that fortreſs bore any reſemblance to the preſent ſtructure, which is adapted to the uſe of fire-arms. Its ſize and form probably reſembled thoſe caſtles which, under the feudal conſtitution, the Engliſh and Scottiſh barons uſed to erect upon their eſtates for dwelling-houſes; and which, in thoſe barbarous ages, they found neceſſary to fortify for their defence, not only againſt foreign invaders, but often againſt the attacks of their own neighbours. It is directly ſuch a Gothic figure as this which repreſents the *Caſtrum Strivelenſe* upon the arms of Stirling.

This fortreſs, after it had continued in the poſſeſſion of the Northumbrian Saxons about 20 years, was, together with the whole country upon the ſouth ſide of the Forth, reſtored to the Scots, upon condition of their aſſiſting the Saxons againſt their turbulent invaders the Danes. Upon the arms of Stirling are two branches of a tree, to repreſent the *Nemus Strivelenſe;* but the ſituation and boundaries of that foreſt, which was probably a wing of the Caledonian, cannot be aſcertained. Upon the ſouth of Stirling, veſtiges of a foreſt are ſtill diſcernible for ſeveral miles. Banks of natural timber ſtill remain in the caſtle park, at Murray's wood, and near Nether Bannockburn; and ſtumps of trees, with much bruſhwood, are to be ſeen in all the adjacent fields.

When Kenneth III. received intelligence of the Danes having invaded his dominions, he appointed the caſtle of Stirling to be the place of rendezvous for his army; and he marched from thence to the battle of Loncarty, where he obtained a victory over thoſe rovers, in the end of the 10th century.

In the 12th century, this caſtle is ſpoken of as a place of great importance, and one of the ſtrongeſt fortreſſes in the kingdom. In 1174, a calamity, not unuſual amongſt the Scottiſh monarchs, befel William, who at that time occupied the throne. He was taken priſoner in an unſucceſsful expedition which he made into England; and, after having been detained 12 months in captivity, was releaſed, upon ſtipulating to pay a large ſum of money for his ranſom; and, until payment thereof, delivering into the hands of the Engliſh the four principal fortreſſes in the kingdom, which in thoſe days were Stirling, Edinburgh, Roxburgh, and Berwick. This was the firſt great aſcendant that England obtained over Scotland; and indeed the moſt important tranſaction which had paſſed between theſe kingdoms from the Norman conqueſt.

Though the Scottiſh monarchs, in their frequent perambulations through the kingdom, often viſited Stirling, and held their courts for ſome time in the caſtle; yet it did not become a royal reſidence till the family of Stuart mounted the throne, and it was from different princes of this family that it received its preſent form. It was the place of the nativity of James II.; and, when raiſed to the throne, he frequently kept his court in it. It is well known to have been the place where that prince perpetrated an atrocious deed, the murder of William earl of Douglas, whom he ſtabbed with his own hand. The royal apartments were at that time in the north-weſt corner of the caſtle, and are now the reſidence of the fort-major. The room where the murder was committed ſtill goes by the name of *Douglas's room.*

James III. contracting a fondneſs for the caſtle on account of its pleaſant ſituation, made it the chief place of his reſidence, and added ſeveral embelliſhments to it. He built within it a magnificent hall, which in thoſe days was deemed a noble ſtructure, and is ſtill entire. It now goes by the name of the *parliament-houſe*, having been deſigned for the accommodation of that ſupreme court. It was covered with an oaken roof of exquiſite workmanſhip, which, though very little decayed, was a few years ago removed to make way for one of more modern ſtructure. James alſo erected a college of ſecular prieſts in the caſtle, which he called the *chapel royal*, and which proved one cauſe of his own ruin. As the expences neceſſary for maintaining the numerous officers of ſuch an inſtitution were conſiderable, he annexed to it the revenues of the rich priory of Coldingham in the Merſe, which at that time happened to become vacant. This priory had for a long time been holden by perſons connected with the family of Hume; and that family, conſidering it as belonging to them, ſtrongly oppoſed the annexation. The diſpute ſeems to have laſted ſeveral years; for one parliament had paſſed a vote, annexing the priory to the chapel-royal, and a ſubſequent one enacted a ſtatute prohibiting every attempt that was contrary or prejudicial to that annexation.

James V. was crowned in the caſtle of Stirling; and the palace, which is the chief ornament of it, was the work of that prince. This is a ſtately and commodious ſtructure, all of hewn ſtone, with much ſtatuary work upon it. It is built in form of a ſquare, with a ſmall court in the middle, in which the king's lions are ſaid to have been kept; and hence it ſtill goes by the name of the *lions den*. The palace contains many large and elegant apartments; the ground ſtory is now converted into barrack-rooms for the ſoldiers of the garriſon; the upper affords a houſe for the governor, with lodgings for ſome of the ſubaltern officers.

Oppoſite to the palace, upon the north, ſtands an elegant chapel, which was built by James VI. for the baptiſm of his ſon, Prince Henry, in 1594. In this chapel is preſerved the hulk of a large boat, which that whimſical monarch cauſed to be built and placed upon carriages, in order to convey into the caſtle the proviſions for that ſolemnity.

A ſtrong battery, with a tier of guns pointing to the bridge over the Forth, was erected during the regency of Mary of Lorraine, mother to Queen Mary. It is called the *French battery*, probably becauſe conſtructed by engineers of that nation. The laſt addition was made to the fortifications in the reign of Queen Anne. Formerly they reached no farther than the old gate, upon which the flag-ſtaff now ſtands: but in that reign they were conſiderably enlarged upon the ſide towards the town; and barracks which are bomb-proof, with ſeveral other conveniences for a ſiege were erected.

Upon the ſouth ſide of the caſtle lies a park incloſed with a ſtone wall, called the *king's park*, and near to the foot of the rock on which the caſtle ſtands, lay the royal gardens; veſtiges of the walks and parterres, with a few ſtumps of fruit trees, are ſtill viſible; but by long neglect, and the natural wetneſs of the ſoil, the place is now little better than a marſh. In the gardens is a mount of earth in form of a table, with benches of earth around it, where, according to tradition, the court ſometimes held *fetes-champetres*. In the caſtle-hill is an hollow, comprehending about an acre of ground, and having all the appearance of an artificial work, which was uſed for jouſts, tournaments, and other feats of chivalry.

Northward of the caſtle lies the Govan, or perhaps more properly the *Gowling* hill (A); in the middle of which is a ſmall mount called *Hurly Hawky*, upon which Duke Murdoch and his two ſons were executed for treaſonable practices in the reign of James I.

The proſpect from the caſtle is moſt delightful, as well as extenſive, being greatly beautified, eſpecially upon the eaſt, by the windings of the Forth; which are ſo numerous, that though the diſtance by land from Stirling to Alloa is, in a ſtraight line, not quite ſix miles, it is ſaid to be 24 by water. As this river generally runs upon plain ground, it rolls its ſtream in ſo ſlow and ſilent a manner, that what Silius Italicus ſaith of the Ticinus is applicable to it, if, inſtead of *lucenti* in that poet, we ſhould read *lutoſo*; for the clay-banks, together with the tide, which flows above Stirling, render the Forth perpetually muddy:

> *Vix credas labi, ripis tam mitis opacis*
> *Somniferam ducit* lutoſo *gurgite lympham.*

The lordſhip and caſtle of Stirling were a part of the uſual dowry of the queens of Scotland, at leaſt after the family of Stuart came to the throne, in which they were inveſted at their marriage.

Robert Lord Erſkine was appointed governor of the caſtle by King David II. and the office continued in that family till 1715.

This fortreſs hath been the ſcene of many tranſactions. Being by its ſituation conſidered as a key to the northern parts of the kingdom, the poſſeſſion of it hath been always eſteemed of great importance to thoſe who ſought to be maſters of Scotland. It was undoubtedly a place of ſtrength when the art of war by ordnance was in its infancy; but though it reſiſted the utmoſt efforts of the rebels in 1746, it could not now hold out three days if beſieged by an army of a few thouſand men conducted by an engineer of knowledge and integrity.

STIRLINGSHIRE, a county of Scotland, of which Stirling is the capital. It extends 20 miles in length and 12 in breadth; being bounded on the weſt by part of Lennox and Clydeſdale; on the eaſt, by Clackmannanſhire, the river Forth, and part of Lothian; on the ſouth-eaſt by Lothian; and on the north by Monteith. The face of the country is open and agreeable, diverſified by hill and dale, well watered with ſtreams and rivers, the principal of which is the Forth, riſing in the neighbourhood of a high mountain called *Ben-Lomond*, and, running eaſtward, forms the frith of Edinburgh. The ſouthern part is hilly, affording plenty of game, and paſturage for ſheep, horſes, and black cattle. The eaſtern part is fertile, producing plentiful harveſts of corn, and great abundance of coal. Lead-ore is found in different parts of the county; and the rivers abound with pike, trout, and ſalmon.

The population of this county at two different periods, and according to the different pariſhes, will be ſeen in the following table:

Pariſhes.	Population in 1755.	Population in 1790--1798.
Airth	2316	2350
Alva	436	612
Baldernock	621	620
Balfron	755	1381
5 Bothkennar	529	600
Buchanan	1699	1111
Campſie	1399	2517
Denny	1392	1400
Drymen	2789	1607
10 Falkirk	3932	8020
Fintry	891	543
Gargunnock	956	830
Killearn	959	973
Kilſyth	1395	2450
15 Kippen	1799	1777
Larbert and Dunipace	1864	4000
Muiravonſide	1539	1065
Polmont	1094	1400
St Ninians	6491	7079
20 Slamannan	1209	1010
Stirling	3951	4698
Strathblane	797	620
	38,813	46,663
		38,813
	Increaſe,	7850*

* Statiſt. Hiſt. of Scotland.

STIRRUP, in the manege, a reſt or ſupport for the horſeman's foot, for enabling him to mount, and for keeping him firm in his ſeat.

Stirrups were unknown to the ancients. The want of them in getting upon horſeback was ſupplied by agility or art. Some horſes were taught to ſtoop to take their riders up; but the riders often leapt up by the help of their ſpears, or were aſſiſted by their ſlaves, or made uſe of ladders for the purpoſe. Gracchus filled the highways with ſtones, which were intended to anſwer the ſame end. The ſame was alſo required of the ſurveyors of the roads in Greece as part of their duty.

Menage obſerves, that St Jerome is the firſt author who mentions them. But the paſſage alluded to is not to be found in his epiſtles; and if it were there, it would prove nothing, becauſe St Jerome lived at a time when ſtirrups are ſuppoſed to have been invented, and after the uſe of ſaddles. Montfaucon denies the authenticity of this paſſage; and, in order to account for the ignorance of the ancients with regard to an inſtrument ſo uſeful and ſo eaſy of invention, he obſerves, that while cloths and houſings only were laid upon the horſes backs, on which the riders were to ſit, ſtirrups could not have been uſed, becauſe they could not have been faſtened with the ſame ſecurity as upon a ſaddle. But it is more

Berenger's Hiſtory and Art of Horſemanſhip, vol. i. p. 65.

(A) So called from the wailings and lamentations (in Scotch, *gowlings*) that were made for Duke Murdoch.

more probable, that in this inſtance, as in many others, the progreſs of human genius and invention is uncertain and ſlow, depending frequently upon accidental cauſes.

STIRRUP of a Ship, a piece of timber put upon a ſhip's keel, when ſome of her keel happens to be beaten off, and they cannot come conveniently to put or fit in a new piece; then they patch in a piece of timber, and bind it on with an iron, which goes under the ſhip's keel, and comes up on each ſide of the ſhip, where it is nailed ſtrongly with ſpikes; and this they call a ſtirrup.

STOBÆUS, John, a laborious Greek writer, who lived at the end of the fourth century, compoſed many works, of which there are only his Collections remaining, and even theſe are not as he compoſed them; many things being inſerted by later authors. This work contains many important ſentiments collected from the ancient writers, poets, and philoſophers.

STOCK, in gardening, &c. the ſtem or trunk of a tree. What ſtock is moſt proper for each kind of fruit, ought as well to be conſidered and known, as what ſoil is moſt ſuitable to trees; for on theſe two things the future vigour of trees, and the goodneſs of fruit, equally depend. The beſt way for thoſe who intend to plant, is to raiſe their own ſtocks, by which they will be better aſſured of what they do; but if they ſhould buy their trees of nurſerymen, they ſhould diligently inquire upon what ſtocks they were propagated. See GRAFTING.

STOCK, in trade. See *CAPITAL Stock*.

STOCK-Broker. See BROKER and STOCKS.

STOCK-Dove. See COLUMBA, ORNITHOLOGY *Index*.

STOCK-Jobbing, the art or myſtery of trafficking in the public ſtocks or funds. See FUND and *Stock-JOBBING*.

STOCK Gilly-flower. See CHEIRANTHUS, BOTANY *Index*.

STOCKHOLM, the capital of Sweden, is ſituated in the province of Upland, in E. Long. 19. 30. and N. Lat. 59. 20. Its foundation is by the beſt Swediſh writers generally attributed to Birger Jarl, regent of the kingdom about the middle of the 13th century during the minority of his ſon Waldemar, who had been raiſed to the throne by the ſtates of the kingdom; but it was not before the 18th century that the royal reſidence was transferred from Upſala to this city.

This capital, which is very long and irregular, occupies, beſide two peninſulas, ſeven ſmall rocky iſlands, ſcattered in the Mæler, in the ſtreams which iſſue from that lake, and in a bay of the gulf of Bothnia. A variety of contraſted and enchanting views are formed by numberleſs rocks of granite riſing boldly from the ſurface of the water, partly bare and craggy, partly dotted with houſes, or feathered with wood. The harbour is an inlet of the Baltic: the water is clear as cryſtal, and of ſuch depth that ſhips of the largeſt burthen can approach the quay, which is of conſiderable breadth, and lined with ſpacious buildings and warehouſes. At the extremity of the harbour ſeveral ſtreets riſe one above another in the form of an amphitheatre; and the palace, a magnificent building, crowns the ſummit. Towards the ſea, about two or three miles from the town, the harbour is contracted into a narrow ſtrait. and, winding among high rocks, diſappears from the ſight; and the proſpect is terminated by diſtant hills, overſpread with foreſts. It is far beyond the power of words, or of the pencil, to delineate theſe ſingular views. The central iſland, from which the city derives its name, and the Ritterholm, are the handſomeſt parts of the town. Excepting in the ſuburbs, where the houſes are of wood painted red, the generality of the buildings are of ſtone, or brick ſtuccoed white. The royal palace, which ſtands in the centre of Stockholm, and upon the higheſt ſpot of ground, was begun by Charles XI.: it is a large quadrangular ſtone edifice, and the ſtyle of architecture is both elegant and magnificent.

Coxe's Travels, vol. ii

It is the habitation not only of the royal family, but alſo of the greater part of the officers belonging to the houſehold. It likewiſe comprehends the national or ſupreme court of juſtice, the colleges of war, chancery, treaſury, and commerce; a chapel, armoury, library, and office for the public records; but the greater number of inferior officers and ſervants belonging to the court, are, with the foot-guards, quartered on the burghers. The caſtle, and all the ſtately edifices in the kingdom, are covered with copper. The palace of the nobility, in which this order ſits during the ſeſſion of the diet, is an elegant building, adorned on the outſide with marble ſtatues and columns, and on the inſide with painting and ſculpture. This and three other palaces ſtand on the banks of the lake, and are built on the ſame model, ſo as to compoſe an uniform piece of architecture. The bank, built at the expence of the city, is a noble edifice, and joins with many ſumptuous houſes belonging to the nobility in exhibiting a ſplendid appearance. The houſes of the burghers are generally built of brick in the city; but in the ſuburbs they are commonly made up of timber, and therefore very ſubject to conflagrations. Theſe houſes are often framed in Finland, according to the plan and dimenſions preſcribed: whence they are tranſported in pieces to Stockholm by water, and there ſet up by the carpenters. Theſe wooden habitations, if kept in proper repair, will laſt 30 or 40 years, and are deemed warmer, neater, and more healthy, than thoſe of brick or ſtone. To prevent the danger of conflagrations, the city is divided into 12 wards. In each of theſe there is a maſter and four aſſiſtants, who forthwith repair to the place where the fire breaks out; and all porters and labourers are obliged to range themſelves under the maſter of the ward to which they belong. A fire-watch patroles the ſtreets by night, to give warning or aſſiſtance as it may be wanted; and a centinel is maintained in the ſteeple of every church, to toll the bell on the firſt appearance of any ſuch accident. The police of Stockholm is entirely ſubjected to the regulations of the grand governor, aſſiſted by a deputy and bailiff of the caſtle. This city is the emporium of Sweden, to which all the commodities of the kingdom are brought for exportation, and where almoſt all the imports from abroad are depoſited. The port or haven formed by the lake Mæler is large enough to contain 1000 ſail of ſhipping; and furniſhed with a key or wharf about an Engliſh mile in length, to which the veſſels may lie with their broadſides. The greateſt inconveniences attending this ſituation are, the diſtance from the ſea, which is not within leſs than 10 miles of the town; the want of tides; and the winding of the river, which is remarkably crooked. It opens into the Baltic; and the entrance, which is dangerous and rocky, the Swedes have ſecured with two ſmall forts: within, it is perfectly ſafe and commodious.

dious. The northern ſuburbs are remarkable for the king's gardens, and for the great number of artiſans who have choſen their habitations in this quarter. In the ſouthern ſuburbs the Muſcovite commodities are ſold; and here is a magnificent exchange where the merchants daily aſſemble. Population 80,000.

STOCKING, that part of the clothing of the leg and foot which immediately covers and ſcreens them from the rigour of the cold. Anciently, the only ſtockings in uſe were made of cloth, or of milled ſtuffs ſewed together; but ſince the invention of knitting and weaving ſtockings of ſilk, wool, cotton, thread, &c. the uſe of cloth ſtockings is quite diſcontinued. Dr Howel, in his Hiſtory of the World (vol. ii. p. 222.) relates, that Queen Elizabeth, in 1501, was preſented with a pair of black knit ſilk ſtockings by her ſilk-woman, and thenceforth ſhe never wore cloth ones any more. The ſame author adds, that King Henry VIII. ordinarily wore cloth hoſe, except there came from Spain, by great chance, a pair of ſilk ſtockings. His ſon, King Edward VI. was preſented with a pair of long Spaniſh ſilk ſtockings by Sir Thomas Greſham, and the preſent was then much taken notice of. Hence it ſhould ſeem, that the invention of ſilk knit ſtockings originally came from Spain. Others relate, that one William Rider, an apprentice on London bridge, ſeeing at the houſe of an Italian merchant a pair of knit worſted ſtockings from Mantua, took the hint, and made a pair exactly like them, which he preſented to William earl of Pembroke, and that they were the firſt of that kind worn in England, anno 1564.

The modern ſtockings, whether woven or knit, are formed of an infinite number of little knots, called *ſtitches*, *loops*, or *meſhes*, intermingled in one another.

Knit ſtockings are wrought with needles made of poliſhed iron or braſs wire, which interweave the threads and form the meſhes the ſtocking conſiſts of. At what time the art of knitting was invented it is perhaps impoſſible to determine, though it has been uſually attributed to the Scots, as it is ſaid that the firſt works of this kind came from Scotland. It is added, that it was on this account that the company of ſtocking-knitters, eſtabliſhed at Paris 1527, took for their patron St Fiacre, who is ſaid to have been the ſon of a king of Scotland. But it is moſt probable that the method of knitting ſtockings by wires or needles was firſt brought from Spain.

Woven ſtockings are generally very fine; they are manufactured on a frame or machine made of poliſhed iron, the ſtructure of which it is needleſs to deſcribe, as it may be ſeen in almoſt every conſiderable town in Great Britain. The invention of this machine is, by Mr Anderſon, attributed to William Lee, M. A. of St John's College, Cambridge, at a period ſo early as 1589. Others have given the credit of this invention to a ſtudent of Oxford at a much later period, who, it is ſaid by Aaron Hill *, was driven to it by dire neceſſity. This young man, falling in love with an innkeeper's daughter, married her though ſhe had not a penny, and he by his marriage loſt a fellowſhip. They ſoon fell into extreme poverty; and their marriage producing the conſequences naturally to be expected from it, the amorous pair became miſerable, not ſo much on account of their ſufferings, as from the melancholy dread of what would become of their yet unborn infant. Their only means of ſupport were the knitting of ſtockings, at which the woman was very expert: "But ſitting conſtantly together from morning to night, and the ſcholar often fixing his eyes, with ſtedfaſt obſervation, on the motion of his wife's fingers in the dexterous management of her needles, he took it into his imagination, that it was not impoſſible to contrive a little loom which might do the work with much more expedition. This thought he communicated to his wife, and joining his head to her hands, the endeavour ſucceeded to their wiſh. Thus the ingenious ſtocking-loom, which is ſo common now, was firſt invented; by which he did not only make himſelf and his family happy, but has left his nation indebted to him for a benefit which enables us to export ſilk ſtockings in great quantities, and to a vaſt advantage, to thoſe very countries from whence before we uſed to bring them at conſiderable loſs in the balance of our traffic."

STOCKS, *or* PUBLIC FUNDS *in England*. By the word *ſtock* was originally meant a particular ſum of money contributed to the eſtabliſhing a fund to enable a company to carry on a certain trade, by means of which the perſon became a partner in that trade, and received a ſhare of the profit made thereby, in proportion to the money employed But this term has been extended farther, though improperly, to ſignify any ſum of money which has been lent to the government, on condition of receiving a certain intereſt till the money is repaid, and which makes a part of the national debt. As the ſecurity both of the government and of the public companies is eſteemed preferable to that of any private perſon, as the ſtocks are negociable and may be ſold at any time, and as the intereſt is always punctually paid when due; ſo they are thereby enabled to borrow money on a lower intereſt than what could be obtained from lending it to private perſons, where there muſt be always ſome danger of loſing both principal and intereſt.

But as every capital ſtock or fund of a company is raiſed for a particular purpoſe, and limited by parliament to a certain ſum, it neceſſarily follows, that when that fund is completed, no ſtock can be bought of the company; though ſhares already purchaſed may be transferred from one perſon to another. This being the caſe, there is frequently a great diſproportion between the original value of the ſhares and what is given for them when transferred: for if there are more buyers than ſellers, a perſon who is indifferent about ſelling will not part with his ſhare without a conſiderable profit to himſelf; and on the contrary, if many are diſpoſed to ſell, and few inclined to buy, the value of ſuch ſhares will naturally fall in proportion to the impatience of thoſe who want to turn their ſtock into ſpecie.

A ſtock may likewiſe be affected by the court of chancery: for if that court ſhould order the money, which is under their direction, to be laid out in any particular ſtock, that ſtock, by having more purchaſers, will be raiſed to a higher price than any other of the like value.

By what has been ſaid, the reader will perceive how much the credit and intereſt of the nation depends on the ſupport of the public funds. While the annuities and intereſt for money advanced is there regularly paid, and the principal inſured by both prince and people (a ſecurity

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* See *An Account of the Riſe and Progreſs of the Beech Oil Invention*, &c. 8vo. 1715.

ſecurity not to be had in other nations), foreigners will lend us their property, and all Europe be intereſted in our welfare; the paper of the companies will be converted into money and merchandiſe, and Great Britain can never want caſh to carry her ſchemes into execution. See the article Fund.

Stocks, a frame erected on the ſhore of a river or harbour, whereon to build ſhipping. It generally conſiſts of a number of wooden blocks, ranged parallel to each other at convenient diſtances, and with a gradual declivity towards the water.

Stocks, a wooden machine to put the legs of offenders in, for ſecuring diſorderly perſons, and by way of puniſhment in divers caſes, ordained by ſtatute, &c.

STOCKTON upon Tees, a handſome town in the county of Durham, about 16 miles ſouth of the city of Durham. It is now a port of conſiderable trade; though, at the reſtoration, it was a deſpicable village, the beſt houſe in which could hardly boaſt of any thing better than clay-walls and a thatched roof. About 40 years ago it ſent out in one year 75 veſſels for the port of London; and the trade is much increaſed ſince.

STOEBE, Bastard Æthiopian, a genus of plants belonging to the claſs ſyngeneſia; and in the natural ſyſtem ranging under the 49th order, *Compoſitæ*. See Botany *Index*.

STOKESIA, a genus of plants belonging to the ſyngeneſia claſs, and order of polygamia æqualis. The corollets in the ray are diſpoſed in the ſhape of a funnel, and are long and irregular. The down is four-briſtled, and the receptacle is naked. One ſpecies only is known, which is a herbaceous plant, and a native of South Carolina.

STOICS, the name given to a ſect of Grecian philoſophers, from Στοα, "the porch in Athens," which the founder of the ſect choſe for his ſchool. For the peculiar tenets of this ſect, ſee Metaphysics, Chap. iv. Part 3. Moral Philosophy, N° 8. and Zeno.

STOLBERG, a ſmall town of Germany, in the circle of Upper Saxony, and territory of Thuringia, of which it is the capital place. It is ſituated between two mountains, 50 miles north-weſt of Leipſic. E. Long. 11. 8. N. Lat. 51. 42.

STOLE, a ſacerdotal ornament worn by the Romiſh pariſh prieſts above their ſurplice, as a mark of ſuperiority in their reſpective churches; and by other prieſts over the alb, at celebrating of maſs, in which caſe it goes acroſs the ſtomach; and by deacons, over the left ſhoulder, ſcarf-wiſe: when the prieſt reads the goſpel for any one, he lays the bottom of his ſtole on his head. The ſtole is a broad ſwath, or ſlip of ſtuff, hanging from the neck to the feet, with three croſſes thereon.

Groom of the Stole, the eldeſt gentleman of his Majeſty's bedchamber, whoſe office it is to preſent and put on his Majeſty's firſt garment, or ſhirt, every morning, and to order the things in the chamber.

STOMACH, in *Anatomy*. See Anatomy, N° 91.

STOMACHIC medicines are ſuch as ſtrengthen the ſtomach and promote digeſtion, &c.

Stomachic corroboratives are ſuch as ſtrengthen the tone of the ſtomach and inteſtines; among which are carminatives, as the roots of galangals, red gentian, zedoary, pimpinella, calamus aromaticus, and arum. Of barks and rinds, thoſe of canella alba, ſaſſafras, citrons, Seville and China oranges, &c. Of ſpices, pepper, ginger, cloves, cinnamon, cardamums, and mace.

STOMOXYS, a genus of inſects belonging to the order of diptera. See Entomology, p. 214.

STONE, Edmund, a diſtinguiſhed ſelf-taught mathematician, was born in Scotland; but neither the place nor the time of his birth is well known; nor have we any memoirs of his life, except a letter from the Chevalier de Ramſay, author of the Travels of Cyrus, in a letter to Father Caſtel, a Jeſuit at Paris, and publiſhed in the Memoirs de Trevoux, p. 109, as follows: "True genius overcomes all the diſadvantages of birth, fortune, and education; of which Mr Stone is a rare example. Born a ſon of a gardener of the duke of Argyle, he arrived at eight years of age before he learnt to read.—By chance a ſervant having taught young Stone the letters of the alphabet, there needed nothing more to diſcover and expand his genius. He applied himſelf to ſtudy, and he arrived at the knowledge of the moſt ſublime geometry and analyſis, without a maſter, without a conductor, without any other guide but pure genius.

"At 18 years of age he had made theſe conſiderable advances without being known, and without knowing himſelf the prodigies of his acquiſitions. The duke of Argyle, who joined to his military talents a general knowledge of every ſcience that adorns the mind of a man of his rank, walking one day in his garden, ſaw lying on the graſs a Latin copy of Sir Iſaac Newton's celebrated *Principia*. He called ſome one to him to take and carry it back to his library. Our young gardener told him that the book belonged to him. 'To you?' replied the duke. 'Do you underſtand geometry, Latin, Newton?' I know a little of them, replied the young man with an air of ſimplicity ariſing from a profound ignorance of his own knowledge and talents. The duke was ſurpriſed; and having a taſte for the ſciences, he entered into a converſation with the young mathematician: he aſked him ſeveral queſtions, and was aſtoniſhed at the force, the accuracy, and the candour of his anſwers. 'But how (ſaid the duke) came you by the knowledge of all theſe things?' Stone replied, 'A ſervant taught me, ten years ſince, to read: Does one need to know any thing more than the 24 letters in order to learn every thing elſe that one wiſhes?' The duke's curioſity redoubled—he ſat down upon a bank, and requeſted a detail of all his proceedings in becoming ſo learned.

"I firſt learned to read, ſaid Stone: the maſons were then at work upon your houſe: I went near them one day, and I ſaw that the architect uſed a rule, compaſſes, and that he made calculations. I inquired what might be the meaning and uſe of theſe things; and I was informed that there was a ſcience called Arithmetic: I purchaſed a book of arithmetic, and I learned it.—I was told there was another ſcience called Geometry: I bought the books, and I learnt geometry. By reading I found that there were good books in theſe two ſciences in Latin: I bought a dictionary, and I learned Latin. I underſtood alſo that there were good books of the ſame kind in French: I bought a dictionary, and I learned French. And this, my lord, is what I have done: it ſeems to me that we may learn every thing when we know the 24 letters of the alphabet."

"This account charmed the Duke. He drew this wonderful

wonderful genius out of his obſcurity; and he provided him with an employment which left him plenty of time to apply himſelf to the ſciences. He diſcovered in him alſo the ſame genius for muſic, for painting, for architecture, for all the ſciences which depend on calculations and proportions."

" I have ſeen Mr Stone. He is a man of great ſimplicity. He is at preſent ſenſible of his own knowledge; but he is not puffed up with it. He is poſſeſſed with a pure and diſintereſted love for the mathematics, though he is not ſolicitous to paſs for a mathematician; vanity having no part in the great labour he ſuſtains to excel in that ſcience. He deſpiſes fortune alſo; and he has ſolicited me twenty times to requeſt the duke to give him leſs employment, which may not be worth the half of that he now has, in order to be more retired, and leſs taken off from his favourite ſtudies. He diſcovers ſometimes, by methods of his own, truths which others have diſcovered before him. He is charmed to find on theſe occaſions that he is not a firſt inventor, and that others have made a greater progreſs than he thought. Far from being a plagiary, he attributes ingenious ſolutions, which he gives to certain problems, to the hints he has found in others, although the connection is but very diſtant," &c.

Mr Stone was author and tranſlator of ſeveral uſeful works; viz. 1. A New Mathematical Dictionary, in 1 vol. 8vo, firſt printed in 1726. 2. Fluxions, in 1 vol. 8vo, 1730. The Direct Method is a tranſlation from the French, of Hoſpital's Analyſe des Infiniments Petits; and the Inverſe Method was ſupplied by Stone himſelf. 3. The Elements of Euclid, in 2 vols. 8vo, 1731. A neat and uſeful edition of thoſe Elements, with an account of the life and writings of Euclid, and a defence of his Elements againſt modern objectors. Beſide other ſmaller works. Stone was a fellow of the Royal Society, and had inſerted in the Philoſophical Tranſactions (vol. xli. p. 218.), an " Account of two ſpecies of lines of the 3d order, not mentioned by Sir Iſaac Newton or Mr Stirling."

STONE, *Jerome*, the ſon of a reputable ſeaman, was born in the pariſh of Scoonie, in the county of Fife, North Britain. His father died abroad when he was but three years of age, and his mother, with her young family, was left in very narrow circumſtances. Jerome, like the reſt of the children, having got the ordinary ſchool education, reading Engliſh, writing, and arithmetic, betook himſelf to the buſineſs of a travelling chapman. But the dealing in buckles, garters, and ſuch ſmall articles, not ſuiting his ſuperior genius, he ſoon converted his little ſtock into books, and for ſome years went through the country, and attended the fairs as an itinerant bookſeller. There is great reaſon to believe that he engaged in this new ſpecies of traffic, more with a view to the improvement of his mind than for any pecuniary emolument. Formed by nature for literature, he poſſeſſed a peculiar talent for acquiring languages with amazing facility. Whether from a deſire to underſtand the Scriptures in their original languages, or from being informed that theſe languages are the parents of many others, he began his philological purſuits with the ſtudy of the Hebrew and Greek tongues; and, by a wonderful effort of genius and application, made himſelf ſo far maſter of theſe, without any kind of aſſiſtance, as to be able to interpret the Hebrew bible and Greek Teſtament into Engliſh *ad aperturam libri*. At this time he did not know one word of Latin. Senſible that he could make no great progreſs in learning, without the knowledge of at leaſt the grammar of that language, he made application to the pariſh ſchoolmaſter for his aſſiſtance. Some time afterwards, he was encouraged to proſecute his ſtudies at the univerſity of St Andrews. An unexampled proficiency in every branch of literature recommended him to the eſteem of the profeſſors; and an uncommon fund of wit and pleaſantry rendered him, at the ſame time, the favourite of all his fellow ſtudents, ſome of whom ſpeak of him to this day with an enthuſiaſtic degree of admiration and reſpect. About this period ſome very humorous poetical pieces of his compoſition were publiſhed in the Scots Magazine. Before he had finiſhed his third ſeſſion, or term, at St Andrew's, on an application to the college by the maſter of the ſchool of Dunkeld for an uſher, Mr Stone was recommended as the beſt qualified for that office; and about two or three years after, the maſter being removed to Perth, Mr Stone, by the favour of his Grace the Duke of Atholl, who had conceived a high opinion of his abilities, was appointed his ſucceſſor.

When he firſt went to Dunkeld, he entertained but an unfavourable opinion of the Gaelic language, which he conſidered as nothing better than a barbarous inarticulate gibberiſh; but being bent on inveſtigating the origin and deſcent of the ancient Scots, he ſuffered not his prejudices to make him neglect the ſtudy of their primitive tongue. Having, with his uſual aſſiduity and ſucceſs, maſtered the grammatical difficulties which he encountered, he ſet himſelf to diſcover ſomething of the true genius and character of the language. He collected a number of ancient poems, the production of Iriſh or Scottiſh bards, which, he ſaid, were daring, innocent, paſſionate, and bold. Some of theſe poems were tranſlated into Engliſh verſe, which ſeveral perſons now alive have ſeen in manuſcript, before Mr Macpherſon publiſhed any of his tranſlations from Oſſian.

He died while he was writing and preparing for the preſs a treatiſe, intitled, " An Inquiry into the Original of the Nation and Language of the ancient Scots, with Conjectures about the Primitive State of the Celtic and other European Nations;" an idea which could not have been conceived by an ordinary genius. In this treatiſe he proves that the Scots drew their original, as well as their language, from the ancient Gauls. Had Mr Stone lived to finiſh this work, which diſcovers great ingenuity, immenſe reading, and indefatigable induſtry, it would have thrown light upon the dark and early periods of the Scottiſh hiſtory, as he opens a new and plain path for leading us through the unexplored labyrinths of antiquity. But a fever put an end to his life, his labours, and his uſefulneſs, in the year 1757, being then only in the 30th year of his age. He left, in manuſcript, a much eſteemed and well-known allegory, intitled, " The Immortality of Authors," which has been publiſhed and often reprinted ſince his death, and will be a laſting monument of a lively fancy, ſound judgement, and correct taſte. It was no ſmall ornament of this extraordinary character, that he paid a pious regard to his aged mother, who ſurvived him two years, and received an annual penſion from the Ducheſs of Atholl as a teſtimony of reſpect to the memory of her ſon.

Stonehive, Stones.

Stones.

STONEHIVE, or STONEHAVEN, a ſmall town in the county of Kincardine, in Scotland, 15 miles ſouth from Aberdeen. It was built in the time of Charles II. and ſtands at the foot of ſome high cliffs, in a ſmall bay, with a rocky bottom, opening a little in one part, ſo that ſmall veſſels may find admittance, but only at high water. A pier runs out from the harbour on the north ſide to ſecure them after their entrance. The town contains about 800 inhabitants. The manufactures are ſail-cloths and oſnaburghs, knit worſted and thread ſtockings.

STONES, in *Natural Hiſtory*, have been defined bodies which are inſipid, not ductile, nor inflammable, nor ſoluble in water. For a view of the claſſification of ſtones, and of their diſtribution, ſee MINERALOGY and GEOLOGY.

Here we ſhall make a few obſervations on ſome ſpeculative diſcuſſions relative to their natural hiſtory.

As philoſophers have perplexed themſelves much about the origin and formation of the earth (a ſubject certainly far beyond the ken of the human intellect, at leaſt if we believe that it was made by the almighty power of God), ſo they have alſo propoſed theories to explain the origin of ſtones. When philoſophers limit their inquiries within the boundaries of ſcience, where they are led by the ſober and ſafe conduct of obſervation and experiment, their concluſions may be ſolid and may be uſeful; but when, throwing experiment and obſervation aſide, they rear a theory upon an airy nothing, or upon a ſingle detached fact, their theories will vaniſh before the touch of true philoſophy as a romantic palace before the rod of the enchanter. Sometimes from whim, or caprice, or vanity, they attempt to confound every thing: they wiſh to prove that the ſoul is mere matter, that plants are animals, and that foſſils are plants, and thus would baniſh two ſubſtances, ſpirit and dead matter, entirely from the world; as if the Author of Nature were actuated by ſordid views of parſimony in the works of creation, though we evidently ſee that a generous profuſion is one of the characteriſtic marks of theſe works. We leave the taſk of confounding the different claſſes of being to thoſe philoſophers whoſe minds are too contracted to comprehend a great variety of being at one view, or who prefer novelty to every thing elſe. We content ourſelves with the old opinion, that the ſoul is a ſpiritual ſubſtance; that plants are plants, and that ſtones are ſtones.

We have been led into theſe remarks by finding that ſome philoſophers ſay that ſtones are vegetables; that they grow and increaſe in ſize like a plant. This theory, we believe, was firſt offered to the world by M. Tournefort, in the year 1702, after returning from his travels in the eaſt. It was founded on a curious fact. In ſurveying the labyrinth of Crete, he obſerved that the names which viſitors had engraved upon the rock were not formed of hollow but of prominent letters like baſſo relievos. He ſuppoſes that theſe letters were at firſt hollowed out by knives; that the hollows have ſince been filled up by the growth of the ſtone; and hence he concludes that ſtones vegetate. We wiſh we were fully aſſured of the fact that the letters were at firſt hollowed, before we attempt to account for their prominency. But even allowing the ſuppoſition to be true that they were at firſt hollow, we reply it is only a ſingle fact, and that it is altogether unphiloſophical to deduce a general ſyſtem from a ſingle fact.

In the *ſecond* place, this protuberancy of the characters is very improperly called vegetation, for it is not produced by a proceſs in any reſpect like the vegetation of a plant. Vegetation ſuppoſes veſſels containing fluids and growth by expanſion; but who ever heard of veſſels in a ſtone, of fluids moving in them, or of the different parts expanding and ſwelling like the branch or trunk of a tree? Even the fact which Tournefort mentions proves nothing. He does not pretend to ſay, that the rock itſelf is increaſing, but only that a few ſmall hollows are filled with new ſtony matter, which riſes a little above the ſurrounding ſurface of the rock. This matter evidently has been once liquid, and at length has congealed in the channel into which it had run. But is not this eaſily explained by a common proceſs, the formation of ſtalactites? When water charged with calcareous matter is expoſed to the action of air, the water evaporates, and leaves the calcareous earth behind, which hardens and becomes like a ſtone.

Having thus examined the principal fact upon which M. Tournefort founds his theory, it is unneceſſary to follow him minutely through the reſt of his ſubject.—He compares the accretion of matter in the labyrinth to the conſolidation of a bone when broken, by a callus formed of the extravaſated nutritious juice. This obſervation is thought to be confirmed, by finding that the projecting matter of the letters is whitiſh and the rock itſelf grayiſh. But it is eaſy to find compariſons. The difficulty, as Pope ſays, is to apply them. The reſemblance between the filling up of the hollow of a ſtone, and the conſolidation of a broken bone by a callus, we confeſs ourſelves not philoſophers enough to ſee. Were we writing poetry in bad taſte, perhaps it might appear. The circumſtance, that the prominent matter of the letters is whitiſh, while the rock is grayiſh, we flatter ourſelves ſtrengthens our ſuppoſition that it conſiſts of a depoſition of calcareous matter. Upon the whole, we conclude, we hope logically, that no ſuch theory as this, that ſtones are vegetables, can be drawn from the ſuppoſed fact reſpecting the labyrinth. We have to regret, that the account which we have ſeen of the ſubject is ſo imperfect, that we have not ſufficient materials for a proper inveſtigation. Tournefort has not even told us of what kind of ſtone or earth the accretion conſiſts; yet this ſingle information would probably have decided the queſtion (A).

(A) To give a more diſtinct notion of Tournefort's theory, we ſhall ſubjoin his concluſions: From theſe obſervations (he ſays) it follows, that there are ſtones which grow in the quarries, and of conſequence that are fed; that the ſame juice which nouriſhes them ſerves to rejoin their parts when broken; juſt as in the bones of animals, and the branches of trees, when kept up by bandages; and, in a word, that they vegetate. There is, then (he ſays), no room to doubt but that they are organized; or that they draw their nutritious juice from

STONES AND EARTHS, ANALYSIS OF.

Preliminary Proceſſes.

AT the cloſe of our article MINERALOGY, we referred to this place for an account of the method of examining the chemical conſtitution of earths and ſtones. In the article ORES, we have given a pretty full detail of the method of analyſing that claſs of minerals. In this place we propoſe briefly to point out the moſt improved proceſſes for the analyſis of the other three claſſes of mineral bodies, viz. earths and ſtones, ſalts, and combuſtibles; to which we ſhall add ſome account of the method of examining ſoils.

But before proceeding to the immediate object of this treatiſe, it may be uſeful to make ſome obſervations on ſome preliminary proceſſes connected with the ſubject under conſideration.

In the firſt place, it is neceſſary that the mineral to be examined be reduced to a fine powder. To effect this with very hard ſtones, they are made red hot, and in this ſtate thrown into cold water. By the ſudden change of temperature in the different parts of the ſtone, it cracks, and falls to pieces. If the pieces be not ſufficiently ſmall, the ſame proceſs is to be repeated. The fragments are then to be reduced to ſmaller pieces in a poliſhed ſteel mortar, and the cavity of this mortar ought to be cylindrical. A peſtle of the ſame metal ſhould be made to fit it exactly, that no part of the ſtone may eſcape during the operation of pounding. The ſtone being in this way reduced to powder, a determinate quantity is taken, 100 or 200 grains, for example, and this is to be reduced to as fine a powder as poſſible; or, as it is called, to an impalpable powder. This operation is moſt ſucceſsfully performed in an agate mortar, with a peſtle of the ſame mineral; a mortar of about four inches in diameter, and rather more than one inch deep, is found to anſwer the purpoſe very well. It is found moſt convenient to operate on ſmall quantities only at a time; not more than five or ſix grains. When the powder feels ſoft, adheres, and appears under the peſtle in the form of a cake, it is then as fine as poſſible. It is now to be accurately weighed, and it is uſually found to have acquired ſome additional weight, ariſing from part of the mortar being worn off during the pounding. This additional weight muſt be attended to, and after the analyſis is completed, a part of the ſubſtance of the mortar muſt be ſubtracted. In the caſe of an agate or flint mortar being uſed, the portion rubbed off, which increaſes the weight, may be regarded as pure ſiliceous earth.

The chemical veſſels neceſſary for the analyſis of minerals are crucibles for expoſing the ſubſtances to heat, glaſſes and ſhallow diſhes for ſolutions and evaporations. The crucibles ſhould be of platina or pure ſilver, and of ſuch a capacity as to hold from ſeven to eight cubic inches of water. The veſſels in which the ſolutions, evaporations, and other proceſſes are performed, ſhould be of glaſs or porcelain; the glaſs veſſels, as being more brittle, and therefore more apt to break, are found to be leſs economical than thoſe of porcelain. Some chemiſts employ porcelain veſſels which are in the form of ſections of ſpheres, and are glazed both in the inſide and outſide, excepting part of the bottom, which comes into immediate contact with the fire. Wedgewood's glazed veſſels for evaporations, are found to anſwer very well; the glaze is thin, and the veſſels are not very apt to crack; but it is ſuppoſed by ſome chemiſts, that it is occaſionally acted on by ſtrong acids. It is ſcarcely neceſſary to add, that an accurate balance is a neceſſary instrument in the hands of the analyſt.

I. *Of the Analyſis of* EARTHS *and* STONES.

The ingredients which have been diſcovered by means of analyſis, in the compoſition of ſimple ſtones are ſilica, alumina, lime, magneſia, zirconia, and glucina, with ſome of the metallic oxides, as thoſe of iron, copper, manganeſe, chromium, and nickel; but it never happens that the whole of theſe ſubſtances are found in combination; and indeed it is a rare circumſtance to meet with more than four or five in the ſame ſtone. With a view of diſcovering the different ſubſtances which enter into the compoſition of ſtones, the following method is recommended.

Take 200 grains of the ſtone to be examined, or, if it be inconvenient to procure this quantity, 100 grains will be ſufficient. Let it be reduced to a fine powder, mixed with three times its weight of pure potaſh, and a ſmall portion of water, and then ſubjected to heat in a crucible of ſilver. The heat muſt be applied ſlowly at firſt, and the matter is to be conſtantly ſtirred, that no part of it may be thrown out of the crucible by the ſwelling of the potaſh. The water being evaporated, the mixture is to be kept at a red heat for half an hour; and being removed from the furnace, ſome notion may be formed of the nature of the ingredients, by examining the contents; for, if the mixture be in a liquid ſtate, the ſtone is chiefly compoſed of ſiliceous earth; if it be of the conſiſtence of paſte, and have an opaque appearance,

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the earth. This juice muſt be firſt filtrated and prepared in their ſurface, which may be here eſteemed as a kind of bark; and hence it muſt be conveyed to all the other parts. It is highly probable the juice which filled the cavities of the letters was brought thither from the bottom of the roots; nor is there any more difficulty in conceiving this than in comprehending how the ſap ſhould paſs from the roots of our largeſt oaks to the very extremities of their higheſt branches. Some ſtones, then (he concludes), muſt be allowed to vegetate and grow like plants: but this is not all; he adds, that probably they are generated in the ſame manner; at leaſt, that there are abundance of ſtones whoſe generation is inconceivable, without ſuppoſing that they come from a kind of ſeeds, wherein the organical parts of the ſtones are wrapped up as thoſe of the largeſt plants are in their ſeeds.

Preliminary Proceſſes.

ance, the other earths predominate; but if it remain in a powdery form, the aluminous earth is in greateſt proportion. The oxides of different metals are indicated by the colour of the maſs; when it is of a dark or browniſh red, the metallic oxide is that of iron; a graſs green colour denotes manganeſe; and yellowiſh green the oxide of chromium.

But there are ſome ſtones on which potaſh has a very feeble action, and in this caſe borax has been ſubſtituted for the alkali. This is the method which was followed by Mr Chenevix in analyſing aluminous ſtones. A hundred grains of ſapphire in powder were mixed with 250 grains of calcined borax, and ſubjected to a ſtrong heat in a crucible of platina for two hours. When the maſs was cold, it exhibited the appearance of a greeniſh blue glaſs, which adhered ſtrongly to the crucible; but the whole being boiled for ſome hours in muriatic acid, it was completely diſſolved; the earthy matter was then precipitated by means of ſub-carbonate of ammonia, and the precipitate, after being well waſhed, was again diſſolved in muriatic acid; and in this way the borax was ſeparated. The remaining part of the analyſis was nearly ſimilar to that directed for other ſtones, excepting only that the alumina was ſeparated from the potaſh by means of muriate of ammonia.

But to return to the examination and farther treatment of the maſs in the ſilver crucible, which after being removed from the furnace, and wiped on the outſide, is to be placed in a porcelain capſule; it is then filled with water, and this water is renewed occaſionally, till the whole matter is ſeparated from the crucible. By this means a part of the compound of the alkali with the ſiliceous and aluminous earths, is diſſolved, and with a ſufficient quantity of water, the whole may be diſſolved. Muriatic acid is now to be added till the whole of the maſs is brought to a ſtate of ſolution. This, however, will not be the caſe, if the ſtone be compoſed chiefly of ſilica. On the firſt addition of the acid, a flakey precipitate is produced, becauſe the acid unites with the alkali, which held the maſs in ſolution. An effervſcence afterwards takes place, which ariſes from the decompoſition of a portion of carbonate of potaſh, formed during the fuſion; and the flakey precipitate is again diſſolved, as well as the matter which remained in the form of powder at the bottom of the veſſel. If the powder be ſilica and alumina, there is no effervſcence; but if it contain lime, an effervſcence is produced. The ſolution in the muriatic acid being formed, if it ſhall appear colourleſs, it may be inferred that it contains no metallic oxide, or at leaſt a very ſmall portion. An orange red colour ſhews that it contains iron, a purpliſh red indicates manganeſe, and a golden yellow, chromium.

The ſolution is now to be introduced into an evaporating diſh of porcelain, and being covered with paper, is to be placed on a ſand bath, and evaporated to dryneſs. Towards the end of the evaporation, as the liquid aſſumes the form of a jelly, it muſt be conſtantly ſtirred with a rod of ſilver or porcelain, to permit the acid and water to paſs off, and to allow the whole maſs to be equally dried; for it is in this way that the ſilica and alumina are ſeparated from each other. The matter being reduced to a dry powder, add to it a large quantity of pure water, expoſe it to a moderate heat, and pour it on a filter. This ſolution may be denominated A. Waſh repeatedly the powder which remains upon the ſilver, till the water with which it is waſhed no longer precipitates ſilver from its ſolutions. The powder remaining is ſiliceous earth, which is firſt to be dried between folds of blotting paper, and then made red hot in a crucible of platina or ſilver; and when it is cold it is to be accurately weighed. If it be pure ſiliceous earth, it is in the form of a white powder, is of a white colour, does not adhere to the fingers, and is inſoluble in acids. If it be at all coloured, it ſhews that it contains ſome metallic oxide, and is a proof that the evaporation has been carried on with too great a heat. To ſeparate the oxide, boil the ſilica with an acid, and then waſh and dry it as before. This acid ſolution is to be added to the ſolution A, and the whole is to be evaporated to about the quantity of an Engliſh pint; then add to it a ſolution of carbonate of potaſh, till the precipitation ceaſes; and it may be neceſſary to boil it a few moments, to allow the whole of the precipitate to fall to the bottom. The whole of the precipitate being collected at the bottom, the ſupernatant liquid is decanted off, and the water being put in its place, the precipitate and water are thrown on a filter; and when the water has run off, the filter with the precipitate upon it is placed on the folds of blotting paper. After the precipitate has acquired ſome degree of conſiſtence, collect it carefully with an ivory knife, mix it with a ſolution of pure potaſh, and boil it in a capſule of porcelain. The potaſh diſſolves the alumina or glucina, and the other ſubſtances remain in the form of a powder. This powder may be called B.

Add to the ſolution of potaſh as much acid as will ſaturate the potaſh, and alſo rediſſolve any precipitate which at firſt appeared; and then add carbonate of ammonia till the taſte of it be perceptible in the liquid. The whole of the alumina is now precipitated in the form of white flakes, while the glucina remains diſſolved, if a ſufficient quantity of carbonate of ammonia had been employed. Filter the liquid; and the alumina remaining on the filter being waſhed and dried, and after being made red hot, and allowed to cool, is weighed. To prove its being alumina, diſſolve it in ſulphuric acid, and a ſufficient quantity of ſulphate or acetate of potaſh being added, the whole of it will be converted into alum cryſtals, if the earth employed be aluminous earth.

To ſeparate the glucina, the liquid which paſſed through the filter is to be boiled for ſome time, and if the ſolution contain any of this earth it will be precipitated in the form of a light powder, which may be dried in the uſual manner, and weighed. It is a fine, ſoft, light, taſteleſs powder, when in a ſtate of purity; and the application of heat does not make it concrete, as happens to alumina.

We now return to the reſiduum B, in which may be expected lime, magneſia, and ſome of the metallic oxides. But if it be ſuſpected that this reſiduum contains any yttria, it is to be treated with carbonate of ammonia, which diſſolves the yttria, and leaves the other bodies untouched. The yttria being ſeparated, the reſiduum B is to be diſſolved in weak ſulphuric acid, and the ſolution evaporated to dryneſs. Add a ſmall quantity of water, which will diſſolve the ſulphate of magneſia, as well as the metallic ſulphates; but the ſulphate of lime remains undiſſolved, or if any part of it ſhould

Preliminary Proceſſes.

diſſolve, it may be thrown down by adding a ſmall portion of weak alcohol. After being made red hot in a crucible, it is to be weighed, and the lime will amount to $\frac{42}{100}$ of the weight. The ſolution containing the remaining ſulphates being diluted with a large portion of water, a ſmall exceſs of acid is to be added, and then a ſaturated carbonate of potaſh. The magneſia and oxide of manganeſe remain diſſolved, and the oxides of chromium, iron, and nickel, are precipitated. This precipitate may be denominated C.

Add to the ſolution a ſolution of hydroſulphuret of potaſh, and the manganeſe in the ſtate of a hydroſulphuret will be precipitated. Calcine the precipitate in contact with air, and weigh it. The addition of pure potaſh to the ſolution will precipitate the magneſia, which being waſhed, and ſubjected to a red heat, is alſo to be weighed.

The reſiduum C is to be repeatedly boiled with nitric acid, and then mixed with pure potaſh; and, being heated, the liquid is to be decanted off. The precipitate thus obtained, conſiſting of the oxides of iron and nickel, is to be waſhed with pure water, and this water is to be added to the ſolution of the nitric acid and potaſh. The chromium, if any be preſent, is contained in that ſolution, and is in the form of an acid. Add to the ſolution muriatic acid in exceſs, and let the evaporation be continued till the liquor become of a green colour; then add a pure alkali, by which the chromium is precipitated in the ſtate of oxide, which is to be dried in the uſual way, and weighed.

The precipitate containing the oxides of iron and nickel is to be diſſolved in muriatic acid; ammonia is to be added in exceſs, when the oxide of iron precipitates; and being collected, waſhed, and dried, is to be weighed. By evaporating the ſolution, the oxide of nickel will be alſo precipitated, or the whole may be precipitated by the addition of hydroſulphuret of ammonia. This being treated in the ſame manner as the other ſubſtances, is alſo to be weighed.

The weight of the whole ſubſtances thus obtained being added together, and being compared with the weight of the matter originally operated upon, if the two be equal, or if the difference do not exceed three or four parts in 100, it may be inferred that the analyſis is nearly correct; but a conſiderable loſs of weight indicates ſome error, and requires the analyſis to be carefully repeated. If the ſame loſs of weight appear, it may be concluded that the ſtone contained ſome ſubſtance which is ſoluble in water, or has been driven off by the heat. To aſcertain the laſt point, a portion of the ſtone is to be broken into ſmall pieces, and expoſed to a ſtrong heat, in a porcelain retort. If it contain water, or any volatile ſubſtance, it will come over into the receiver, and by this means the nature and weight of the ingredients ſeparated may be aſcertained. If nothing come over into the receiver, or if what is obtained be not equal to the deficient weight, it may be inferred that the ſtone contains ſome matter which is ſoluble in water.

A fixed alkali has been not unfrequently found in ſimple ſtones; and to aſcertain whether the mineral ſubjected to analyſis contains any alkaline matter, different methods have been purſued. Theſe methods we ſhall now deſcribe. The ſtone being reduced to an impalpable powder, is cautiouſly heated repeatedly with ſulphuric acid, and the maſs is to be digeſted in water; and this ſolution being properly concentrated, is ſet aſide for ſome days. The appearance of cryſtals of alum is a certain indication that the mineral contained potaſh; and the quantity of potaſh may be eſtimated at $\frac{104}{1000}$ of the weight of thoſe cryſtals; but if no cryſtals be obtained, the ſolution is to be evaporated to dryneſs, and the reſiduum expoſed to a moderate red heat. Digeſt it afterwards in water, and add carbonate of ammonia, and filter; evaporate again to dryneſs, expoſe the reſidue to a heat of 700°, and rediſſolve it. The ſolution being properly concentrated, will give cryſtals of ſulphate of ſoda or of potaſh, as the one or the other alkali is preſent. Potaſh may be diſcovered by adding to the ſolution of the ſalt, a ſolution of nitro-muriate of platina ſomewhat concentrated. A yellow precipitate, which is muriate of platina and potaſh, is thus obtained.

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Klaproth's method for diſcovering fixed alkalies in minerals is the following. He takes four parts of nitrate of barytes to one of the mineral to be examined, and fuſes them together in a porcelain crucible. A ſpongy maſs of a light-blue colour was thus obtained, and with the addition of diluted muriatic acid, was completely diſſolved. The ſolution, which was of a yellow colour, was then mixed with a ſufficient quantity of ſulphuric acid, by which the barytes is precipitated, and the muriatic acid expelled. The liquid is next evaporated to dryneſs, and the maſs being digeſted in water, is filtered, and the ſulphate of barytes and ſilica remain on the filter. The clear ſolution is ſaturated with carbonate of ammonia, and filtered a ſecond time; and all the earthy and metallic bodies being ſeparated, the ſulphates of fixed alkali and ammonia only remain in the ſolution, which being evaporated to dryneſs, the dry ſaline maſs is introduced into a porcelain crucible, and ſubjected to ſuch a degree of heat as is ſufficient to drive off the ſulphate of ammonia. The reſiduum is then diſſolved in water, and cryſtallized; and thus a pure, fixed alkaline ſulphate is obtained, which is again diſſolved in water, and decompoſed, by adding acetate of barytes. The ſolution is then filtered, and the liquid is evaporated to dryneſs. The ſaline maſs obtained is the acetate of a fixed alkali, which being expoſed to heat in a crucible, became of a reddiſh colour. The carbonaceous reſiduum is then to be diſſolved in water, filtered, and cryſtallized, and the ſalt thus procured is a carbonate of a fixed alkali, the nature of which may be eaſily recogniſed by the means ſtated above.

Mr Davy's method of detecting a fixed alkali in minerals, is different *. One hundred grains of the ſtone in very fine powder are to be fuſed for half an hour at a ſtrong red heat, in a crucible of platina or ſilver, with 200 grains of boracic acid. An ounce and a half of nitric acid diluted with ſeven or eight times its quantity of water, is then digeſted upon the fuſed maſs, till the decompoſition of the whole is completed. Evaporate the fluid to about two ounces, or one ounce and a half; by this means the ſiliceous earth is ſeparated, which being collected on a filter, is to be waſhed with diſtilled water, till the boracic acid and the whole of the ſaline matter are ſeparated. The fluid is then mixed with water that has paſſed through the filter, and evaporated to the quantity of half a pint, after which it is ſaturated with carbonate of ammonia, and boiled with an exceſs of this ſalt, till the whole of the ſubſtances capable of being

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* Nich. Jour. xiii. 86.

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being precipitated, have been thrown down. The ſolution being filtered, the earths and metallic oxides remain on the filter. Add nitric acid to the liquid till it acquire a ſtrong ſour taſte, and evaporate till the boracic acid appear free.

The fluid is then to be filtered, and evaporated to dryneſs, and the dry maſs being expoſed to a heat of about 450° Fahrenheit, the nitrate of ammonia is decompoſed, and the nitrate of potaſh or ſoda remains behind.

To detect fluoric acid, which has been ſometimes met with as a component part of ſtones, Klaproth heats the mineral with ſulphuric acid in a glaſs retort, the corroſion of which, and the depoſition of ſilica in the water of the receiver, are certain teſts of fluoric acid.

After the general obſervations which have now been offered, we proceed to give examples of the analyſis of minerals belonging to the different genera of earths and ſtones; and we ſhall follow the ſame order in which thoſe genera are deſcribed in the article MINERALOGY.

1. ZIRCON Genus.

The mineral affording the earth which characteriſes this genus, was analyſed by Klaproth in the following manner *. We ſelect that ſpecies which is called hyacinth.

A. 100 grains of hyacinth being levigated in the flint-mortar, received an increaſe of weight of half a grain.

B. This pulverized hyacinth, digeſted with two ounces of nitro-muriatic acid, yielded, upon ſaturating the ſolution with potaſh, a light-brown precipitate, of three grains and a half, when dried. Ammonia, added to it, diſſolved nothing; and it remained colourleſs. After the precipitate had been again ſeparated from the volatile alkali, muriatic acid was added, which diſſolved its ferruginous contents, leaving a white earth behind, which, when ignited, weighed 1½ grain. The portion of iron, precipitated by cauſtic ammonia from the muriatic ſolution, weighed half a grain, when ignited, and became black and reſplendent. It was fuſed with a neutral phoſphate, upon charcoal, to find whether it contained manganeſe; no trace was perceptible.

C. The above 1½ grain of earth B were now added again to the hyacinth, after treatment with acids. The ſtone was then ſubjected to red heat, with ſix times its quantity of cauſtic alkali, in the manner explained in the eſſay on the jargon of Ceylon; the ignited maſs was again liquefied with water; and the earth remaining after this proceſs weighed 123 grains, when collected, edulcorated, and dried.

D. The alkaline lixivium was then ſaturated with muriatic acid, and evaporated. At firſt it continued clear; but towards the end ſiliceous earth ſeparated, the quantity of which, after ignition, amounted to ſix grains.

E. To the 123 grains, previouſly well waſhed with water, a ſufficient quantity of muriatic acid was added; which, with the aſſiſtance of heat, diſſolved nearly the whole, a trifling reſidue excepted. This muriatic ſolution, evaporated in a moderate heat to a ſixth or eighth part, loſt its fluidity, and formed a limpid gelatinous coagulum. It was then covered with water, and expoſed, with repeated agitation, to a digeſting heat. By this management, the ſiliceous earth ſeparated in ſlimy, intumeſced grains, and weighed, after ignition, 23½ grains.

F. The ſolution, thus freed from its ſilica, was now ſaturated with a boiling ley of mild alkali; and the precipitate was waſhed and dried in the air. This laſt weighed 114 grains, proving, upon every trial, to be jargonic earth. A fourth part of it, heated to redneſs, weighed 16½ grains; which make the whole amount to 66 grains.

Siliceous Genus.

G. The above ſix grains D, with the 23½ grains E, in the whole 29½ grains of ſiliceous earth, were ignited with a quadruple weight of vegetable alkali. When this maſs had been again ſoftened with water, it left a reſidue, which was extracted by muriatic acid. From this muriatic ſolution, alſo, when ſaturated with potaſh, jargonic earth fell down, weighing four grains after ignition. Hence, ſubtracting theſe, the quantity of ſiliceous earth is reduced to 25½ grains.

One hundred parts of hyacinth, therefore, have given

Jargonia,	-	F	66	}	70
		G	4	}	
Silica,	-	G	25½		
	Subtract	A	½		
					25
Oxide of iron,		B	-	-	0.50
					95.50
				Loſs,	4.50
					100

2. Of the SILICEOUS Genus.

A great proportion of the ſtones belonging to this genus are tranſparent, and have a vitreous appearance. They are ſo hard as to ſcratch glaſs, and, excepting the fluoric acid, they are not acted upon by acids. By fuſion with alkalies they form glaſs; they alſo enter into fuſion with boracic acid, and the acid of phoſphorus. Stones compoſed chiefly of pure ſilica, are tranſparent and colourleſs. When a mineral is preſented for examination, even if it poſſeſs moſt of the properties which characterize ſtones belonging to this genus, ſome preliminary proceſſes may be purſued to aſcertain farther its nature and component parts.

A. It is ſometimes difficult to reduce ſiliceous ſtones to a fine powder. To facilitate this operation, a portion of the ſtone may be heated to redneſs, and in this ſtate ſuddenly plunged into cold water. If by the firſt heating it is not ſufficiently brittle, the operation may be repeated until the mineral can be reduced to a fine powder, as already directed.

B. One part of the ſtone in fine powder is now to be mixed with four or five parts of potaſh, diſſolved in the ſame quantity of water. The mixture is introduced into a ſilver crucible, and evaporated to dryneſs, ſtirring it conſtantly with a ſilver rod, according to the directions given above. The maſs being evaporated to dryneſs, the heat is to be gradually increaſed, till the crucible appears of a dull red heat, or till the maſs enter into quiet fuſion. In this ſtate it is kept for an hour.

C. Remove the crucible from the fire before it is completely cold; ſoften the maſs with water, by adding freſh

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* Eſſays, i. 195.

freſh portions from time to time, till the whole is detached from the crucible, and then add 12 times its bulk of water to effect a ſolution. If the ſtone conſiſted chiefly of ſiliceous earth, the greater part of the maſs will be diſſolved.

D. Add muriatic acid till no farther precipitate is effected, and without ſeparating the precipitate, evaporate the whole to dryneſs.

E. Pour ſix times its bulk of muriatic acid, previouſly diluted with four parts of water, on the dry maſs; boil the mixture for half an hour; let the inſoluble part ſubſide, and then collect it on a filter, and after being dried, ſubject it in a crucible to a red heat. This powder is the ſiliceous earth contained in the mineral.

But ſtones included under this genus contain very different proportions, not only of ſiliceous earth, but alſo of the other earths; and ſome of them even contain a far greater proportion of other earths than that which characterizes the genus under which they are arranged.

Analyſis of Leucite.

The analyſis of this mineral is particularly intereſting, not only as Klaproth firſt detected in it potaſh, which was ſuppoſed to belong excluſively to the vegetable kingdom, and hence called vegetable alkali, but alſo as it places the ſkill and addreſs of that eminent chemiſt in its examination in a very conſpicuous light. The proceſs was conducted in the following manner *.

Ignited alone upon charcoal, the leucite is completely infuſible. It undergoes no manner of alteration, and its ſplinters loſe nothing of their luſtre.

A ſmall fragment, put into fuſed borax, is for a long time moved about in it before it diſſolves, which it does by degrees; and the glaſs globule obtained is clear and light-brown.

By fuſion with a neutral phoſphate, the ſolution is ſtill ſlower, and a colourleſs rifty glaſs pearl is produced.

One hundred grains of coarſely pounded leucite expoſed for an hour to a ſtrong red heat, in a ſmall porcelain pot, loſt of weight only one-eighth of a grain, and even the violent heat of the porcelain furnace produced in the leucite only an inconſiderable change.

A. One hundred grains of leucite, reduced to an impalpable powder, being ſeveral times digeſted in muriatic acid, diſſolved a conſiderable part. A ſiliceous reſidue of 54 grains remained after ignition.

B. The ſiliceous earth ignited with twice its weight of cauſtic alkali, ſoftened again with water, covered with muriatic acid, added to exceſs of ſaturation, and, after ſufficient digeſtion with this laſt, being collected on the filter, and heated to redneſs, was found to have loſt little of its weight.

C. Pruſſiate of potaſh added to the muriatic ſolution produced a precipitate which indicated one-eighth of a grain of oxide of iron.

D. The ſolution by cauſtic ammonia being decompoſed, and the precipitate being ſeparated, the remaining liquor was tried with carbonate of ſoda, but no farther change was effected.

E. The precipitate produced by means of pure ammonia D was firſt dried. It was next purified by digeſting it with diſtilled vinegar, and afterwards neutralizing this acid by ammonia. It weighed 24 grains and a half, when edulcorated and ignited. Diluted ſulphuric acid completely diſſolved it to a limpid liquor, and when properly treated, the ſolution yielded only alum.

F. To obtain the earth, which poſſibly might have remained latent in the ſeveral waſhings, the whole were evaporated to dryneſs. After having re-diſſolved the ſaline maſs in water, the remaining portion of earth was collected, it amounted only to half a grain, and was ſiliceous earth.

There were therefore obtained,

Silica,	-	(A)	54		
——	-	(F)	½		
			54½	-	54.50
Alumina,	-	(E)	-	-	24.50
					79
			Loſs,		21
					100

The remarkable loſs of more than one-fifth of the whole weight of the mineral under examination, excited ſuſpicion that ſome error had crept into the analyſis, and led to a repetition of the experiments, by varying the proceſſes as follows.

A. One hundred grains of leucite in fine powder were ignited for half an hour, with double their weight of cauſtic potaſh. To the maſs ſoftened with water muriatic acid was added, juſt to the point of ſaturation, and the mixture being filtered, the remaining undiſſolved reſiduum was waſhed and dried.

B. The mineral thus prepared for decompoſition, was then treated with muriatic acid, and kept for ſome time at a boiling heat. By this proceſs a quantity of ſilica ſeparated, which after being heated to redneſs weighed 54 grains and a half.

C. Oxalate of potaſh being added to the muriatic ſolution, concentrated by evaporation, produced no turbidity. The alumina was ſeparated by the ſame means as in the former experiments, and its weight amounted to nearly the ſame. By other trials it did not appear to have any mixture of other earths, and no other earth could be obtained by evaporating the waters with which the powders had been waſhed.

Thus, after varying the experiments, the ſame reſults were obtained, and the ſame loſs ſtill appeared. In the farther proſecution of this inveſtigation, the following experiments were had recourſe to.

A. Two hundred grains of leucite in fine powder were repeatedly digeſted with muriatic acid, and the ſiliceous earth collected on the filter, waſhed, and weighed after being red hot, amounted to 109 grains.

B. The muriatic ſolution was of a yellowiſh colour, and being reduced by evaporation in a ſand heat to the conſiſtence of honey, the ſurface appeared covered with a ſaline cruſt; and when completely cooled, the maſs appeared like a thick clear oil, of a golden yellow colour, and full of cryſtals, ſome of which were of a cubical, and ſome of a tabular form. The yellow fluid was gently poured off, and the ſalt rinſed with ſmall portions of alcohol. The ſolution diluted with alcohol was again evaporated, and the ſmall portion of ſalt thus obtained

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* *Eſſays*, i. 348.

Siliceous Genus.

tained was again waſhed with alcohol, and added to the firſt. The whole of the ſalt being dried, weighed 70 grains. This was diſſolved in water, and ſome drops of a ſolution of ammonia being added, threw down ſome particles of alumina. The ſolution being cryſtallized in a warm place, yielded only cubical cryſtals, ſome of which were elongated to four-ſided columns.

C. That part of the muriatic ſolution which ſhot into cryſtals being diluted with water, and decompoſed in a boiling heat, by carbonate of ſoda, yielded a precipitate, which, after waſhing, drying, and ignition, amounted to 47¾ grains of aluminous earth. Three times its weight of concentrated ſulphuric acid was added, and the mixture was evaporated nearly to dryneſs. The maſs was again diſſolved in water, and combined with ſolution of acetate of potaſh, which being cryſtallized, produced only alum.

D. The ſiliceous earth A was mixed with double its weight of potaſh, and ſubjected to a ſtrong red heat for an hour. The maſs was reduced to powder, and diluted with water. Muriatic acid was added in exceſs, and digeſted with it. The filtered muriatic ſolution being ſaturated with ſoda yielded 1½ grain of aluminous earth, after which there remained of ſilica 107½ grains.

The 200 grains of leucite have thus afforded of

	Grs.
Silica D,	107.50
Alumina C,	47.75
——— D,	1.55
	156.75

Here there was ſtill a deficiency of 43.25 grains, to account for which the 70 grains of ſalt B muſt be examined. This examination was conducted in the following manner.

1. The taſte and figure of the cryſtals were found to be the ſame with thoſe of muriate of potaſh.

2. The ſolution produced no change in vegetable blues, or in reddened litmus paper.

3. When heated to redneſs, the ſalt made a crackling noiſe, and remained fixed in the fire.

4. Neither carbonate of ſoda nor cauſtic ammonia produced any turbidity in the ſolution.

5. Two parts of ſtrong ſulphuric acid were added to three of the ſalt, and the muriatic acid being driven off by heat, the maſs was again diſſolved in water, which afforded cryſtals of ſulphate of potaſh.

6. The remaining portion of ſalt was diſſolved in a ſmall quantity of water, and to this was added a concentrated ſolution of cryſtallized acid of tartar. The acidulous tartrate of potaſh (cream of tartar) was thus immediately produced and precipitated in the form of ſand. This was waſhed, dried, burnt in a ſilver crucible, and the coal obtained repeatedly waſhed with water. The ſolution being evaporated to dryneſs, after being examined by the proper teſts, appeared to be a carbonate of potaſh, which being ſaturated with nitric acid, afforded nitrate of potaſh.

Thus it appears that the baſe of the 70 grains of ſalt conſiſted entirely of pure potaſh, which was neutralized by part of the muriatic acid employed in decompoſing the mineral; and according to the proportion of baſe in muriate of potaſh, the 70 grains A contain 42.7 grains of alkali; and in this way the deficiency in the examination of the leucite is accounted for.

Siliceous Genus.

The reſult of the analyſis is as follows.

	Grs.
Silica,	53.75
Alumina,	24.62
Potaſh,	21.35
	129.72

Analyſis of Pitchſtone.

The pitchſtone which is the ſubject of the following analyſis, alſo conducted by Kalproth, is the tranſparent yellowiſh or olive green variety of that mineral from Meiſſen. It forms an example of ſoda, the other fixed alkali, forming a component part of ſtones.

A. 100 grains in coarſe fragments were introduced into a covered crucible, and were ſubjected to a red heat for half an hour. When taken from the fire they appeared of a white gray mixed with a yellowiſh colour, and having a rough feel, with ſomething of the appearance of glazing. They loſt 8½ grains of weight.

B. In the heat of a porcelain furnace, the pitchſtone was fuſed both in the clay and charcoal crucible, and was converted into a clear glaſs, full of ſmall froth holes.

C. 100 grains of pitchſtone in fine powder were treated with a ſolution of 200 grains of cauſtic ſoda, and being put into a ſilver crucible, were kept for half an hour in a pretty ſtrong red heat. The maſs was then ſoftened with water; muriatic acid was added in exceſs; the ſolution was evaporated in a ſand heat, nearly to dryneſs; water was again poured upon it, after which it was filtered, and 73 grains of ſiliceous earth were obtained.

D. Cauſtic ſoda was mixed in exceſs with the muriatic ſolution, and the whole was digeſted in a boiling heat, by which the precipitate formed at the beginning of the proceſs was again diſſolved; a brown reſiduum ſtill remained, which being ſeparated, the alkaline ſolution was neutralized, and precipitated with carbonate of ſoda. The precipitate, which was alumina, after being waſhed, dried, and heated to redneſs, amounted to 14½ grains. The whole of it yielded cryſtals of alum, with ſulphuric acid and potaſh.

E. The reſiduum which remained undiſſolved by the cauſtic ſoda, D, was firſt diſſolved in muriatic, and then united with ſulphuric acid. Sulphate of lime was obtained, which was collected, and waſhed with diluted alcohol. By reducing the filtered fluid by evaporation to a ſmaller quantity, and combining it with ſulphuric acid, another portion of ſulphate of lime, which, added to the firſt, amounted to three grains, indicating 18 grains of pure lime.

F. The fluid was now freed from the calcareous earth; the iron which it contained was precipitated by carbonate of ammonia, which amounted to one grain. The remaining fluid was evaporated to dryneſs, and water being added to the ſaline reſiduum, fine minute flocks of oxide of mangane ſe ſeparated, but in no greater quantity than one-tenth of a grain.

G. 100 grains of pitchſtone in powder were mixed with 300 grains of cryſtallized nitrate of barytes, and heated to redneſs in a porcelain veſſel, till the ſalt was entirely

Argillaceous Genus.

entirely decompoſed. The cold maſs was ſoftened with water, neutralized with muriatic acid, and combined in ſuch proportion with ſulphuric acid, that the latter, after the evaporation of the mixture, and ſeparation of the muriatic acid by heat, was ſtill in exceſs. The maſs was waſhed with hot water; the reſiduum ſeparated by filtration; and the clear fluid was mixed with carbonate of ammonia in exceſs. The precipitate thus obtained was collected on a filter, and the remaining fluid was evaporated to dryneſs, and the portion of ſulphate of ammonia ſubjected to a moderate heat in a porcelain veſſel, was driven off. A fixed ſalt remained, which appeared to be ſulphate of ſoda. This was rediſſolved, and decompoſed by acetate of barytes; the filtered ſolution was evaporated to dryneſs; the dry ſalt was heated to redneſs in a crucible of platina. The ſaline reſiduum being rediſſolved, filtered, and again evaporated to dryneſs, yielded three grains of dry carbonate of ſoda, indicating 1¾ grain of pure ſoda. This being neutralized with nitric acid, gave cryſtals of nitrate of ſoda.

The 100 grains of the mineral thus examined conſiſt of

	Grs.
Silica C,	73.
Alumina D,	14.5
Lime E,	1.
Oxide of iron D,	1.
——— manganeſe D,	.10
Soda G,	1.75
Water A,	8.50
	99.85

3. Argillaceous Genus.

As many of the ſtones included under this genus are compoſed of ſimilar ſubſtances with thoſe arranged in the former genus, it is obvious that the examination is to be conducted in the ſame way. We ſhall therefore give one example of the analyſis of a ſtone belonging to this genus, and the example is that of baſalt by Klaproth *.

* Eſſays ii. 195.

Analyſis of Baſalt.

A. Small fragments of this ſtone were ſubjected to a ſtrong red heat for 30 minutes; the loſs of weight was two per cent. and the maſs became of a lighter colour, and more readily yielded to the peſtle.

B. Baſalt expoſed to the heat of a porcelain furnace in a common clay crucible, fuſed into a compact black brown glaſs, which in thin ſplinters was tranſparent. It alſo entered into thin fuſion in a crucible of ſemi-indurated ſteatites; part of it ran into the clefts produced in the ſteatites, and the reſt was found cryſtallized in brown ſhining lamellæ, which on the ſurface were ſtriated, and cellularly concreted. In a charcoal crucible it was converted into a dull gray and finely porous maſs, in which were inſerted numerous grains of iron.

C. To aſcertain whether this ſtone contained ſoda, 100 grains of baſalt in fine powder were mixed with 400 grains of nitrate of barytes, and were at firſt expoſed in a large porcelain veſſel to a moderate heat, and afterwards to a heat gradually raiſed to ignition. The mixture ſwelled up, and when the heat was increaſed, white fumes aroſe on uncovering the veſſel, which led to a ſuppoſition that the ſoda was beginning to volatilize. The fire was then removed.

Argillaceous Genus.

D. The porous maſs, after cooling and being reduced to powder, was drenched with water, and treated with muriatic acid. The whole entered into ſolution, and produced a clear yellow fluid. The ſolution was evaporated, and ſulphuric acid was added gradually, till it was in exceſs. The ſulphate of barytes was precipitated.

E. The ſaline maſs by filtration was reduced to dryneſs, and water was added, the ſediment ſeparated, and appeared to conſiſt of the ſulphate of barytes, and the ſiliceous earth of the ſtone. The clear fluid was ſaturated with ammonia, and the precipitate, which was obtained being filtered off, the neutralized liquor was evaporated to dryneſs, and then expoſed in a porcelain veſſel to a moderately intenſe heat, till the whole ſulphate of ammonia was driven off. The fixed portion remaining diſſolved in water, and cryſtallized, appeared to be pure ſulphate of ſoda. This was diſſolved, decompoſed by acetate of barytes; the precipitate, which was ſulphate of barytes, was ſeparated by the filter, and the clear fluid being evaporated to dryneſs, the dry acetate of ſoda was heated to redneſs in a crucible of platina; and in this way 4½ grains of dry carbonate of ſoda was obtained, which is equal to 2.6 grains of pure ſoda.

F. To ſeparate the other ingredients, 100 grains of powdered baſalt were ignited for two hours with 400 grains of carbonate of ſoda, in a crucible of porcelain; but with a degree of heat which did not produce fuſion. It united into a yellowiſh, ſomewhat hard maſs, which being reduced to powder, and ſoftened with water, was neutralized with muriatic acid. It was then a little ſuperſaturated with nitric acid, and evaporated to dryneſs. The colour of the dry maſs was ſaffron yellow. It was diffuſed in water, ſlightly acidulated with muriatic acid, and after being digeſted for a ſhort time it was filtered. The ſiliceous earth collected on the filter was expoſed to a red heat, and being weighed, amounted to 44½ grains.

G. The muriatic ſolution being ſufficiently diluted with water, was precipitated at the temperature of boiling water, by means of carbonate of ſoda. The precipitate being ſeparated, was digeſted with a ſolution of cauſtic ſoda, and a dark brown reſiduum was ſeparated by filtration. Muriatic acid was added in a ſmall exceſs to the alkaline fluid, and this was precipitated with carbonate of ammonia. The precipitate obtained after being waſhed and ignited, amounted to 16¼ grains. It yielded alum, when treated with ſulphuric acid and potaſh, and was therefore aluminous earth.

H. The brown reſiduum G was diſſolved in muriatic acid with particular attention to the preciſe point of ſaturation. Succinate of ammonia was added to the ſolution, to precipitate the iron; and the ſuccinate of iron obtained, when perfectly waſhed and ſtrongly heated in a covered crucible, afforded 20 grains of oxide of iron, which were attracted by the magnet.

I. The iron being ſeparated, the fluid was treated at the temperature of boiling with carbonate of ſoda; a white precipitate was obtained, which was diſſolved in nitric acid; and ſulphuric acid being combined with the ſolution, threw down ſulphate of lime. This was ſeparated, and the remaining liquor being evaporated nearly

nearly to dryneſs, was again diluted with a mixture of water and alcohol. Another portion of ſulphate of lime fell down, which being ſeparated, was added to the former. The whole of the ſulphate of lime was decompoſed by boiling it with carbonate of ſoda in ſolution, and the carbonate of lime thus obtained, after being waſhed and dried, weighed 17 grains, indicating nine grains and a half of pure lime.

K. Upon the fluid left from the laſt proceſs, cauſtic ſoda was affuſed; a ſlimy precipitate was formed, which rapidly diſſolved in ſulphuric acid, and communicated a brown colour to the ſolution. It was evaporated in a ſand bath; looſe brown flakes fell down at the commencement of the proceſs, and theſe being ſeparated by the filter, appeared to be oxide of mangaueſe; the quantity eſtimated did not exceed one-eighth of a grain.

L. The remaining portion of the fluid was evaporated to dryneſs, and the reſiduum was expoſed in a ſmall crucible to a ſtrong red heat. It was again diſſolved in water, and yielded a ſmall portion of alumina coloured with iron, and contaminated with mangaueſe. After ignition it did not weigh more than half a grain; but the clear ſolution was entirely cryſtallized, and afforded ſulphate of magneſia. Carbonate of ſoda was added to the magneſian ſalt in ſolution, by which the earthy baſe was precipitated in the ſtate of carbonate. It weighed ſix grains, which is equal to 2¼ grains of pure magneſia.

The following is the reſult of the preceding analyſis.

Silica F,	44.5 grs.
Alumina G,	16.25
——— I,	.5
Oxide of iron H,	20.
Lime I,	9.5
Magneſia L,	2.25
Oxide of mangaueſe K,	.12
Soda E,	2.60
Water A,	2.
	97.72

4. Magnesian Genus.

Beſides ſeveral of the earths detected in minerals belonging to the former genera, the ſtones arranged under this genus are diſtinguiſhed by being combined with magneſia. We ſhall only give one example of the analyſis of a magneſian ſtone.

Analysis of Steatites.

This mineral, which was found in Cornwall, was analyzed by Klaproth in the following manner.

A. One ounce of the ſtone in ſmall pieces was ſubjected to a ſtrong red heat, by placing the glaſs retort which contained it in an open fire. A ſmall portion of water diſtilled over, which was pure and taſteleſs. The mineral loſt 75 grains of its weight, and became darker in the colour, and conſiderably harder.

B. After being reduced to powder, it was carefully mixed, and heated red hot, with two ounces of carbonate of potaſh in a porcelain pot. The concreted maſs was levigated with water, and digeſted with muriatic acid in exceſs. A white looſe ſlimy earth was precipitated, which after being waſhed, dried, and ſubjected to a red heat, weighed 204 grains. It was pure ſilica.

C. Pruſſiate of potaſh was added to the filtered ſolution, and produced a blue precipitate, which being collected, waſhed, dried, and ignited with a little wax, was found, after cooling, to weigh ſeven grains. The whole of it was attracted by the magnet. The portion of iron belonging to the pruſſiate of potaſh being ſubtracted, left 3¾ grains of oxide of iron as a conſtituent of the mineral under examination.

D. Carbonate of potaſh being added to the ſolution freed from the iron, precipitated its earthy ingredient. This, after waſhing, and gentle ignition, weighed 192 grains. Theſe were covered with a proportionate quantity of concentrated diſtilled vinegar, and being digeſted in a low heat, were thrown upon the filter. The earth remaining on the paper, which, after being dried and heated red hot, weighed 93 grains, was mixed with three times its weight of ſtrong ſulphuric acid, and the mixture being evaporated in a ſand heat nearly to dryneſs, the dry maſs was diſſolved in water and filtered; 26 grains of ſiliceous earth were thus obtained.

E. In the ſulphuric ſolution D, there ſtill remained 67 grains of earth, which being precipitated by an alkali, appeared to conſiſt entirely of aluminous earth.

F. Ninety-nine grains of the firſt, 192 grains of the earthy precipitate D, were taken up by the acetic acid, which being precipitated by carbonate of potaſh, and the earth obtained being tried by ſulphuric acid, was found to be pure magneſia.

This analyſis ſhows that the 480 grains of ſteatites thus examined, afforded

Silica B,	204
——— D,	26
Magneſia F,	99
Alumina E,	67
Oxide of iron C,	3.75
Water A,	75.
	474.75
Loſs,	5.25
	480.00

or 100 parts of the mineral contain

Silica,	48
Magneſia,	20.5
Alumina,	14.
Oxide of iron,	1.
Water,	15.5
	99.0

5. Calcareous Genus.

The analyſis of ſtones belonging to this genus muſt be varied according to the nature of the combination into which the lime has entered. With regard to the proceſſes to be followed in the examination of calcareous ſtones, they are ſuſceptible of a natural diviſion into ſuch as are ſoluble in muriatic or nitric acid with effervescence, and ſuch as are ſcarcely ſoluble in thoſe acids, and do not effervesce. To the firſt belong all the ſtones called limeſtones, or carbonates of lime; and to the ſecond belongs ſulphate of lime, or gypſum.

Analysis of Carbonate of Lime.

Carbonate of lime, whether in the form of lime ſpar, or in a leſs pure ſtate, in the form of limeſtone, is ſoluble with

Calcareous Genus.

with efferveſcence in nitric or muriatic acid. When expoſed to heat, it yields carbonic acid gas, and is converted into quicklime; and when fuſed with an alkali, does not form a uniform maſs. But we ſhall give a ſhort view of the proceſſes to be followed in a more particular examination.

A. Let a determinate quantity of the ſtone be reduced to a fine powder. Digeſt it repeatedly with muriatic acid till no further action is produced upon it. Dilute the ſolution, throw it upon a filter, and, after drying, weigh the inſoluble reſiduum.

B. Let the remaining ſolution be diluted with 24 times its bulk of water; add ſulphuric acid diluted; a precipitate takes place if the ſtone contained any barytes, the amount of which, after being collected and dried, may be aſcertained by weighing.

C. Add to the filtered ſolution, after the barytes has been ſeparated, a ſolution of carbonate of ſoda, as long as any precipitate is formed. Collect this precipitate, and let it be ſo much dried that it may be eaſily removed from the filter.

D. Affuſe the precipitate with ſulphuric acid till all efferveſcence ceaſes.

E. Introduce the whole into a mixture of three parts of diſtilled water, and one of alcohol, in the proportion of eight parts of the mixture to the quantity of the ſubſtance previouſly diſſolved in nitric acid. Let the whole be digeſted for ſome hours in the cold, filter the fluid, and dry the inſoluble reſiduum and weigh it.

F. The remaining ſolution is next to be decompoſed by a ſolution of carbonate of potaſh, and the precipitate being collected, is to be waſhed, dried, and weighed.

By this examination, if the ſtone is to be ranked with carbonate of lime, the weight of the inſoluble part E, after ſubtracting from it one-third, muſt exceed the weight of the inſoluble parts A and B.

Analysis of Sulphate of Lime.

As this is inſoluble in nitric or muriatic acids, its analyſis muſt be conducted in a different manner.

A. Let one part of the mineral, reduced to fine powder, be boiled with four times its weight of carbonate of potaſh, in a ſufficient quantity of water for two or three hours; as the fluid evaporates, water is to be added.

B. Introduce the inſoluble maſs obtained by the laſt proceſs into a flaſk containing diluted nitric acid, and the whole being diſſolved, let it be evaporated to dryneſs, and weighed.

C. Add to the dried maſs more than its own weight of ſtrong ſulphuric acid; apply heat, and let it be gradually increaſed till fumes ceaſe to riſe, and let it be again weighed.

D. Let the inſoluble part be digeſted in twice its weight of cold water; filter the fluid, collect the inſoluble reſiduum, and dry it in a dull red heat. To aſcertain the quantity of lime, ſubtract from the weight of the inſoluble maſs left (in C) 59 parts; what remains is equal to the quantity of lime.

E. The quantity of lime alſo may be aſcertained, by ſubjecting for ſome hours to a red heat, the inſoluble maſs B; for by this proceſs it will be converted into quicklime.

Analysis of Fluate of Lime.

In the examination of this mineral, a quantity of it may be reduced to powder, and moiſtened with ſulphuric acid, in a leaden or pewter veſſel. The mixture being heated, fumes ariſe, to which a plate of glaſs being expoſed, is ſoon corroded. In this way the fluoric acid may be detected, and the quantity of baſe may be aſcertained by decompoſing the mineral by means of ſulphuric acid, and afterwards analyſing the ſulphate of lime, as already directed.

Calcareous Genus.

Analysis of Phoſphate of Lime.

The analyſis of this mineral may be conducted in the following manner.

A. Let a determinate portion be digeſted in five times its quantity of muriatic acid, and let the operation be repeated till the acid has no farther action upon the reſiduum; decant the fluid, and then let it be diluted with water and filtered.

B. Add to the muriatic ſolution, liquid ammonia; collect the precipitate which is formed, and after being waſhed and dried, expoſe it to heat.

C. Add nitric acid to the precipitate till the whole is diſſolved. Precipitate again by means of ſulphuric acid; let the whole then be filtered, and let the inſoluble reſiduum be waſhed with as little water as poſſible.

D. Evaporate the filtered fluid to the conſiſtence of ſyrup; the fluid thus obtained is phoſphoric acid, if the ſtone examined have been phoſphate of lime. The teſt of phoſphoric acid is, that it precipitates lime water, and alſo forms precipitates with the ſolutions of ſulphate of iron, and nitrate of mercury; but it does not precipitate the muriate or nitrate of barytes.

6. BARYTIC Genus.

Analysis of Carbonate of Barytes.

A. Take a determinate quantity of the mineral, and diſſolve it in diluted nitric acid; take a portion of the ſolution, and add to it a ſolution of ſulphate of ſoda. If a precipitate take place, by adding a ſmall quantity of the ſalt to the ſolution of the earth, diluted with 24 times its bulk of water, it may be inferred that the baſe of the mineral is barytes.

B. Let the nitric ſolution be evaporated to dryneſs, and expoſed in a ſilver crucible to a white heat; the earth obtained is barytes, which is ſoluble in 20 times its weight of water; and after evaporation, cryſtallizes into long four-ſided priſms.

Analysis of Sulphate of Barytes.

This mineral was analyzed by Klaproth in the following manner.

A. 200 grains were mixed with 500 grains of carbonate of potaſh, and were expoſed for two hours to a red heat; the maſs was reduced to powder, boiled with water, and the undiſſolved earth was collected on the filter.

B. To ſeparate the ſiliceous earth, the fluid was neutraliſed by muriatic acid, and evaporated to dryneſs. The ſaline maſs was rediſſolved in water, and the ſilica remaining after being ignited, weighed 18 grains.

C. The barytic earth, freed from the ſulphuric acid B, was covered with water; muriatic acid was added; the whole was diſſolved by digeſtion, except two grains of ſilica. The filtered ſolution was cryſtallized, and afforded muriate of barytes.

D. The cryſtals were rediſſolved in water, and ſulphuric acid was added to the ſolution, while any precipitate appeared, and the regenerated ſulphate of barytes being

being waſhed and dried, weighed 185 grains, but after ignition, only 180 grains.

One hundred parts of this mineral are therefore compoſed of

Sulphate of barytes D,	90
Silica B,	9
—— C,	1
	100 *

7. Strontian Genus.

Analyſis of Carbonate of Strontites.

This mineral was analyzed by Klaproth, in the following manner.

A. 100 parts were diſſolved in muriatic acid, diluted with half its quantity of water. Thirty parts of carbonic acid were driven off during the ſolution, which being evaporated, afforded cryſtals in the ſhape of needles; and theſe cryſtals being diſſolved in alcohol, communicated to it the property of burning with a carmine red flame. This is the teſt of ſtrontitic earth.

B. To aſcertain whether the mineral examined contained any barytes, three drops of a ſolution of one grain of ſulphate of potaſh in ſix ounces of water were added to the muriatic ſolution; no appearance of precipitate was obſerved till next day, and therefore it contained no barytes, as in that caſe an immediate precipitate would have taken place.

C. Carbonate of potaſh was then added to the muriatic ſolution; a decompoſition took place; and the carbonate of ſtrontites was precipitated. This being ſubjected to a ſtrong heat, the carbonic acid was driven off, and the whole of the remaining earth being diſſolved in water, cryſtallized. After being dried, it weighed 69.5.

One hundred parts of this mineral therefore contain

Pure earth,	69.5
Carbonic acid,	30.
Water,	.5
	100.0 †

II. Salts.

The analyſis of minerals arranged under this claſs, is in general leſs difficult, in conſequence of their eaſy ſolubility, than thoſe already examined. We ſhall therefore give only one example.

Analyſis of Native Saltpetre.

This native ſalt was examined by Klaproth ‡, according to the following method.

A. 1000 grains of the native ſalt, with limeſtone and gypſum to which it adhered, were covered with boiling water. The colourleſs ſolution was gently evaporated; during the cryſtallization, tender needle-ſhaped cryſtals of ſelenite appeared, and the whole of the ſolution cryſtallized to a perfect priſmatic nitre. The ſelenite weighed 40 grains, and the ſalt amounted to 446 grains.

B. To aſcertain whether any common ſalt could be detected in the mineral, the cryſtals were rediſſolved in water, and acetate of barytes was dropt into the ſolution. A precipitate was obtained, amounting to 26 grains of ſulphate of barytes, ſhewing that 18½ grains of ſelenite were ſtill combined with the neutral ſalt. A ſolution of nitrate of ſilver was added to the nitric ſolution, which produced a precipitate of 4½ grains of muriate of ſilver, ſo that the quantity of common ſalt can only be eſtimated at two grains. The pure nitre is thus reduced to 425½ grains. Klaproth ſuſpects that the neutral muriate mixed with the native nitre, is rather a muriate of potaſh, than muriate of ſoda.

C. The ſtony matters remaining amounted to 500 grains; muriatic acid was poured upon them, and produced great efferveſcence with pieces of limeſtone. One hundred and eighty-ſix grains of white gypſum remained; and the ſulphuric acid being ſeparated from it, by boiling with carbonate of potaſh, the carbonate of lime remaining behind diſſolved without reſiduum in nitric acid.

D. The limeſtone taken up by the muriatic acid, weighed 304 grains. Being farther examined, it appeared to be calcareous earth, ſlightly contaminated with iron.

One hundred parts, therefore, of this ſalt contain

Pure priſmatic nitre B,	42.55
Muriate of a neutral ſalt B,	.20
Sulphate of lime A B C,	25.45
Carbonate of lime D,	30.4
Loſs,	1.4
	100.00

III. Combustibles.

Analyſis of Coal.

The conſtituent parts of coal are carbone and bitumen, with ſome earthy matters, and ſometimes a ſmall quantity of metallic matter. The proportion of earthy matters contained in coal may be aſcertained by weighing a determinate quantity, and burning it. The nature of the earths contained in the reſiduum may be diſcovered by the proceſſes already given.

To aſcertain the proportion of charcoal and bitumen contained in coal, we ſhall deſcribe the method followed by Mr Kirwan.

It has been found that a certain proportion of carbone or pure charcoal, detonated with nitre in the ſtate of ignition, decompoſes a given proportion of that ſalt; and it appears from the experiments of Lavoiſier, that 13.21 parts of charcoal decompoſe 100 parts of nitre, while the detonation is performed in cloſe veſſels; but in an open crucible, a ſmaller proportion of charcoal is required, in conſequence of part of the nitre being decompoſed by the action of the air of the atmoſphere. According to Kirwan, about 10 parts of charcoal are ſufficient to decompoſe 96 parts of nitre. Mr Kirwan alſo found that vegetable pitch and maltha did not produce any detonation with nitre, but merely burnt on its ſurface; and that the ſame quantity of charcoal was required for the decompoſition of the nitre, as if no bituminous ſubſtance had been employed. Since, therefore, bitumen produces no effect in decompoſing nitre, Kirwan thought that the proportion of charcoal, in any coal, might be aſcertained by detonation with nitre. In this way the proportion of carbonaceous and earthy matter in any coal being diſcovered, the proportion of bitumen which it contains may be eſtimated by calculation.

In the experiments on the analyſis of coal, Mr Kirwan employed a large crucible placed in a wind furnace, and expoſed to an equable heat. The coal was reduced to

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* Eſſays, i. 375.

Ibid. i. 31.

Ibid. i. 70.

Combuſtibles.

ſmall pieces of the ſize of a pin head, and was projected in portions of one or two grains at a time, into the nitre, the moment it became red hot. This was continued till the detonation ceaſed.

By this proceſs it appeared that 50 grains of Kilkenny coal were neceſſary to decompoſe 480 grains of nitre. According to the ſame proportion, 96 grains of nitre would have required for its decompoſition 10 grains of coal, which is exactly equal to the quantity of charcoal that would have been required to produce the ſame effect; and thus it appeared that Kilkenny coal is almoſt entirely compoſed of carbonaceous matter.

In the examination of cannel coal, Mr Kirwan burnt 240 grains, till the whole of the carbonaceous matter was conſumed; a reſiduum of ſeven grains and a half of reddiſh brown aſhes, which appeared to be chiefly aluminous earth, was left, or about 3.12 per cent. Sixty-ſix grains and a half of this coal were found neceſſary to decompoſe 480 grains of nitre. Fifty grains of charcoal would have produced the ſame effect, and hence $66\frac{1}{2}$ grains of coal contain 50 of charcoal, and 2.08 parts of aſhes, which being ſubtracted from $66\frac{1}{2}$ grains, leaves 14.42 for the quantity of bitumen contained in the coal. Hence the conſtituent parts of this coal are,

Charcoal,	75.2
Bitumen,	21.68
Aſhes,	3.1
	99.98

For a more particular analyſis of combuſtible minerals, ſee Mr Hatchett's experiments, detailed in the Philoſophical Tranſactions for 1804.

IV. *Analyſis of* Soils.

The examination of ſoils is by no means the leaſt important, becauſe on a knowledge of the nature and proportions of the ingredients which enter into the compoſition of ſoils, depends the opinion to be formed of their fertility. Soils conſiſt of different combinations of the earths, mixed with a certain proportion of animal and vegetable matter. The inveſtigation of the nature of ſoils has been particularly proſecuted by Mr Kirwan * and Mr Davy. From the obſervations of the latter, the following account of the analyſis of ſoils is extracted.

* See his *Treatiſe on Manures.*

1 Inſtruments for the analyſis of ſoils.

1. The really important inſtruments required for the analyſis of ſoils are few, and but little expenſive. They are, a balance capable of containing a quarter of a pound of common ſoil, and capable of turning when loaded with a grain; and a ſeries of weights from a quarter of a pound troy to a grain; a wire ſieve, ſufficiently coarſe to admit a pepper-corn through its apertures; an Argand lamp and ſtand; ſome glaſs bottles; Heſſian crucibles; porcelain or queen's ware evaporating baſons; a Wedgewood peſtle and mortar; ſome filters made of half a ſheet of blotting paper, folded ſo as to contain a pint of liquid, and greaſed at the edges; a bone knife, and an apparatus for collecting and meaſuring aeriform fluids.

The chemical ſubſtances or reagents required for ſeparating the conſtituent parts of the ſoil, are muriatic acid (ſpirit of ſalt), ſulphuric acid, and pure volatile alkali diſſolved in water, ſolution of pruſſiate of potaſh, ſoap lye, ſolution of carbonate of ammonia, of muriate of ammonia, ſolution of neutral carbonate of potaſh, and nitrate of ammonia.

Soils.

2 Mode of collecting ſoils for analyſis.

2. In caſes when the general nature of the ſoil of a field is to be aſcertained, ſpecimens of it ſhould be taken from different places, two or three inches below the ſurface, and examined as to the ſimilarity of their properties. It ſometimes happens, that upon plains the whole of the upper ſtratum of the land is of the ſame kind, and in this caſe one analyſis will be ſufficient; but in valleys, and near the beds of rivers, there are very great differences, and it now and then occurs, that one part of a field is calcareous, and another part ſiliceous; and in this caſe, and in analogous caſes, the portions different from each other ſhould be ſeparately ſubmitted to experiment.

Soils, when collected, if they cannot be immediately examined, ſhould be preſerved in phials quite filled with them, and cloſed with ground glaſs ſtoppers.

The quantity of ſoil moſt convenient for a perfect analyſis is from two to four hundred grains. It ſhould be collected in dry weather, and expoſed to the atmoſphere till it becomes dry to the touch.

The ſpecific gravity of a ſoil, or the relation of its weight to that of water, may be aſcertained by introducing into a phial, which will contain a known quantity of water, equal volumes of water and of ſoil; and this may be eaſily done by pouring in water till it is half full, and then adding the ſoil till the fluid riſes to the mouth; the difference between the weight of the ſoil and that of the water will give the reſult. Thus, if the bottle contain 400 grains of water, and gains 200 grains when half filled with water and half with ſoil, the ſpecific gravity of the ſoil will be two, that is, it will be twice as heavy as water; and if it gained 165 grains, its ſpecific gravity would be 1825, water being 1000.

It is of importance that the ſpecific gravity of a ſoil ſhould be known, as it affords an indication of the quantity of animal and vegetable matter it contains; theſe ſubſtances being always moſt abundant in the lighter ſoils.

The other phyſical properties of ſoils ſhould likewiſe be examined before the analyſis is made, as they denote, to a certain extent, their compoſition, and ſerve as guides in directing the experiments. Thus ſiliceous ſoils are generally rough to the touch, and ſcratch glaſs when rubbed upon it; aluminous ſoils adhere ſtrongly to the tongue, and emit a ſtrong earthy ſmell when breathed on; and calcareous ſoils are ſoft, and much leſs adheſive than aluminous ſoils.

3 Mode of aſcertaining the quantity of water abſorbed by ſoils.

3. Soils, though as dry as they can be made by continued expoſure to air, in all caſes ſtill contain a conſiderable quantity of water, which adheres with great obſtinacy to the earths and animal and vegetable matter, and can only be driven off from them by a conſiderable degree of heat. The firſt proceſs of analyſis is, to free the given weight of the ſoil from as much of this water as poſſible, without, in other reſpects, affecting its compoſition; and this may be done by heating it for ten or twelve minutes over an Argand's lamp, in a baſon of porcelain, to a temperature equal to 300 Fahrenheit; and in caſe a thermometer is not uſed, the proper degree may be eaſily aſcertained, by keeping a piece of wood in contact with the bottom of the diſh: as long as the colour of the wood remains unaltered, the heat is not too high; but when the wood begins to be charred, the proceſs muſt be ſtopped. A ſmall quantity of water will perhaps remain in the ſoil even after this operation, but

but it always affords uſeful comparative reſults; and if a higher temperature were employed, the vegetable or animal matter would undergo decompoſition, and in conſequence the experiment be wholly unſatisfactory.

The loſs of weight in the proceſs ſhould be carefully noted; and when in 400 grains of ſoil it reaches as high as 50, the ſoil may be conſidered as in the greateſt degree abſorbent, and retentive of water, and will generally be found to contain a large proportion of aluminous earth. When the loſs is only from 20 to 10, the land may be conſidered as only ſlightly abſorbent and retentive, and the ſiliceous earth as moſt abundant.

4
Separation of ſtones, &c.

4. None of the looſe ſtones, gravel, or large vegetable fibres ſhould be divided from the pure ſoil till after the water is drawn off; for theſe bodies are themſelves often highly abſorbent and retentive, and in conſequence influence the fertility of the land. The next proceſs, however, after that of heating, ſhould be their ſeparation, which may be eaſily accompliſhed by the ſieve, after the ſoil has been gently bruiſed in a mortar. The weights of the vegetable fibres or wood, and of the gravel and ſtones, ſhould be ſeparately noted down, and the nature of the laſt aſcertained: if calcareous, they will efferveſce with acids; if ſiliceous, they will be ſufficiently hard to ſcratch glaſs; and if of the common aluminous claſs of ſtones, they will be ſoft, eaſily ſcratched with a knife, and incapable of efferveſcing with acids.

5
Separation of the ſand and clay, or loam, from each other.

5. The greater number of ſoils, beſides gravel and ſtones, contain larger or ſmaller proportions of ſand of different degrees of fineneſs; and it is a neceſſary operation, the next in the proceſs of analyſis, to detach them from the parts in a ſtate of more minute diviſion, ſuch as clay, loam, marle, and vegetable and animal matter. This may be effected in a way ſufficiently accurate, by agitation of the ſoil in water. In this caſe, the coarſe ſand will generally ſeparate in a minute, and the finer in two or three minutes; whilſt the minutely divided animal or vegetable matter will remain in a ſtate of mechanical ſuſpenſion for a much longer time; ſo that, by pouring the water from the bottom of the veſſel, after one, two, or three minutes, the ſand will be principally ſeparated from the other ſubſtances, which, with the water containing them, muſt be poured into a filter, and, after the water has paſſed through, collected, dried, and weighed. The ſand muſt likewiſe be weighed, and their reſpective quantities noted down. The water of lixiviation muſt be preſerved, as it will be found to contain the ſaline matter, and the ſoluble animal or vegetable matters, if any exiſt in the ſoil.

6
Examination of the ſand.

6. By the proceſs of waſhing and filtration, the ſoil is ſeparated into two portions, the moſt important of which is generally the finely divided matter. A minute analyſis of the ſand is ſeldom or never neceſſary, and its nature may be detected in the ſame manner as that of the ſtones or gravel. It is always either ſiliceous ſand, or calcareous ſand, or a mixture of both. If it conſiſt wholly of carbonate of lime, it will be rapidly ſoluble in muriatic acid, with efferveſcence; but if it conſiſt partly of this ſubſtance, and partly of ſiliceous matter, the reſpective quantities may be aſcertained by weighing the reſiduum after the action of the acid, which muſt be applied till the mixture has acquired a ſour taſte, and has ceaſed to efferveſce. This reſiduum is the ſiliceous part; it muſt be waſhed, dried, and heated ſtrongly in a crucible: the difference between the weight of the whole, indicates the proportion of calcareous ſand.

7
Examination of the finely divided matter of ſoils, and mode of detecting mild lime and magneſia.

7. The finely divided matter of the ſoil is uſually very compound in its nature; it ſometimes contains all the four primitive earths of ſoils, as well as animal and vegetable matter; and to aſcertain the proportions of theſe with tolerable accuracy, is the moſt difficult part of the ſubject.

The firſt proceſs to be performed, in this part of the analyſis, is the expoſure of the fine matter of the ſoil to the action of the muriatic acid. This ſubſtance ſhould be poured upon the earthy matter in an evaporating baſon, in a quantity equal to twice the weight of the earthy matter; but diluted with double its volume of water. The mixture ſhould be often ſtirred, and ſuffered to remain for an hour or an hour and a half before it is examined.

If any carbonate of lime or of magneſia exiſt in the ſoil, they will have been diſſolved in this time by the acid, which ſometimes takes up likewiſe a little oxide of iron; but very ſeldom any alumina.

The fluid ſhould be paſſed through a filter; the ſolid matter collected, waſhed with rain water, dried at a moderate heat, and weighed. Its loſs will denote the quantity of ſolid matter taken up. The waſhings muſt be added to the ſolution; which, if not ſour to the taſte, muſt be made ſo by the addition of freſh acid, when a little ſolution of common pruſſiate of potaſh muſt be mixed with the whole. If a blue precipitate occur, it denotes the preſence of oxide of iron, and the ſolution of the pruſſiate muſt be dropped in till no further effect is produced. To aſcertain its quantity, it muſt be collected in the ſame manner as other ſolid precipitates, and heated: the reſult is oxide of iron.

Into the fluid freed from oxide of iron, a ſolution of neutralized carbonate of potaſh muſt be poured till all efferveſcence ceaſes in it, and till its taſte and ſmell indicate a conſiderable exceſs of alkaline ſalt.

The precipitate that falls down is carbonate of lime; it muſt be collected on the filter, and dried at a heat below that of redneſs.

The remaining fluid muſt be boiled for a quarter of an hour, when the magneſia, if any exiſt, will be precipitated from it, combined with carbonic acid, and its quantity is to be aſcertained in the ſame manner as that of the carbonate of lime.

If any minute proportion of alumina ſhould, from peculiar circumſtances, be diſſolved by the acid, it will be found in the precipitate with the carbonate of lime, and it may be ſeparated from it by boiling for a few minutes with ſoap lye, ſufficient to cover the ſolid matter. This ſubſtance diſſolves alumina, without acting upon carbonate of lime.

Should the finely divided ſoil be ſufficiently calcareous to efferveſce very ſtrongly with acids, a very ſimple method may be adopted for aſcertaining the quantity of carbonate of lime, and one ſufficiently accurate in all common caſes.

Carbonate of lime, in all its ſtates, contains a determinate proportion of carbonic acid, *i. e.* about 45 per cent.; ſo that when the quantity of this elaſtic fluid, given out by any ſoil during the ſolution of its calcareous matter in an acid, is known, either in weight or meaſure, the quantity of carbonate of lime may be eaſily diſcovered.

When

When the proceſs by diminution of weight is employed, two parts of the acid and one part of the matter of the ſoil muſt be weighed in two ſeparate bottles, and very ſlowly mixed together till the efferveſcence ceaſes; the difference between their weight before and after the experiment denotes the quantity of carbonic acid loſt; for every four grains and a half of which, ten grains of carbonate of lime muſt be eſtimated.

The beſt method of collecting the carbonic acid, ſo as to diſcover its volume, is by the pneumatic apparatus, the conſtruction and application of which are deſcribed at the end of this article. The eſtimation is, for every ounce meaſure of carbonic acid, two grains of carbonate of lime.

8
Mode of aſcertaining the quantity of inſoluble finely divided animal and vegetable matter.

8. After the fine matter of the ſoil has been acted upon by muriatic acid, the next proceſs is to aſcertain the quantity of finely divided inſoluble animal and vegetable matter that it contains.

This may be done with ſufficient preciſion, by heating it to ſtrong ignition in a crucible over a common fire till no blackneſs remains in the maſs. It ſhould be often ſtirred with a metallic wire, ſo as to expoſe new ſurfaces continually to the air; the loſs of weight that it undergoes denotes the quantity of the ſubſtance that it contains deſtructible by fire and air.

It is not poſſible to aſcertain whether this ſubſtance is wholly animal or vegetable matter, or a mixture of both. When the ſmell emitted during the incineration is ſimilar to that of burnt feathers, it is a certain indication of ſome animal matter; and a copious blue flame at the time of ignition almoſt always denotes a conſiderable proportion of vegetable matter. In caſes when the experiment is needed to be very quickly performed, the deſtruction of the decompoſable ſubſtances may be aſſiſted by the agency of nitrate of ammonia, which, at the time of ignition, may be thrown gradually upon the heated maſs, in the quantity of twenty grains for every hundred of reſidual oil. It affords the principle neceſſary to the combuſtion of the animal and vegetable matter, which it cauſes to be converted into elaſtic fluids; and it is itſelf at the ſame time decompoſed and loſt.

9
Mode of ſeparating aluminous and ſiliceous matter and oxide of iron.

9. The ſubſtances remaining after the decompoſition of the vegetable and animal matter, are generally minute particles of earthy matter containing uſually alumina and ſilica with combined oxide of iron.

To ſeparate theſe from each other, the ſolid matter ſhould be boiled for two or three hours with ſulphuric acid, diluted with four times its weight of water; the quantity of the acid ſhould be regulated by the quantity of ſolid reſiduum to be acted on, allowing for every hundred grains two drachms or one hundred and twenty grains of acid.

The ſubſtance remaining after the action of the acid may be conſidered as ſiliceous; and it muſt be ſeparated and its weight aſcertained, after waſhing and drying in the uſual manner.

The alumina and the oxide of iron, if they exiſt, are both diſſolved by the ſulphuric acid; they may be ſeparated by carbonate of ammonia, added to exceſs; it throws down the alumina, and leaves the oxide of iron in ſolution; and this ſubſtance may be ſeparated from the liquid by boiling.

Should any magneſia and lime have eſcaped ſolution in the muriatic acid, they will be found in the ſulphuric acid; this, however, is ſcarcely ever the caſe; but the proceſs for detecting them, and aſcertaining their quantities, is the ſame in both inſtances.

The method of analyſis by ſulphuric acid is ſufficiently preciſe for all uſual experiments; but if very great accuracy be an object, dry carbonate of potaſh muſt be employed as the agent, and the reſiduum of the incineration muſt be heated red for half an hour, with four times its weight of this ſubſtance, in a crucible of ſilver, or of well baked porcelain. The maſs obtained muſt be diſſolved in muriatic acid, and the ſolution evaporated till it is nearly ſolid; diſtilled water muſt then be added, by which the oxide of iron and all the earths, except ſilica, will be diſſolved in combination as muriates. The ſilex, after the uſual proceſs of lixiviation, muſt be heated red; the other ſubſtances may be ſeparated in the ſame manner as from the muriatic and ſulphuric ſolutions.

10
Mode of diſcovering ſoluble animal and vegetable matter, and ſaline matter.

10. If any ſaline matter, or ſoluble vegetable or animal matter, be ſuſpected in the ſoil, it will be found in the water of lixiviation uſed for ſeparating the ſand.

This water muſt be evaporated to dryneſs in an appropriate diſh, at a heat below its boiling point.

If the ſolid matter obtained is of a brown colour and inflammable, it may be conſidered as partly vegetable extract. If its ſmell, when expoſed to heat, be ſtrong and fœtid, it contains animal mucilaginous or gelatinous ſubſtance; if it be white and tranſparent, it may be conſidered as principally ſaline matter. Nitrate of potaſh (nitre), or nitrate of lime, is indicated in this ſaline matter, by its detonating with a burning coal. Sulphate of magneſia may be detected by its bitter taſte; and ſulphate of potaſh produces no alteration in ſolution of carbonate of ammonia, but precipitates ſolution of muriate of barytes.

11
Mode of detecting ſulphate of lime (gypſum) and phoſphate of lime in ſoils.

11. Should ſulphate or phoſphate of lime be ſuſpected in the entire ſoil, the detection of them requires a particular proceſs upon it. A given weight of it, for inſtance four hundred grains, muſt be heated red for half an hour in a crucible, mixed with one third of powdered charcoal. The mixture muſt be boiled for a quarter of an hour, in a half-pint of water, and the fluid collected through the filter, and expoſed for ſome days to the atmoſphere in an open veſſel. If any ſoluble quantity of ſulphate of lime (gypſum) exiſted in the ſoil, a white precipitate will gradually form in the fluid, and the weight of it will indicate the proportion.

Phoſphate of lime, if any exiſt, may be ſeparated from the ſoil after the proceſs for gypſum. Muriatic acid muſt be digeſted upon the ſoil, in quantity more than ſufficient to ſaturate the ſoluble earths; the ſolution muſt be evaporated, and water poured upon the ſolid matter. This fluid will diſſolve the compounds of earths with the muriatic acid, and leave the phoſphate of lime untouched.

12
Reſults and products.

12. When the examination of a ſoil is completed, the products ſhould be claſſed, and their quantities added together; and if they nearly equal the original quantity of ſoil, the analyſis may be conſidered as accurate. It muſt however be noticed, that when phoſphate or ſulphate of lime is diſcovered by the independent proceſs 11. a correction muſt be made for the general proceſs, by ſubtracting a ſum equal to their weight from the quantity of carbonate of lime obtained by precipitation from the muriatic acid.

In arranging the products, the form ſhould be in the order

order of the experiments by which they were obtained.

Thus, 400 grains of a good ſiliceous ſandy ſoil may be ſuppoſed to contain

Of water of abſorption,	18 grs.
Of looſe ſtones and gravel, principally ſiliceous,	42
Of undecompounded vegetable fibres,	10
Of fine ſiliceous ſand,	200
Of minutely divided matter ſeparated by filtration, and conſiſting of	
Carbonate of lime,	25
Carbonate of magneſia,	4
Matter deſtructible by heat, principally vegetable,	10
Silica,	40
Alumina,	32
Oxide of iron,	4
Soluble matter, principally ſulphate of potaſh and vegetable extract,	5
Gypſum,	3
Phoſphate of lime,	2
Amount of all the products,	395
Loſs,	5

In this inſtance the loſs is ſuppoſed ſmall; but in general, in actual experiments, it will be found much greater, in conſequence of the difficulty of collecting the whole quantities of the different precipitates; and when it is within thirty for four hundred grains, there is no reaſon to ſuſpect any want of due preciſion in the proceſſes.

13 Chemical compoſition f fertile orn ſoils n this climate.

13. A very fertile corn ſoil from Ormiſton in Eaſt Lothian afforded, in 100 parts, only 11 parts of mild calcareous earth; it contained 25 parts of ſiliceous ſand: the finely divided clay amounted to 45 parts. It loſt nine in decompoſed animal and vegetable matter, and four in water, and afforded indications of a ſmall quantity of phoſphate of lime.

This ſoil was of a very fine texture, and contained very few ſtones or vegetable fibres. It is not unlikely that its fertility was in ſome meaſure connected with the phoſphate; for this ſubſtance is found in wheat, oats, and barley, and may be a part of their food.

A ſoil from the low lands of Somerſetſhire, celebrated for producing excellent crops of wheat and beans without manure, was found to conſiſt of one-ninth of ſand, chiefly ſiliceous, and eight-ninths of calcareous marl tinged with iron, and containing about five parts in 100 of vegetable matter. No phoſphate or ſulphate of lime could be detected in it; ſo that its fertility muſt have depended principally upon its power of attracting principles of vegetable nouriſhment from water and the atmoſphere.

Mr Tillet, in ſome experiments made on the compoſition of ſoils at Paris, found that a ſoil compoſed of three-eighths of clay, two-eighths of river ſand, and three eighths of the parings of limeſtone, was very proper for wheat.

14 ompoſition f ſoils proper for bulbous roots and for rees.

14. In general, bulbous roots require a ſoil much more ſandy and leſs abſorbent than the graſſes. A very good potato ſoil, from Varſel in Cornwall, afforded ſeven-eighths of ſiliceous ſand; and its abſorbent power was ſo ſmall, that 100 parts loſt only two by drying at 400 Fahrenheit.

Plants and trees, the roots of which are fibrous and hard, and capable of penetrating deep into the earth, will vegetate to advantage in almoſt all common ſoils which are moderately dry, and which do not contain a very great exceſs of vegetable matter.

The ſoil taken from a field at Sheffield-place in Suſſex, remarkable for producing flouriſhing oaks, was found to conſiſt of ſix parts of ſand, and one part of clay and finely divided matter. And 100 parts of the entire ſoil, ſubmitted to analyſis, produced

Water,	3 parts
Silica,	54
Alumina,	28
Carbonate of lime,	3
Oxide of iron,	5
Decompoſing vegetable matter,	4
Loſs,	3

15 Improvements made by changing the compoſition of the earthy parts of ſoils.

15. From the great difference of the cauſes that influence the productiveneſs of lands, it is obvious that, in the preſent ſtate of ſcience, no certain ſyſtem can be deviſed for their improvement, independent of experiment: but there are few caſes in which the labour of analytical trials will not be amply repaid by the certainty with which they denote the beſt methods of amelioration; and this will particularly happen when the defect of compoſition is found in the proportions of the primitive earths.

In ſupplying animal or vegetable manure, a temporary food only is provided for plants, which is in all caſes exhauſted by means of a certain number of crops; but when a ſoil is rendered of the beſt poſſible conſtitution and texture, with regard to its earthy parts, its fertility may be conſidered as permanently eſtabliſhed. It becomes capable of attracting a very large portion of vegetable nouriſhment from the atmoſphere, and of producing its crops with comparatively little labour and expence.

Deſcription of the Apparatus for the Analyſis of Soils.

Plate DIX.

A, Retort.

B, B, Funnels for the purpoſe of filtrating.

D, Balance.

E, Argand's lamp.

F, G, H, K, The different parts of the apparatus required for meaſuring the quantity of elaſtic fluid given out during the action of an acid on calcareous ſoils.

F, Repreſents the bottle for containing the ſoil.

K, The bottle containing the acid furniſhed with a ſtopcock.

G, The tube connected with a flaccid bladder.

I, The graduated meaſure.

H, The bottle for containing the bladder. When this inſtrument is uſed, a given quantity of ſoil is introduced into F; K is filled with muriatic acid diluted with an equal quantity of water; and the ſtopcock being cloſed is connected with the upper orifice of F, which is ground to receive it. The tube G is introduced into the lower orifice of F, and the bladder connected with it placed in its flaccid ſtate into H, which is filled with water. The graduated meaſure is placed under the tube of H. When the ſtopcock of K is turned ed, the acid flows into F, and acts upon the ſoil; the elaſtic fluid generated paſſes through G into the bladder, and diſplaces a quantity of water in H equal to it in bulk, and this water flows through the tube into the graduated meaſure; the water in which gives by its volume the indication of the proportion of carbonic acid diſengaged from the ſoil; for every ounce meaſure of which two grains of carbonate of lime may be eſtimated.

L, Repreſents the ſtand for the lamp.

M, N, O, P, Q, R, S, Repreſent the bottles containing the different reagents [*].

Artificial STONE. See STUCCO.

Elaſtic STONE. Some marbles poſſeſs the property of elaſticity, and hence come under the denomination of elaſtic ſtones. But the moſt remarkable ſtone of this nature is the elaſtic ſandſtone from Brazils. It is a micaceous ſandſtone in laminæ not exceeding half an inch in thickneſs. Some ſiliceous ſtones alſo have the ſame property, or acquire it by being expoſed to a certain degree of heat.

Philoſopher's STONE. See PHILOSOPHER'S *Stone*.

Precious STONES. See GEM.

Rocking STONE, or *Logan*, a ſtone of a prodigious ſize, ſo exactly poiſed, that it would rock or ſhake with the ſmalleſt force. Of theſe ſtones the ancients give us ſome account. Pliny ſays, that at Harpaſa, a town of Aſia, there was a rock of ſuch a wonderful nature, that if touched with the finger it would ſhake, but could not be moved from its place with the whole force of the body [*]. Ptolemy Hepheſtion mentions [†] a gygonian ſtone near the ocean, which was agitated when ſtruck by the ſtalk of an aſphodel, but could not be removed by a great exertion of force. The word *gygonius* ſeems to be Celtic; for *gwingog* ſignifies *motitans*, the rocking-ſtone.

Many rocking ſtones are to be found in different parts of this iſland; ſome natural, others artificial, or placed in their poſition by human art. In the pariſh of St Leven, Cornwall, there is a promontory called *Caſtle Treryn*. On the weſtern ſide of the middle group, near the top, lies a very large ſtone, ſo evenly poiſed that any hand may move it from one ſide to another; yet it is ſo fixed on its baſe, that no lever nor any mechanical force can remove it from its preſent ſituation. It is called the *Logan-ſtone*, and is at ſuch a height from the ground that no perſon can believe that it was raiſed to its preſent poſition by art. But there are other rocking ſtones, which are ſo ſhaped and ſo ſituated, that there can be no doubt but they were erected by human ſtrength. Of this kind Borlaſe thinks the great *Quoit* or *Karn-lehau*, in the pariſh of Tywidnek, to be. It is 39 feet in circumference, and four feet thick at a medium, and ſtands on a ſingle pedeſtal. There is alſo a remarkable ſtone of the ſame kind in the iſland of St Agnes in Scilly. The under rock is 10 feet ſix inches high, 47 feet round the middle, and touches the ground with no more than half its baſe. The upper rock reſts on one point only, and is ſo nicely balanced, that two or three men with a pole can move it. It is eight feet ſix inches high, and 47 in circumference. On the top there is a baſon hollowed out, three feet eleven inches in diameter at a medium, but wider at the brim, and three feet deep. From the globular ſhape of this upper ſtone, it is highly probable that it was rounded by human art, and perhaps even placed on its pedeſtal by human ſtrength. In Sithney pariſh, near Helſton, in Cornwall, ſtood the famous logan, or rocking ſtone, commonly called *Men Amber*, q. d. *Men an Bar*, or the *top-ſtone*. It was eleven feet by ſix, and four high, and ſo nicely poiſed on another ſtone that a little child could move it, and all travellers who came this way deſired to ſee it. But Shrubſall, Cromwell's governor of Pendennis, with much ado cauſed it to be undermined, to the great grief of the country. There are ſome marks of the tool on it, and, by its quadrangular ſhape, it was probably dedicated to Mercury.

That the rocking ſtones are monuments erected by the Druids cannot be doubted; but tradition has not informed us for what purpoſe they were intended. Mr Toland thinks that the Druids made the people believe that they alone could move them, and that by a miracle; and that by this pretended miracle they condemned or acquitted the accuſed, and brought criminals to confeſs what could not otherwiſe be extorted from them. How far this conjecture is right we ſhall leave to thoſe who are deeply verſed in the knowledge of antiquities to determine.

Sonorous STONE, a kind of ſtone remarkable for emitting an agreeable ſound when ſtruck, and much uſed in China for making muſical inſtruments which they call *king*.

The various kinds of ſonorous ſtones known in China differ conſiderably from one another in beauty, and in the ſtrength and duration of their tone; and what is very ſurpriſing, is that this difference cannot be diſcovered either by the different degrees of their hardneſs, weight, or fineneſs of grain, or by any other qualities which might be ſuppoſed to determine it. Some ſtones are found remarkably hard, which are very ſonorous; and others exceedingly ſoft, which have an excellent tone; ſome extremely heavy emit a very ſweet ſound; and there are others as light as pumice ſtone which have alſo an agreeable ſound.

The chemiſts and naturaliſts of Europe have never yet attempted to diſcover, whether ſome of our ſtones may not have the ſame properties as the ſonorous ſtones of the extremities of Aſia. It however appears, that the Romans were formerly acquainted with a ſonorous ſtone of the claſs of *hiang-che*. Pliny (ſays the Abbé du Bos, in his Reflections on Poetry and Painting, when ſpeaking of curious ſtones) obſerves that the ſtone called *chalcophonas*, or *brazen ſound*, is black; and that, according to the etymology of its name, it ſends forth a ſound much reſembling that of braſs when it is ſtruck. The paſſage of Pliny is as follows: *Chalcophonas nigra eſt; ſed eliſa æris tinnitum reddit.*

Some ſonorous ſtones were at length ſent into France, and

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[*] Phil. Mag. vol. xxiii. p. 26.

[*] Lib. ii. c. 69.

[†] Lib. iii. c. 3.

Borlaſe, chap. iv. p. 181.

Stone, Stonehenge.

and the late Duke de Chaulnes examined them with particular attention. The following are ſome of his obſervations: "The Academy of Sciences, Mr Romé de Liſle, and ſeveral other learned mineralogiſts, when aſked if they were acquainted with the black ſtone of which the Chineſe king was made, for anſwer cited the paſſage of Pliny mentioned by Boetius de Boot, Linnæus, and in the Dictionary of Bomare, and added what Mr Anderſon ſays in his Natural Hiſtory of Iceland reſpecting a bluiſh kind of ſtone which is very ſonorous. As the black ſtone of the Chineſe becomes of a bluiſh colour when filed, it is probably of the ſame ſpecies. None of the reſt who were conſulted had ever ſeen it. The Chineſe ſtone has a great reſemblance at firſt ſight to black marble, and like it is calcareous; but marble generally is not ſonorous. It alſo externally reſembles touchſtone, which is a kind of baſaltes, and the baſaltes found near volcanoes; but theſe two ſtones are vitrifications."

The duke next endeavoured to procure ſome information from the ſtone-cutters. They all replied, that blue-coloured marble was very ſonorous, and that they had ſeen large blocks of it which emitted a very ſtrong ſound; but the duke having ordered a king to be conſtructed of this kind of ſtone, it was found that it did not poſſeſs that property. By trying the black marble of Flanders, a piece was at length found which emitted an agreeable ſound: it was cut into a king, which is almoſt as ſonorous as thoſe of China. All theſe obſervations give us reaſon to believe that the ſtones of which the king are formed are nothing elſe but a black kind of marble, the conſtituent parts of which are the ſame as thoſe of the marble of Europe, but that ſome difference in their organization renders them more or leſs ſonorous.

*Swine-*STONE (*lapis ſuillus*), or *fetid ſtone*, ſo called from its exceſſively fetid ſmell, is a calcareous ſtone impregnated with petroleum. See MINERALOGY *Index*.

STONE-*Marrow*, a variety of clay ſo called from its having the appearance of marrow.

STONE-*Ware*, a ſpecies of pottery ſo called from its hardneſs. See *DELFT-Ware* and PORCELAIN.

STONE *in the Bladder*. See MEDICINE, N° 400, and SURGERY *Index*.

STONE, in merchandize, denotes a certain weight for weighing commodities. A ſtone of beef at London is the quantity of eight pounds: in Herefordſhire 12 pounds: in the North 16 pounds. A ſtone of glaſs is five pounds; of wax eight pounds. A ſtone of wool (according to the ſtatute of 11 Hen. VII.) is to weigh 14 pounds; yet in ſome places it is more, in others leſs; as in Glouceſterſhire 15 pounds; in Herefordſhire 12 pounds. Among horſe-courſers a ſtone is the weight of 14 pounds.

The reaſon of the name is evident. Weights at firſt were generally made of ſtone. See Deut. xxv. 13. where the word אבן, tranſlated *weight*, properly ſignifies a *ſtone*.

STONE-*Chatter*. See MOTACILLA, ORNITHOLOGY *Index*.

STONEHENGE, a celebrated monument of antiquity, ſtands in the middle of a flat area near the ſummit of a hill ſix miles diſtant from Saliſbury. It is incloſed by a circular double bank and ditch near 30 feet broad, after croſſing which we aſcend 30 yards before we reach the work. The whole fabric conſiſted of two circles and two ovals. The outer circle is about 108 feet diameter, conſiſting when entire of 60 ſtones, 30 uprights and 30 impoſts, of which remain only 24 uprights, 17 ſtanding and 7 down, $3\frac{1}{2}$ feet aſunder, and 8 impoſts. Eleven uprights have their 5 impoſts on them by the grand entrance. Theſe ſtones are from 13 to 20 feet high. The leſſer circle is ſomewhat more than 8 feet from the inſide of the outer one, and conſiſted of 40 leſſer ſtones (the higheſt 6 feet), of which only 19 remain, and only 11 ſtanding: the walk between theſe two circles is 300 feet in circumference. The adytum or cell is an oval formed of 10 ſtones (from 16 to 22 feet high), in pairs, with impoſts, which Dr Stukeley calls *trilithons*, and above 30 feet high, riſing in height as they go round, and each pair ſeparate, and not connected as the outer pair; the higheſt 8 feet. Within theſe are 19 more ſmaller ſingle ſtones, of which only 6 are ſtanding. At the upper end of the adytum is the altar, a large ſlab of blue coarſe marble, 20 inches thick, 16 feet long, and 4 broad; preſſed down by the weight of the vaſt ſtones that have fallen upon it. The whole number of ſtones, uprights, impoſts, and altar, is exactly 140. The ſtones are far from being artificial, but were moſt probably brought from thoſe called the *Grey Weathers* on Marlborough Downs, 15 or 16 miles off; and if tried with a tool they appear of the ſame hardneſs, grain, and colour, generally reddiſh. The heads of oxen, deer, and other beaſts, have been found on digging in and about Stonehenge; and human bones in the circumjacent barrows. There are three entrances from the plain to this ſtructure, the moſt conſiderable of which is from the north-eaſt, and at each of them were raiſed on the outſide of the trench two huge ſtones with two ſmaller within parallel to them.

Stonehenge.

Gough's edition of Camden's Britannia, vol i. p. 107.

It has been long a diſpute among the learned, by what nation, and for what purpoſe, theſe enormous ſtones were collected and arranged. The firſt account of this ſtructure we meet with is in Geoffroy of Monmouth, who, in the reign of King Stephen, wrote the hiſtory of the Britons in Latin. He tells us, that it was erected by the counſel of Merlin the Britiſh enchanter, at the command of Aurelius Ambroſius the laſt Britiſh king, in memory of 460 Britons who were murdered by Hengiſt the Saxon. The next account is that of Polydore Virgil, who ſays that the Britons erected this as a ſepulchral monument of Aurelius Ambroſius. Others ſuppoſe it to have been a ſepulchral monument of Boadicea the famous Britiſh queen. Inigo Jones is of opinion, that it was a Roman temple; from a ſtone 16 feet long, and four broad, placed in an exact poſition to the eaſtward altar-faſhion. Mr Charlton attributed it to the Danes, who were two years maſters of Wiltſhire. A tin tablet, on which were ſome unknown characters, ſuppoſed to be Punic, was digged up near it in the reign of Henry VIII. but is loſt; probably that might have given ſome information reſpecting its founders. Its common name, *Stonehenge*, is Saxon, and ſignifies a "ſtone gallows," to which thoſe ſtones, having tranſverſe impoſts, bear ſome reſemblance. It is alſo called in Welch *choir gour*, or "the giants dance."

Mr Groſe thinks that Dr Stukeley has completely proved this ſtructure to have been a Britiſh temple in which the Druids officiated. He ſuppoſes it to have been the metropolitan temple of Great Britain, and tranſlates

Groſe's Antiquities, vol. iv. p. 40.

tranſlates the words *choir gour* "the great choir or temple." The learned Mr Bryant is of opinion that it was erected by a colony of Cuthites probably before the time of the Druids; becauſe it was uſual with them to place one vaſt ſtone upon another for a religious memorial; and theſe they often placed ſo equably, that even a breath of wind would ſometimes make them vibrate. Of ſuch ſtones one remains at this day in the pile of Stonehenge. The ancients diſtinguiſhed ſtones erected with a religious view, by the name of *amber*; by which was ſignified any thing ſolar and divine. The Grecians called them *πετραι αμβροσιαι*, *petræ ambroſiæ*. Stonehenge, according to Mr Bryant, is compoſed of theſe amber ſtones: hence the next town is denominated *Ambreſbury*; not from a Roman Ambroſius, for no ſuch perſon ever exiſted, but from the *ambroſiæ petræ*, in whoſe vicinity it ſtood. Some of theſe were rocking ſtones; and there was a wonderful monument of this ſort near Penzance in Cornwall, which ſtill retains the name of *main-amber*, or the ſacred ſtones. Such a one is mentioned by Apollonius Rhodius, ſuppoſed to have been raiſed in the time of the Argonautæ, in the iſland Tenos, as the monument of the two winged ſons of Boreas, ſlain by Hercules; and there are others in China and other countries.

STOOK, a term uſed in many parts of the kingdom for a ſhock of corn containing 12 ſheaves.

STOOL, in *Medicine*, an evacuation or diſcharge of the fæces by the anus.

STOOL, in *Mining*, is uſed when the miners leave off digging deeper, and work in the ends forward. The end before them is called the *ſtool*.

STOOL, in *Ship-building*, the name of the ſupporters of the poop and top lanterns.

STOOPING, in *Falconry*, is when a hawk, being upon her wings at the height of her pitch, bends down violently to take the fowl.

STOPPERS, in a ſhip, certain ſhort pieces of rope, which are uſually knotted at one or both ends, according to the purpoſe for which they are deſigned. They are either uſed to ſuſpend any heavy body, or to retain a cable, ſhroud, &c. in a fixed poſition. Thus, the anchors, when firſt hoiſted up from the ground, are hung to the cat-head by a ſtopper attached to the latter, which paſſing through the anchor ring, is afterwards faſtened to the timber-head; and the ſame rope ſerves to faſten it on the bow at ſea; or to ſuſpend it by the ring which is to be ſunk from the ſhip to the bottom. The ſtoppers of the cable have a large knot and a laniard at one end, and are faſtened to a ring-bolt in the deck by the other. They are attached to the cable by the laniard, which is faſtened ſecurely round both by ſeveral turns paſſed behind the knot, or about the neck of the ſtopper; by which means the cable is reſtrained from running out of the ſhip when ſhe rides at anchor.

The ſtoppers of the ſhroud have a knot and a laniard at each end. They are only uſed when the ſhrouds are cut aſunder in battle, or diſabled by tempeſtuous weather: at which time they are laſhed, in the ſame manner as thoſe of the cables, to the ſeparated parts of the ſhroud, which are thereby reunited, ſo as to be fit for immediate ſervice. This, however, is only a temporary expedient.

STOPS. See PUNCTUATION; and SCRIPTURE, N° 136.

STORAX. See STYRAX, MATERIA MEDICA *Index*.

STORK. See ARDEA, ORNITHOLOGY *Index*.

STOVE for heating apartments, greenhouſes, hothouſes, fruit-walls, &c.

When treating of the mechanical properties of air, we explained in ſufficient detail the manner in which the expanſion produced in a maſs of air by heat produces that motion up our chimneys which is called the draught of the chimney; and, in the article SMOKE, we conſidered the circumſtances which tend to check, to promote, or to direct this current, ſo as to free us from the ſmoke and vitiated air which neceſſarily accompanies the conſumption of the fuel. In PNEUMATICS we alſo attended to the manner in which our fires immediately operate in warming our apartments. At preſent, when about to deſcribe a method of warming intrinſically different, we muſt pay ſome more attention to the diſtinguiſhing circumſtance. Without pretending to explain the phyſical connection of heat and light, it may ſuffice to obſerve, that heat, as well as light, is communicated to diſtant bodies in an inſtant by radiation. A perſon paſſing haſtily by the door of a glaſs-houſe feels the glow of heat in the very moment he ſees the dazzling light of the furnace mouth, and it is interrupted by merely ſcreening his face with his hand. In this way is an apartment partly warmed by an open fire; and we avoid the oppreſſive heat by ſitting where the fire is not ſeen, or by interpoſing a ſcreen. We are apt to connect this ſo ſtrongly in the imagination with the light emitted by the fire, that we attribute the heat to the immediate action of the light. But this opinion is ſhown to be gratuitous by a curious experiment made before the Royal Society by Dr Hooke, and afterwards, with more care and accurate examination, by Mr Scheele. They found, that by bringing a plate of the moſt tranſparent glaſs briſkly between the fire and one's face, the heat is immediately intercepted without any ſenſible diminution of the light. Scheele, by a very pretty inveſtigation, diſcovered that the glaſs made the ſeparation, and did it both in refraction and reflection; for he found, that when the light of the ſame fire was collected into a focus by means of a poliſhed metal concave ſpeculum, a thermometer placed there was *inſtantly* affected. But if we employ a glaſs ſpeculum foiled in the uſual manner with quickſilver, of the ſame diameter and focal diſtance, and of equally brilliant reflection, there is hardly any ſenſible heat produced in the focus, and the thermometer muſt remain there for a very long while before it is ſenſibly affected. When we repeated this curious experiment, we found, that after the glaſs has remained a long while in this poſition, whether tranſmitting or reflecting the light, it loſes in a great meaſure its power of intercepting the heat. By varying this obſervation in many of its circumſtances, we think ourſelves entitled to conclude, that the glaſs abſorbs the heat which it intercepts, and is very quickly heated by the abſorption. While it riſes in its own temperature, it intercepts the heat powerfully; but when it is, as it were, ſaturated, attracting no more than what it immediately imparts to the air in corporeal contact with it, the heat paſſes freely through along with the light. If the

the glaſs be held ſo near the fire that the ſurrounding air is very much heated, no ſenſible interruption of heat is perceived after the glaſs is thus ſaturated. We found the cheek more quickly ſenſible than the thermometer of this inſtantaneous radiation of the heat which accompanies the light, or is ſeparated from it in this experiment. It is a very inſtructive experiment in the phyſiology of heat.

We cannot ſay how far this radiation of heat may extend, nor whether the accompaniment of light is abſolutely neceſſary. The mathematician proceeds on the ſuppoſition that it extends as far as the radiation of light, and that, being alſo rectilineal, the denſity of the heat is proportional to that of the light. But theſe notions are ſomewhat gratuitous; and there are appearances which render them doubtful. When with a lens of an inch in diameter we form a focus on a piece of black unpoliſhed marble of an inch diameter, the mathematician muſt allow that no more rays fall on the marble than if the lens were away: therefore the marble ſhould be equally warmed in either caſe. But it is by no means ſo, as we have repeatedly found by expoſing it during equal times, and then dropping it into water. The water which is heated by the marble on which the focus has been formed will be found to have acquired from it much more heat than from the other. The tops of lofty mountains which are never ſhaded by clouds, but enjoy perpetual ſunſhine and ſerenity, inſtead of being warmer than the valleys below, are covered with never-melting ſnow; and we have ſome grounds to ſuſpect that the genial influence of the ſun requires the co-operation of the atmoſphere, and to doubt whether there is any warmth at the moon, on which no atmoſphere like ours can be obſerved. Perhaps the heat which cheers us, and fertilizes our earth, is chemically ſeparated from our atmoſphere by its elective attraction for the light of the ſun. Our ſucceſſors in the ſtudy of meteorology need not fear that the ſubject of their reſearch will be ſoon deprived of ſcientific allurements. We know but little of it after all the progreſs we have made during this laſt century, and it ſtill preſents an ample field of diſcuſſion.

We ſaid that the accompaniment of light is not demonſtrably neceſſary. We are certain that heat may be imparted without any ſenſible light, in a manner which we can hardly ſuppoſe any thing but radiation. If a piece of very hot iron be placed a little without the principal focus of a metallic concave ſpeculum, and a very ſenſible air-thermometer be placed in its conjugate focus, it will inſtantly ſhow an elevation of temperature, although the iron is quite imperceptible to an eye which has even been a long while in the dark. No ſuch riſe of temperature is obſerved if the thermometer be placed a little to one ſide of the focus of the ſpeculum; therefore the phenomenon is preciſely ſimilar to the radiation of light. We are obliged therefore to acknowledge that the heat is radiated in this experiment in the ſame way that light is in the common optical experiments.

Although this is the moſt uſual way that we in this country employ fuel for warming our apartments, it is by no means the only way in which the heat diffuſed from this fuel may be imparted to diſtant bodies. It is not even the moſt effectual method; it is diffuſed alſo by immediate communication to bodies in contact. The air in immediate contact with the burning fuel is heated, and imparts ſome of its heat to the air lying beyond it, and this is partly ſhared with the air which is ſtill farther off; and this diffuſion, by communication in *contactu*, goes on till the remote air contiguous to the walls, the floor, the ceiling, the furniture, the company, all get a ſhare of it in proportion to their attractions and their capacities. And as the air is thus continually ſupplied, and continually gives out heat, the walls, &c. become gradually warmer, and the room becomes comfortable and pleaſant, But we apprehend that no great proportion of the heat actually acquired by the room is communicated in this way. This diffuſion by contact is but ſlow, eſpecially in air which is very dry; ſo ſlow indeed, that the air in the immediate neighbourhood of the fuel is hurried up the chimney before it has time to impart any of the heat received in contact. We know that the time employed in diffuſing itſelf in this way through ſtagnant air to any moderate diſtance is very conſiderable. We imagine therefore that the heat, communicated to our rooms by an open fire is chiefly by radiation, but in a way ſomething different from what we mentioned before. We imagine, that as the piece of glaſs in Dr Hooke's experiment abſorbs the heat, ſo the whole maſs of air which fills the room intercepts the radiated heat in every part of the room where the fire is ſeen, and is as it were ſaturated with it throughout, and ready to impart it to every body immerſed in it. We cannot otherwiſe account for the *equability* of the heat in the different parts of the room. Mere radiation on the ſolid bodies would warm them in the inverſe duplicate ratio of their diſtances from the fire; and diffuſion by contact, if compatible with the rapid current up the chimney, would heat the room ſtill more unequably. Recollect how ſlowly, and with what rapid diminution of intenſity, the colour of blue vitriol is communicated to water even to a very ſmall diſtance. But becauſe all parts of the air of the room abſorb radiated heat, what is ſaturated at a higher temperature, being nearer to the fire riſes to the ceiling, ſpreads outwards along the ceiling, and has its place ſupplied by the air, which is thus puſhed towards the fire from the places which are not directly illuminated.

Far different is the method of warming the room by a ſtove. Here the radiation, if any, is very feeble or ſcanty; and if a paſſage were allowed up the chimney for the warmed air, it would be quickly carried off. This is well known to the Engliſh who reſide in the cold climates of St Peterſburgh, Archangel, &c. They love the exhilarating flutter of an open fire, and often have one in their parlour; but this, ſo far from warming the room during the extreme cold weather, obliges them to heat their ſtoves more frequently, and even abſtracts the heat from a whole ſuit of apartments. But all paſſage this way is ſhut up when we warm a room by ſtoves. The air immediately contiguous to the ſtove is heated by contact, and this heat is gradually, though ſlowly, diffuſed through the whole room. The diffuſion would however be very ſlow indeed, were it not for the great expanſibility of air by heat. But the air ſurrounding the ſtove quickly expands and riſes to the ceiling, while the neighbouring air ſlides in to ſupply the place, nay is even puſhed in by the air which goes outwards aloft. Thus the whole air is ſoon mixed, and the room acquires almoſt an equal temperature throughout.

The warming by ſtoves muſt therefore be managed upon very different principles from thoſe adopted in the employment of open fires. The general principle is, 1ſt, To employ the fuel in the moſt effectual manner for heating the external part of the ſtove, which is immediately efficient in warming the contiguous air; and, 2d, To keep in the room the air already warmed, at leaſt as much as is conſiſtent with wholeſomeneſs and cleanlineſs.

The firſt purpoſe is accompliſhed by conducting the flue of the furnace round its external parts, or, in ſhort, by making every part of the flue external. Of all forms, that of a long pipe, returned backwards and forwards, up and down (provided only that the place of its laſt diſcharge be conſiderably higher than its entry from the fire-place), would be the moſt effectual. We have ſeen a very ſmall ſtove conſtructed in this way, the whole being incloſed in a handſome caſe of poliſhed iron plate, pierced and cut into elegant foliage like the cock of a watch, ſo that the odd looking pipes were completely concealed. Though only three feet long, one foot thick, and ſix feet high, it warmed a very lofty room of 24 feet by 18, and conſumed leſs than half the fuel of a ſtove of the more uſual make, which did not ſo fully warm a ſmaller chamber.

It would occupy a volume to deſcribe the immenſe variety of ſtoves which ingenuity or architectonic taſte has conſtructed. We ſhall content ourſelves with giving a ſpecimen of the two chief claſſes into which they may be diſtinguiſhed.

The air of a room may be equally warmed, either by applying it to the ſurface of a ſmall ſtove made very hot, or to the ſurface of a much larger ſtove more moderately heated. The firſt kind is chiefly uſed in Holland, Flanders, and the milder climates of Germany and Poland. The laſt are univerſally uſed in the frozen climates of Ruſſia and Sweden. The firſt are generally made of caſt-iron, and the laſt of brick-work covered with glazed tiles or ſtucco.

Plate DX. fig. 1.

Fig. 1. repreſents a ſmall German ſtove fully ſufficient for warming a room of 24 feet by 18. The baſe is about three feet broad and 14 inches deep, that is, from back to front, and ſix or ſeven feet high. The decoration is in the faſhion of that country; but the operative ſtructure of it will admit of any ſtyle of ornament. A, is the fire-place, and the wood or charred coal is laid on the bottom, which has no bars. Bars would admit the air too freely among the fuel, and would both conſume it too faſt and raiſe too great a heat. That no heat may be uſeleſsly expended, the ſole of the fire-place and the whole bottom of the ſtove is raiſed an inch or two above the floor of the room, and the air is therefore warmed by it in ſucceſſion, and riſes upwards. For the ſame reaſon the back of the ſtove is not in contact with the wall of the room, or of the niche in which it is placed. The fire-place is ſhut up by a door which fits cloſely to its caſe, and has a ſmall wicket at the bottom, whoſe aperture is regulated by a ſliding plate, ſo as to admit no more air than what ſuffices for ſlowly conſuming the fuel. The flame and heated air riſe to the top of the fire-place three or four inches above the arch or mantle-piece, and get out laterally by two narrow paſſages B, B, immediately below the top plate of the baſe. The current bends downward on each ſide, paſſes at C, C, under the partition plates which divide the two ſide chambers, and then riſes upwards through the outer diviſion of each, and paſſes through narrow ſlits D, D, in the top plate, and from thence along the two hollow piers E, E. The two lateral currents unite at the top of the arch, and go through the ſingle paſſage F into the larger hollow behind the eſcutcheon G. From this place it either goes ſtraight upwards into the vent in the wall by a pipe on the top of the ſtove, or it goes into the wall behind by a pipe inſerted in the back of the ſtove. The propriety of this conſtruction is very obvious. The current of hot air is applied to exterior parts of the ſtove everywhere except in the two ſide chambers of the baſe, where the partition-plates form one ſide of the canal. Even this might be avoided by making each of theſe ſide-chambers a detached hollow pillar. But this would greatly increaſe the trouble of conſtruction and joining together, and is by no means neceſſary. The arch H has a graceful appearance, and affords a very warm ſituation for any thing that requires it, ſuch as a drink in a ſick perſon's bed-chamber, &c. Perſons of a certain claſs uſe this place for keeping a diſh warm; nay, the lower part of the arch is frequently occupied by an incloſed chamber, where the heat riſes high enough even for dreſſing victuals, as will be eaſily imagined when we reflect that the ſole of it is the roof of the fire-place.

The ſtove now deſcribed is ſupplied with fuel and with air by the front door opening into the room. That there may be room for fuel, this middle part projects a few inches before the two ſide-chambers. Theſe laſt, with the whole upper part of the ſtove, are not more than ten inches deep. The paſſages, therefore, from the fire-place are towards the back of it; ſo that if we have a mind to ſee the fire (which is always cheerful), the door may be thrown open, and there is no danger of the ſmoke coming out after the current has once warmed the upper part of the ſtove. When the ſtove is of ſuch dimenſions that the baſe is about two feet and a half or three feet high, the fire-place may be furniſhed with a ſmall grate in the Britiſh ſtyle. If the door is ſo hung that it can not only be thrown back, but lifted off its hinges, we have a ſtove grate of the completeſt kind, fully adequate, in our mild climate, to warm a handſome apartment, even with an open fire; and when we hang on the door, and ſhut up the fire-place, a ſtove of the dimenſions already given is almoſt too much for a large drawing room.

We have frequently remarked, that one ſide of theſe ſtoves grows much warmer than the other, and that it was difficult to prevent or remedy this; and we imagine that this is an unavoidable defect in all ſtoves with a double flue. It is ſcarcely poſſible to make the fire ſo equable in the fire-place, that one ſide ſhall not be a little warmer than the other, and a briſker current will then be produced in it. This muſt increaſe the conſumption of the fuel on this ſide, which will increaſe the current, will heat this ſide ſtill more, and thus go on continually till the fuel on this ſide is expended; after which the other ſide will obtain and increaſe the ſuperiority. The flue is made double, that the fire-place may occupy the middle of the front; and it will be difficult to gain this point of ſymmetry with one flue. The inconvenience may, however, be corrected by damping valves placed in ſome part of the upright funnels E, E.

In the colder winters on the continent, it is thought neceſſary to increaſe the effect by making the fire-place open to the back of the ſtove. Its mouth or door communicates with or is joined to an opening of the ſame dimenſions formed in the wall, and the door is on the other ſide in an antichamber or lobby. In Weſtphalia, and other places of Germany, the apartments are diſpoſed round a ſpacious lobby, into which all their fireplaces open, and are there ſupplied with fuel. By this conſtruction it is plain that the air of the room, already warmed by the ſtove, is not carried off, and the room is more heated. But this method is very unfavourable to cheerfulneſs and health. The ſame air, confined, and repeatedly breathed and compounded with all the volatile emanations of the room, quickly loſes that refreſhing quality that is ſo deſirable, and even ſo neceſſary for health. It is never renewed except by very partial admixtures when the room doors are thrown open, and becomes diſagreeable to any perſon coming in from the open air; and in the houſes of the leſs opulent becomes really offenſive and nauſeous.

Something of this is unavoidable in all rooms heated by ſtoves. Even in our apartments in this iſland, perſons of delicate nerves are hurt by what they call the cloſe air of a room; and it is long before the ſmell of dinner is quite removed from a dining-room, notwithſtanding the copious current up the chimney. This muſt be incomparably more ſenſible in a room heated by a ſtove; and this inconvenience is peculiarly ſenſible with reſpect to the ſtove which we are conſidering at preſent, where we employ a ſmall ſurface heated to a great degree.

Such ſtoves are ſeldom made of any thing elſe than caſt-iron. This (in thoſe parts at leaſt which are in immediate contact with the fuel) is in a ſtate of continual calcination, and even throwing off ſcales. This indeed is not ſeen, becauſe it is the bottom or ſole of the fireplace which is ſo heated: but the effect on the air of the room is the ſame. The calcination of the iron is occaſioned by the combination of pure vital air with the iron. This is abſtracted from the general maſs of atmoſpheric air in the room, of which it uſually conſtitutes about two-fifths. By this abſtraction the remainder becomes leſs fit for ſupporting animal life or flame, and may even become highly deleterious In every degree the remainder becomes leſs refreſhing, and grows dull and oppreſſive. This is always accompanied by a peculiar ſmell, which, though not diſguſting, is unpleaſant. It reſembles the ſmell of burnt feathers, or more exactly the ſmell we feel if we rub violently for ſome time the palms of our hands together when perfectly dry.

For ſimilar reaſons theſe iron ſtoves occaſion a ſickly ſmell, by burning every particle of duſt which falls on the hot parts; and if they be wiped with a woollen cloth, or any cloth not perfectly free from every kind of greaſy or oily matter, a ſmell is produced for a day or days afterwards; ſo that without the moſt ſcrupulous attention we ſuffer by our very cleanlineſs.

For ſuch reaſons we think that the ſtoves of brickwork covered with ſtucco or with glazed tiles are vaſtly preferable. Theſe are much uſed in the genteeler houſes in Flanders and Holland, where they are made in the moſt elegant forms, and decorated with beautiful ſculpture or enamel; but it is plain that they cannot be ſo effectual, nor equally warm a room with the ſame expence of fuel. Earthen ware, eſpecially when covered with porous ſtucco, is far inferior to metal in its power of conducting heat. If built of bricks, they muſt be vaſtly more bulky when the fire-place and flues are of the ſame dimenſions. The moſt perfect way of conſtructing them would certainly be to make them of pottery, in parts exactly fitted to each other, and joined by a proper cement. This mode of conſtructing would admit of every elegance of form or richneſs of ornament, and would not be ſo bulky as thoſe which are built of bricks. The great difficulty is to prevent their cracking by the heat. Different parts of the ſtove being of very different heats, they expand unequally, and there is no cement which can withſtand this, eſpecially when we recollect that the ſame heat which expands the baked earth cauſes the clay or cement, with which the parts of the ſtove are put together or covered, to contract. Accordingly thoſe earthen ware ſtoves ſeldom ſtand a winter or two without cracking in ſome place or other, even when ſtrengthened by iron hoops and cramps judiciouſly diſpoſed within them. Even hooping them externally, which would be very unſightly, will not prevent this; for nothing can reſiſt the expanſion and contraction by heat and cold. When a crack happens in a ſtove, it is not only unſightly, but highly dangerous; becauſe it may be ſo ſituated, that it will diſcharge into the room the air vitiated by the fire.

For theſe and other reaſons, we can ſcarcely hope to make ſtoves of brick work or pottery which ſhall bear the neceſſary heat without cracking; and their uſe muſt therefore be confined to caſes where very moderate heat is ſufficient. We need not deſcribe their conſtruction. It is evident that it ſhould be more ſimple than that of iron ſtoves; and we imagine that in the very few caſes in which they are likely to be employed in this country, a ſingle fire place, and an arch over it, divided, if we pleaſe, by a partition or two of thin tile to lengthen the flue, will be quite enough. If the ſtove is made in whole or in part of potters ware, a baſe for the fireplace, with an urn, column, obeliſk, or pyramid above it, for increaſing the ſurface, will alſo be ſufficient. The failure commonly happens at the joinings, where the different pieces of a different heat, and perhaps of a different baking, are apt to expand unequally, and by working on each other one of them muſt give way. Therefore, inſtead of making the joints cloſe and uſing any cement, the upper piece ſhould ſtand in a groove formed in the undermoſt, having a little powdered chalk or clay ſprinkled over it, which will effectually prevent the paſſage of any air; and room being thus given for the unequal expanſion, the joint remains entire. This may be conſidered as a general direction for all furnace-work, where it is in vain to attempt to hinder the mutual working of the parts.

We have ſeen ſtoves in ſmall apartments at St Peterſburg, which were made internally of potters ware, in a great variety of forms, and then covered with a thick coat of ſtucco, finiſhed externally with the utmoſt elegance of ornament, and we were informed that they were very rarely ſubject to crack. They did not give much heat, on account of the very low conducting power of the porous ſtucco; but we imagine that they would be abundantly warm for a moderate room in this country.

When fitted up in theſe ſituations, and with theſe precautions, the brick or pottery ſtoves are incomparably more ſweet and pleaſant than the iron ores.

But in the intenſe colds of Ruſſia and Sweden, or even for very large rooms in this kingdom, ſtoves of theſe ſmall dimenſions are not ſufficiently powerful, and we muſt follow the practice of thoſe countries where they are made of great ſize, and very moderately heated. It is needleſs to deſcribe their external form, which may be varied at pleaſure. Their internal ſtructure is the ſame in all, and is diſtinctly deſcribed in Pneumatics, N° 364. We ſhall only enlarge a little on the peculiarities connected with the general principle of their conſtruction.

The ſtove is intended as a ſort of magazine, in which a great quantity of heat may be quickly accumulated, to be afterwards ſlowly communicated to the air of the room. The ſtove is therefore built extremely maſſive; and it is found that they are more powerful when coated with clay as wet as can be made to hang together. We imagine the reaſon of this to be, that very wet clay, and more particularly ſtucco, muſt be exceedingly porous when dry, and therefore a very ſlow conductor of heat. Inſtead of ſticking on the glazed tiles with no more clay or ſtucco than is ſufficient to attach them, each tile has at its back a ſort of box baked in one piece about two or three inches deep. It is repreſented in fig. 2. This is filled with mortar, and then ſtuck on the brick-work of the ſtove, which has a great number of iron pins or hooks driven into the joints, which may ſink into this clay and keep it firmly attached when dry. This coating, with the maſſive brick-work, forms a great maſs of matter to be heated by the fuel. The loweſt chamber, which is the fire-place, is ſomewhat wider, and conſiderably thicker than the ſtories above, which are merely flues. When the fire-place is finiſhed and about to be arched over, a flat iron bar of ſmall thickneſs is laid along the top of the ſide-wall on both ſides, a ſet of finiſhing bricks being moulded on purpoſe with a notch to receive the iron bar. Croſs bars are laid over theſe, one at each end and one or two between, having a bit turned down at the ends, which takes hold of the longitudinal bars, and keeps them from being thruſt outwards either by the preſſure of the arch or by the ſwelling in conſequence of the heat. In fig. 3. A is the croſs ſection of one of the long bars, and BC is part of one of the croſs bars, and CD is the clench which confines the bar A. This precaution is chiefly neceſſary, becauſe the contraction of the ſtove upwards obliges the walls of the other ſtories to bear a little on the arch of the fire-place. The building above is kept together in like manner by other courſes of iron bars at every ſecond return of the flue. The top of the ſtove is finiſhed by a pretty thick covering of brick work. The laſt paſſage for the air at H (ſee Pneumatics, fig. 62.) has a ring lining its upper extremity, and projecting an inch or two above it. The flat round it is covered with ſand. When we would ſtop this paſſage, a covered ſhape like a baſon or cover for diſhes at table is whelmed over it. The rim of this, reſting on the ſand, effectually prevents all air from coming through and getting up the vent. Acceſs is had to this damper by a door which can be ſhut tight enough to prevent the heated air of the room from waſting itſelf up the vent. When the room is too warm, it may be very rapidly cooled by opening this door. The warm air ruſhes up with great rapidity, and is replaced by cool air from without.

Fig. 2.

Fig. 3.

The management of the ſtove is as follows. About eight o'clock in the morning the *pietchnick*, or ſervant who has the charge of the ſtoves, takes off the cover, ſhuts the damper-door, and opens the fire-place door. He then puts in a handful of wood ſhavings or ſtraw, and kindles it. This warms the ſtove and vent, and begins a current of air through it. He then lays a few chips on the ſole of the fire-place, immediately within the door; and behind this he arranges the billets of birchwood, with their ends inwards. Then he lays on more wood in the front, till he thinks there is enough. He ſets fire to the chips, ſhuts the door, and opens the ſmall wicket at its bottom. The air blows the flame of the chips upon the billets behind them, and thus kindles them. They conſume ſlowly, while the billets in front remain untouched by the fire. The ſervant, having made his firſt round of the rooms, returns to this ſtove, and opens the door above to admit air into the vent. This is to ſupply its draught, and thus to check the draught in the body of the ſtove, which is generally too ſtrong at this time, and would conſume the fuel too faſt. By this time the billets in the front are burning, firſt at the bottom, and the reſt in ſucceſſion as they ſink down on the embers and come oppoſite to the wicket. The room does not yet feel any effect from the fire, the heat of which has not yet reached its external ſurface; but in about half an hour this grows warm. The upper door is ſhut again, that no heat may now be waſted. The pietchnick by and by ſpreads the embers and aſhes over the whole bottom of the fire-place with a rake, by which the bottom is greatly heated, and heats the air contiguous to it externally (for it ſtands on little pillars) very powerfully. He takes care to bring up to the top of the aſhes every bit of wood or coal that is not yet conſumed, that all may be completely expended. He does this as briſkly as poſſible, that the room may not loſe much warmed air by keeping open the fire-place door. At his laſt viſit, when he obſerves no more glowing embers, he ſhuts the fire-place door and wicket, and puts the damper on the paſſage above, and ſhuts its door.—All this is over in about an hour and a half after kindling the fire. All current of air is now at an end within the ſtove, and it is now a great maſs of brick-work, heated to a great degree within, but only about blood-warm externally. The heat gradually ſpreads outwards, and the external ſurface of the ſtove acquires its greateſt heat about three o'clock in the afternoon; after which it gradually cools till next morning.

This heat ſeldom is ſo great that one cannot bear to touch the ſtove with his cheek, and to keep it there. In conſequence of this it can burn none of the duſt which unavoidably falls on the ſtove, and we are never troubled with the ſickening ſmells that are unavoidable when we employ the ſmall caſt-iron ſtoves much heated. The great expence of heat in a room ariſes from the glaſs windows. The pane is ſo thin that the external air keeps it continually cold, and thus the windows are continually robbing the air of the room of its heat. This expence of heat is reduced to leſs than one-third by double caſements. The inner caſement is about as much colder than the room as the outer caſement is warmer

warmer than the air of the fields; and we have the ſingular advantage of having no ice formed on the glaſſes. But to enſure this laſt advantage, the ſeams of the inner caſement muſt be paſted with paper, and thoſe of the outer caſement muſt be left unpaſted. If we do the contrary, we ſhall certainly have ice on the outer caſement; the reaſon of which is eaſily ſeen.

We have been thus particular in our deſcription of the management, becauſe the reaſons of ſome particulars are not very obvious, and the practice would not readily occur to us in this country; ſo that a perſon who, on the faith of our recommendation, ſhould prefer one of theſe ſtoves to the German ſtove, whoſe management is ſimple and obvious, might be greatly diſappointed. But by following this method, we are confident that the Ruſſian ſtove will be found much ſuperior both in warmth and agreeable air. The ſpreading out of the embers, and waiting till all is reduced to aſhes before the doors are ſhut, is alſo abſolutely neceſſary, and a neglect of it would expoſe us to imminent danger of ſuffocation by fixed air; and this is the only inconvenience of the Ruſſian ſtove, from which the other ſtove is free. The fixed air has no ſmell; and the firſt indication of its preſence is a ſlight giddineſs and laſſitude, which diſpoſes us to ſit down and to ſleep. This would be fatal; and we muſt immediately open the upper paſſage and the fireplace door, ſo as to produce a ſtrong current to carry the vitiated air of the room up the chimney. Throwing up the ſaſhes, or at leaſt opening all the doors, is proper on ſuch an occaſion.

If we burn pit-coal, either raw or charred, this precaution is ſtill more neceſſary; becauſe the cinder is not ſo eaſily or ſo ſoon completely conſumed. This fuel will require a little difference in the management from wood fuel, but which is eaſily ſeen by any perſon of reflection. The ſafe way would be to rake out all half-burnt coal before ſhutting up the doors.

If we uſe raw pit-coal, great care is neceſſary to prevent the accumulation of ſoot in the upper part of the ſtove. It is an inacceſſible place for the chimney-ſweep; and if we attempt to burn it out, we run a great riſk of ſplitting that part of the ſtove which is the moſt ſlightly conſtructed. It is adviſable therefore to burn it away every day, by giving a briſk draught with an open door for five minutes. With wood or coak there is no danger.

It will not be improper in this place to give ſome inſtructions for the conſtruction of ſtoves for warming ſeveral floors in a great manufactory, ſuch as a cotton-mill, or a public library or muſeum.

In ſuch ſituations we think cleanlineſs, wholeſomeneſs, and ſweetneſs of air, no leſs neceſſary than in the drawing room of a man of opulence. We therefore recommend the brick-ſtove in preference to the iron one; and though it would not be the beſt or moſt economical practice to heat it but once a-day, and we ſhould rather prefer the German practice of conſtant feeding, we ſtill think it highly proper to limit the heat to a very moderate degree, and employ a large ſurface.

If the diſpoſition of the rooms allows us the conveniency of a thick party-wall, we would place the ſtove in the middle of this wall, in an arch which pierces through the wall. Immediately above this arch we would carry up a very wide chimney through the whole height. This chimney muſt have a paſſage opening into each floor on both ſides, which may be very accurately ſhut up by a door. The ſtove being ſet up under the arch, it muſt have a pipe communicating with its flue, and riſing up through this chimney. Could an earthen pipe be properly ſupported, and ſecured from ſplitting by hoops, we ſhould prefer it for the reaſons already given. But as this is perhaps expecting too much, we muſt admit the uſe of a caſt iron pipe. This is the real chimney or flue of the ſtove, and muſt be of as great diameter as poſſible, that it may act, by an extenſive ſurface, all the way up.

The ſtove ſtands under the arch in the wall; but the air that is warmed by its ſurface would eſcape on both ſides, and would be expended in that ſingle floor. To prevent this, the ſtove muſt be incloſed in a caſe: this may be of brick-work, at the diſtance of two or three inches from the ſtove all round. It muſt be well ſhut in above, and at the foundation muſt have a row of ſmall holes to admit the air all around it. This air will then be warmed over the whole ſpace between the ſtove and the caſe, paſs up the chimney, and there receive additional heat from the flue-pipe which is in the middle. Great care muſt be taken that the fire-place door have no communication with the ſpace between the ſtove and its caſe, but be incloſed in a mouth-piece which comes through the caſe, and opens into the feeding-room. Thus all the air which goes up to the rooms will be pure and wholeſome, provided we take care that every thing be kept clean and ſweet about the air-holes below. Obſerve that thoſe air-holes which are near the furnace door muſt be incloſed in a wooden trunk which takes in its air at ſome diſtance from this door; for ſince the current between the ſtove and caſe may be almoſt as great as the current within the ſtove (nay, when a puff of wind beats down the chimney, it may even exceed it), there is a riſk of ſome vitiated air and ſmoke being drawn into the caſe.

If the ſtove cannot be placed in the arch of a party-wall, it may be ſet adjoining to a ſide or outer wall, and furniſhed with a caſe, a large chimney, and a flue-pipe, in the ſame manner. But in this caſe a great deal of heat is waſted on this outer wall, and carried off by the external air. In this ſituation we would recommend to line that part of the wall which is behind the ſtove (at two or three inches diſtance), and the whole of the chimney, with plaſter on laths. Theſe ſhould be nailed on battens properly faſtened on the wall, leaving a ſpace of an inch between the laths and the wall. The plaſter ſhould be of the moſt ſpongy kind, having in it a quantity of clay in powder inſtead of the full proportion of ſand. Horſe-dung, waſhed with water and ſtrained through coarſe flannel, leaves a great portion of unaſſimilated vegetable fibre, which will mix very intimately in the plaſter, and make it a ſubſtance very unfit for conducting heat. There is no danger of catching fire by this lining. We have ſeen a moſt tremendous fire rage for three hours, in contact with a partition of lath and plaſter (on the plaſter-ſide however), without diſcolouring the thin laths on the other ſide. We once ſaw a cottage chimney on fire, and burn till the ſoot was conſumed. This chimney was nothing but a pipe of a foot wide, made of laths, and plaſtered on the inſide and outſide; and it paſſed through a thatched roof. We therefore recommend this in place of the brick-caſe for incloſing the ſtove. It would ſave heat; and as it might be made in pieces on detached frames, which could be joined by iron ſtraps and hinges, any part of the ſtove could be laid open for repairs at pleaſure.

We have no heſitation in ſaying that a ſtove conſtructed in this manner would be greatly ſuperior in power to any we have ſeen, and would be free from many of their diſguſting defects. We beg leave therefore to introduce here the deſcription of one which was to have been erected in one of the churches of the city of Edinburgh.

Fig. 4.

Fig. 4. is a ſketch of the plan of the church contained in the parallelogram AFED. P marks the place of the pulpit, and LMNO the front of the galleries. Theſe are carried back to the ſide-walls AB and DC. But at the end oppoſite to the pulpit they do not reach ſo far, but leave a ſpace BFEC about 12 feet wide. Below the back of the galleries, on each ſide, there is a paſſage ABGH, KICD, ſeparated from the ſeated part of the church by partitions which reach from the floor to the galleries, ſo that the ſpace HGIK is completely ſhut in. The church is an ancient Gothic building, of a light and airy ſtructure, having two rows of large windows above the arcades, and a ſpacious window in the eaſt end above the pulpit. The congregation complain of a cold air, which they feel pouring down upon their heads. This is more particularly felt by thoſe ſitting in the fronts of the galleries. We imagine that this ariſes chiefly from the extenſive ſurface of the upper row of windows, and of the cold ſtone-walls above, which robs the air of its heat as it glides up along the ſides of the church. It becomes heavier by collapſing, and in this ſtate deſcends in the middle of the church.

The ſtove S is placed againſt the middle of the weſt wall at the diſtance of a few inches, and is completely incloſed in a caſe of lath and plaſter. The vent, which is to carry off the ſmoke and burnt air, is conveyed up or along the wall, and through the roof or ſide-wall, but without any communication with the caſe. In like manner the fire-place door is open to the paſſage, without communicating with the caſe; and care is taken that the holes which admit the air into the caſe are ſo diſpoſed that they ſhall run no riſk of drawing in any air from the fire-place door.

From the top of this caſe proceed two trunks Q, R, each of which is two feet broad and ſix inches deep, coated within and without with the moſt ſpungy plaſter that can be compoſed. For this purpoſe we ſhould recommend a compoſition of powdered charcoal and as much clay and quicklime as will give it a very ſlight coheſion. We know that a piece of this may be held in the hand, without inconvenience, within an inch of where it is of a glowing red heat.—Theſe trunks open into another trunk XVTYZ, which ranges along the partition immediately under the galleries, and may be formed externally into a corniche, a little maſſive indeed, but not unſightly in a building of this ſtyle. This trunk is coated in the ſame manner. It has ſeveral openings *a*, *a*, &c. which have ſliders that can be drawn aſide by means of handles acceſſible from the outer paſſage.—At the extremities X and Z of this trunk are two perpendicular trunks which come up through the galleries, and are continued to a conſiderable height. At their junction with the horizontal trunk are two doors large enough to admit a lamp. Each perpendicular trunk has alſo a valve by which it can be completely ſtopped.

The ſtove is managed as follows: Early in the morning the ſuperintendant ſhuts all the ſliders, and ſets a lamp (burning) in each of the trunks X and Z, and ſhuts the doors. He then puts on and kindles the fire in the ſtove, and manages it either in the Ruſſian or German method. Perhaps the latter is preferable, as being liable to feweſt accidents from miſtake or neglect.

The lamps ſet in the lower ends of the upright trunks preſently warm them, and produce a current of air upwards. This muſt be ſupplied by the horizontal trunk, which muſt take it from the caſe round the ſtove. Thus a current is begun in the direction we wiſh. By and by the air in the caſe acquires heat from the ſtove, and the current becomes extremely briſk. When the manager perceives this, he removes the lamps, ſhuts the valves, and opens the holes *a*, *a*, &c. beginning with the moſt remote, and proceeding ſlowly towards the ſtove from each extremity of the horizontal branches. The heated air now iſſues by theſe holes, glides along the ceiling below the galleries, and eſcapes, by riſing up along the fronts of the galleries, and will be ſenſibly felt by thoſe ſitting there, coming on their faces with a gentle warmth. It will then riſe (in great part) ſtraight up, while ſome of it will glide backwards, to the comfort of thoſe who ſit behind.

The propriety of ſhutting the valves of the upright trunks is evident. If they were left open, no air would come out by the holes *a*, *a*, &c.; but, on the contrary, the air would go in at theſe holes to ſupply the current, and the ſtove be rendered uſeleſs. The air delivered by theſe holes will keep cloſe to the ceiling, and will not, as we imagine, incommode thoſe who ſit below the galleries. But if it ſhould be found to render theſe parts too warm, holes may be pierced through the ceiling, by which it will riſe among the people above, and muſt be very comfortable. It will require the careful attention of ſome intelligent perſon to bring all this into a proper train at firſt, by finding the proper apertures of the different holes, ſo as to render the heat equable through the whole ſpace. But this being once aſcertained the difficulty is over.

The air trunks muſt be very capacious, but may be contracted towards the extremities as their lateral diſcharges diminiſh; and the row of holes which admit the air to the caſe round the ſtove muſt be fully able to ſupply them.

It muſt be obſerved, that in this conſtruction the aſcenſional force is but ſmall. It is only the height of a ſhort column of warm air from the ground to the galleries. At firſt indeed it is great, having the unlimited height of the perpendicular trunks at X and Z; but during the uſe of the ſtove it is reduced to nine or ten feet. It is neceſſary, therefore, that the ſtove be highly heated, perhaps conſiderably beyond the Ruſſian practice, but yet inferior to the heat of the German iron ſtoves. But ſtill we ſtrongly recommend the brick or pottery ſtoves, on account of the wholeſome ſweetneſs of the air which they furniſh: and we are certain that a ſtove of moderate dimenſions, eight feet long, for inſtance, by eight feet high, will be ſufficient for warming a church holding 1200 or 1500 people. If the ſtove could be placed lower, which in many ſituations is very practicable, its effect would be proportionally greater, becauſe all depends on the rapidity of the current. When we are limited in height, we muſt extend the ſtove

STOVE.

PLATE DX.

Andersons Patent Stove

See Errata at the end of Vol. 20.

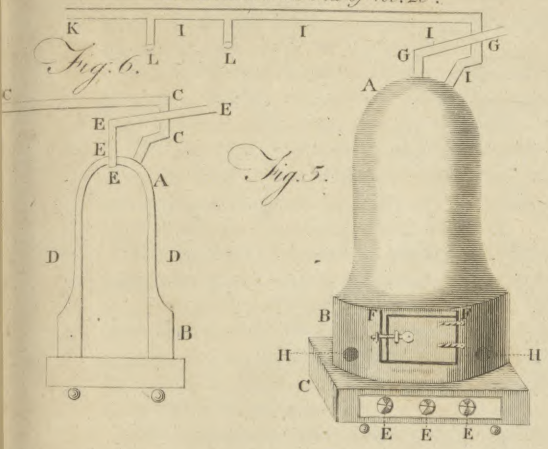


Fig. 2.

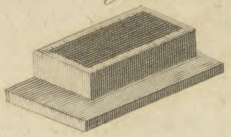


Fig. 1.

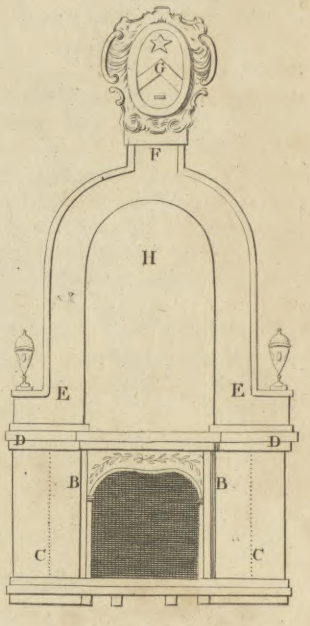


Fig. 3.

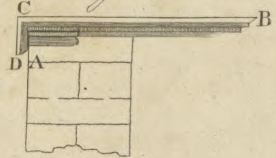


Fig. 7.

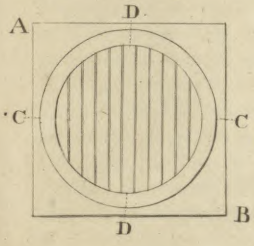


Fig. 4.

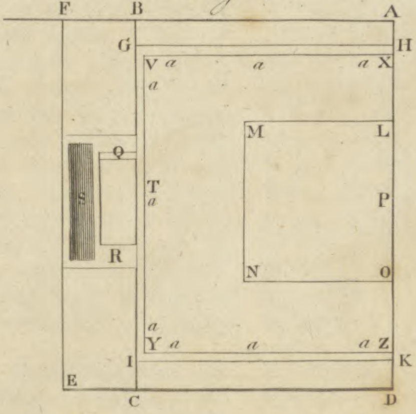


Fig. 8. Side

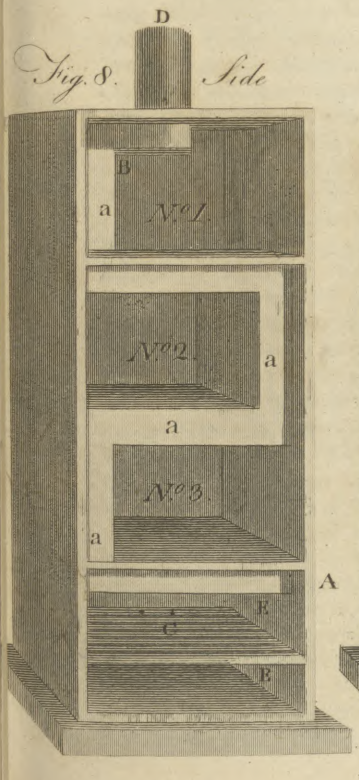


Fig. 9. Front

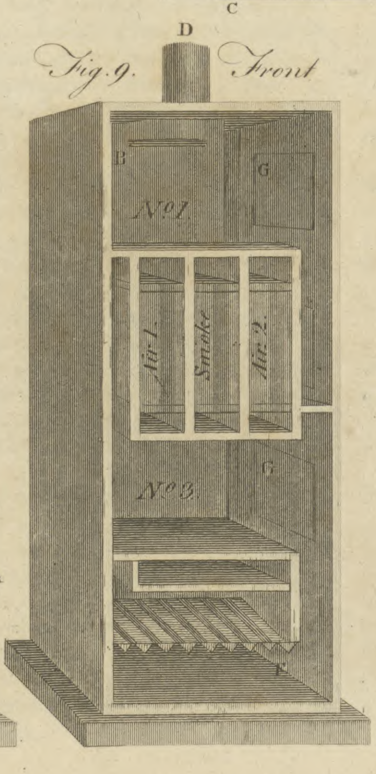
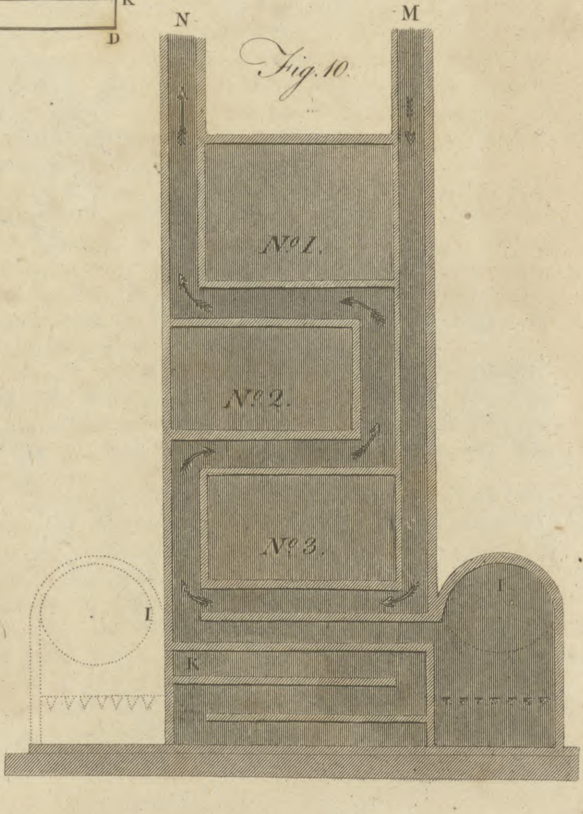


Fig. 10.



E. Mitchell sculp.

ſtove ſo much the more in length, and make the air trunks more capacious. Theſe and many other circumſtances of local modification muſt be attended to by the erector of the ſtove; and without the judicious attention of an intelligent artiſt, we may expect nothing but diſappointment. It is hardly poſſible to give inſtructions ſuited to every ſituation; but a careful attention to the general principle which determines the aſcenſional force will free the artiſt from any great riſk of failure.

We may ſay the ſame thing of ſtoves for conſervatories, hot-houſes, hot walls, &c. and can hardly add any thing of conſequence to what we have already ſaid on theſe heads in the article PNEUMATICS.

We muſt not, however, diſmiſs the ſubject without taking notice of the very ſpecious projects which have been frequently offered for drying malt by ſtoves. Many of theſe are to be ſeen in the publications of the Academies of Stockholm, Upſal, Copenhagen; and ſome have been erected in this kingdom, but they have not been found to anſwer.

We apprehend that they cannot anſwer. To dry malt, and make it fit for the ales and beers for which this iſland is ſo famous, it is by no means enough that we give it a proper and an equable ſupply of heat.—This alone would bake it and make it flinty, cauſing the moiſture to penetrate the mealy particles of the grain; and, by completely diſſolving the ſoluble parts, would render each kernel an uniform maſs, which would dry into a flinty grain, breaking like a piece of glaſs.—A grain of malt is not an inert pulp. It is a SEED, in an active ſtate, growing, and of an organized ſtructure. We wiſh to ſtop it in this ſtate, and kill it, not by heating it, but by abſtracting its moiſture. We thus leave it in its granulated or organized form, ſpungy, and fit for imbibing water in the maſh tub, without running into a paſte.

To accompliſh theſe purpoſes, the conſtruction of our malt kilns ſeems very well adapted. The kiln is the only flue of the furnace, and a copious *current* of air is formed through among the grains, carrying off with it the water which is evaporating by the heat. But this evaporation, being chiefly in conſequence of the vapour being immediately diſſolved by the paſſing air, will ſtop as ſoon as the current of air ſtops. This current has to make its way through moiſt grain, laid in a pretty thick bed, and matted together. Some force, therefore, is neceſſary to drive it through. This is furniſhed by the draught of the kiln. Subſtituting a ſtove, immediately applied to the malt, will not have this effect. The only way in which we think this can be done different from the preſent, is to have a horizontal flue, as has been propoſed in theſe projects, ſpread out at a ſmall diſtance below the grate on which the malt is laid, and to cover the whole with a high dome, like a glaſs-houſe dome. This being filled with a tall column of hot air, and having no paſſage into it but through the malt, would produce the current which we want. We are convinced that this will make much leſs fuel ſerve; but we are by no means certain that the ſulphureous and carbonic acid which accompanies the air in our common kiln is not a neceſſary or a uſeful ingredient in the proceſs. It is well known that different coaks, cinders, or charcoals, impart different qualities to the malts, and are preferred *each for its own purpoſe*.

A patent ſtove conſtructed on ſimilar principles, but compoſed of very different materials, has been lately erected in ſeveral of the churches in Edinburgh. This ſtove, which is formed entirely of caſt iron, may be conſidered as a double ſtove, an outer caſe, and a furnace or inner ſtove. The fuel is burnt in the inner ſtove; and the ſmoke produced during the proceſs of combuſtion, is carried off by a chimney, which paſſes through the top of the outer ſtove, and is conveyed to the outſide of the building. The outer caſe includes not only the furnace or inner ſtove, but alſo a conſiderable ſpace, occupied by the air of the atmoſphere, which is freely admitted through a number of openings placed around it; and when any current of air is produced, it paſſes off from the ſpace between the outer caſe and inner ſtove, and is conveyed by tubes through the body of the apartment. But we ſhall firſt deſcribe the different parts of which the ſtove is compoſed, after which we ſhall be better able to underſtand its mode of operation.

Fig. 5. exhibits a perſpective view of this ſtove. AB is the body, which is about three feet high, and of a circular form. BC is a ſquare pedeſtal on which the ſtove is placed, and which contains the aſh pit DD. The height of the pedeſtal is about a foot, and it is nearly inſulated by reſting on the ſpherical ſupports *a a*, alſo of caſt iron. EEE are openings in front of the aſh pit through which the air enters to ſupport the combuſtion. Theſe openings can be enlarged or diminiſhed, or opened and ſhut at pleaſure. FF is the door of the furnace through which the fuel is introduced. This door is attached to the inner furnace, and is double. It is one foot broad, and 11 inches high. GG is the chimney, which paſſes from the furnace within, through the outer caſe, and conveys the ſmoke out of the building. HH are openings in the outer caſe, and are eight in number, through which the air enters, and being heated, is greatly rarefied, and paſſes off through the funnel or pipe IIII. This pipe communicates only with the outer ſtove, and being ſhut at the end K, the air ruſhes out from the ſmall tubes LL, inſerted into the ſide of the pipe IIII, and thus mixes with the cold air of the church. The diameter of the outer caſe at the bottom is about two feet, and the diameter of the furnace within is about 16 inches.

Fig. 6. is a ſection of the ſtove. AB is the outer caſe, from which paſſes off the pipe or funnel CCC, by which the heated air is conveyed through the church. DD is the furnace in the inſide, in which the fuel is burnt, and EEE is the chimney or funnel which conveys the ſmoke from the inner furnace out of the building. It paſſes through the outer ſtove AB at F.

Fig. 7. is a plan of this ſtove. AB is the pedeſtal on which it reſts, and which contains the aſh pit. CC is the outer caſe, and DD is the furnace within, in which are ſeen the tranſverſe bars which ſupport the fuel.

The length of the body of the church, in which two ſtoves of the form and dimenſions now deſcribed are erected, is about 60 feet, and the breadth is about 45 feet. The tubes IIII are conveyed along the lower edge of the gallery, about half the length of the church. The fires are lighted up about four or five o'clock on the Sunday morning, during the earlier part of the cold ſeaſon; but as the ſeaſon advances, it is uſual to light them up the night before. From this time till the congregation aſſemble for the afternoon ſervice, the furnaces are

are kept conſtantly ſupplied with fuel. By this management the air in the church is kept comfortably warm during the coldeſt ſeaſon of the year.

Theſe ſtoves, it appears to us, are ſuſceptible of ſome improvement, both in their conſtruction and in the places in which they are erected. With regard to the firſt circumſtance, an external coating of plaſter work, or of the ſame kind of materials as are uſed for coating the inſide of chemical furnaces, would be of ſome uſe in preventing an unneceſſary waſte of heat, as well as the diſagreeable ſmell which is ſometimes complained of, and which is ſuppoſed to ariſe from the combuſtion of light bodies floating in the air and drawn by the current to the heated metal; and with regard to the laſt, viz. the places in which they are erected, it is perfectly obvious that they ought to be as completely inſulated as poſſible, and particularly ought not to communicate with good conductors of heat. Some of the ſtoves erected in the churches of Edinburgh are faulty in this reſpect. But to the uſe of this ſtove there is a ſtronger objection. The air that is heated has circulated through the apartment, and has been reſpired and conſequently vitiated. Hence ſome unpleaſant effects have ariſen from its uſe.

A ſtove erected by Mr A. Kilpatrick, tinſmith in Edinburgh, is free from this ſerious objection. In his ſtoves the whole of the air heated is conveyed from the outſide of the building. Stoves of this deſcription anſwer well for heating large halls, ſtaircaſes, and churches.

The following is the deſcription of an improved ſtove by Mr Field of Newman Street London, in which, it is ſtated by the author, the various advantages of heating, boiling, ſteaming, evaporating, drying, ventilating, &c. are united; ſome of which we ſhall detail in his own words.

“ Fig. 8. repreſents a longitudinal ſection of the ſtove, ſhowing the courſe of the air from its entrance into the flues of the ſtove at A, to its entrance into the upper chamber of the ſtove at B; and alſo the courſe of the ſmoke from the fire-place at C, till it eſcapes from the ſtove at D. E, E, are the doors or openings of the fire-place and aſh-hole.

“ Fig. 9. is a ſimilar ſection at right angles with the above, exhibiting the courſe of the air through the chambers of the ſtove, from its entrance into the chamber N° 1. at B to its entrance beneath the fire-place at F. This figure alſo ſhows ſections of the flues, with the diviſions through which the air and ſmoke paſs ſeparately, the ſmoke-flue in the centre, and the air-flues, on each ſide. G, G, are doors and openings through which the articles to be dried are introduced into the chambers.

“ When the fire is lighted, and the doors of the chambers, aſh-hole, and fire-place, cloſed, the air by which the fire is ſupplied enters at A, fig. 8. paſſes through the air-flues *a, a, a, a*, enters the upper chamber at B, traverſes and deſcends through the chambers N° 1, 2, 3, and arrives beneath the fire at F, fig. 9. Having ſupplied the fire with oxygen, it paſſes through the flue with the ſmoke, and eſcapes at D, heating in its protracted courſe the chambers and air-flues.

“ As the cold air enters the ſtove at A, immediately above a plate forming the top of the fire-place, and purſues a ſimilar route with the fire-flue, it enters the chambers very much heated and rarefied. Hence any moiſt ſubſtance placed in the chambers evaporates in conſequence, not only of the heated flues circulating round them, but of a ſtream of warm rarefied air, which, while it continually raiſes evaporation, as continually bears away the exhaled moiſture in its paſſage to the fire, thus imitating the gradual and efficacious plan of nature in drying by the ſun and air. While theſe effects are taking place within the ſtove, part of the air which enters at A, fig. 8. and 9. paſſes through air-flues on the other ſide of the fire-flue, purſues a parallel courſe with the firſt, and gives out a current of warm air to the room at an aperture H. This effect may be obtained in a much higher degree, if the doors of the chambers and aſh-hole are opened: ſhould the hand or face be then brought near, they would be fanned with a ſtream of warm air, eſpecially from the upper chamber.

“ By means of this ſtove I have evaporated milk to dryneſs, without burning or diſcolouring it; and have dried cherries, plums, and other fruits, ſo as to imitate thoſe which are received from abroad. I have repeatedly dried colours and the moſt delicate ſubſtances without the ſlighteſt injury, even though the operation proceeded quickly.

“ The height of the ſtove is about five feet and a half; its diameter two feet and a half, and that of the flues four inches. The external part is conſtructed of brick, and the internal parts of thin Ryegate or fire-ſtone, except the top of the fire-place, which is a plate of caſt iron. Were it to be wholly formed of iron, its effects would neceſſarily be more powerful.

“ Fig. 10. repreſents an extenſion of the plan, in which ſtoves of this kind may be advantageouſly connected with one or more furnaces for chemical or other uſes. The fire-place, brought out, either in front or on one ſide, by the preſent poſitions of its crown I, forms a reverberatory furnace, or will make a ſand-bath by reverſing it.

“ The ſpace occupied by the fire-place in fig. 8. may in this be converted into apartments for evaporating ſubſtances, or occaſionally for cooling them by an opening at K to admit cold air, while the warm air of the ſtove is excluded by a regiſter or door. The dotted lines ſhow the manner in which a ſecond furnace may be connected by an opening into the flue at L.

“ In addition to the uſes already pointed out, this ſtove would probably be found extremely ſerviceable in drying japanners goods, and conſuming the noxious fumes and gas which ariſe from the oil and varniſh uſed in this buſineſs.

“ Since the ſtove is not limited to any certain dimenſions, it might be adapted to the drying of malt and hops, perhaps of herbs, corn, and ſeeds generally. It might alſo be accommodated to the purpoſe of the ſugar-bakers, connected with the great fires they employ for their boilers. It has been ſhown to be uſeful in the confectioners art, and probably it may be equally ſo in baking biſcuits for the navy; nor leſs ſo in drying linen for the laundreſs, dyer, calico-printer, and bleacher. I have myſelf found it well accommodated for a chemical elaboratory *.”

STOURBRIDGE, or **Sturbich**, the name of a field near Cambridge, noted for its famous fair kept annually on the 7th of September, and which continues for a fortnight. The commodities are, horſes, hops, iron, wool, leather, cheeſe, &c. This place is alſo noted

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noted for an excellent ſpecies of clay capable of reſiſting an intenſe heat. It is uſed in making pots for glaſs-houſes, fire-bricks, &c.; and is ſold at an high price.

STOW, the name of a market-town in Glouceſterſhire in England, ſituated in W. Long. 1. 50. N. Lat. 51. 54. It is alſo the name of a fine ſeat of the marquis of Buckingham in Buckinghamſhire. Here are the beſt gardens in England, adorned with buſts, ſtatues, obeliſks, pavilions, and temples. It is two miles from the town of Buckingham.

STOW, *John*, the induſtrious hiſtorian, ſon of Thomas Stow merchant-taylor of St Michael's, Cornhill, in London, was born about the year 1525. Of the early part of his life we know very little, except that he was bred to his father's buſineſs, which in the year 1560 he relinquiſhed, devoting himſelf entirely to the ſtudy of our ancient hiſtorians, chronicles, annals, charters, regiſters, and records. Of theſe he made a conſiderable collection, travelling for that purpoſe to different parts of the kingdom, and tranſcribing ſuch manuſcripts as he could not purchaſe. But this profeſſion of an antiquary being attended with no preſent emolument, he was obliged for ſubſiſtence to return to his trade.—It happened, however, that his talents and neceſſities were made known to Dr Parker archbiſhop of Canterbury; who being himſelf an antiquary, encouraged and enabled Mr Stow to proſecute his darling ſtudy. In thoſe times of perſecution, though Elizabeth was then upon the throne, honeſt John Stow did not eſcape danger. His collection of Popiſh records was deemed cauſe of ſuſpicion. His younger brother Thomas preferred no leſs than 140 articles againſt him before the eccleſiaſtical commiſſion; but the proof being inſufficient, he was acquitted. In 1565 he firſt publiſhed his Summary of the Chronicles of England. About the year 1584 he began his Survey of London. In 1585 he was one of the two collectors for a great muſter of Limeſtreet ward: in the ſame year he petitioned the corporation of London to beſtow on him the benefit of two freemen to enable him to publiſh his ſurvey; and in 1589 he petitioned again for a penſion. Whether he ſucceeded, is not known. He was principally concerned in the ſecond edition of Holinſhed's chronicle, publiſhed in 1587. He alſo corrected and twice augmented, Chaucer's works, publiſhed in 1561 and in 1597. His ſurvey of London was firſt publiſhed in 1598. To theſe laborious works he would have added his large Chronicle, or Hiſtory of England; but he lived only to publiſh an abſtract of it under the title of *Flores Hiſtoriarum.* The folio volume, which was printed after his death, with the title of *Stow's Chronicle*, was taken from his papers by Edmund Howes. Having thus ſpent his life and fortune in theſe laborious purſuits, he was at laſt obliged to ſolicit the charitable and well diſpoſed for relief. For this purpoſe, King James I. granted him, in 1603, a brief, which was renewed in 1604, authorizing him to collect in churches the benefactions of his fellow-citizens. He died in April 1605, aged 80; and was buried in his pariſh church of St Andrew's, Underſhaft, where his widow erected a decent monument to his memory. John Stow was a moſt indefatigable antiquarian, a faithful hiſtorian, and an honeſt man.

STOWMARKET, a town of Suffolk, in England, ſituated in E. Long. 1. 6. N. Lat. 52. 16. It is a large handſome place, ſituated between the branches of the rivers Gypping and Orwell, and is remarkable for having the beſt cherries in England.

STOWAGE, the general diſpoſition of the ſeveral materials contained in a ſhip's hold, with regard to their figure, magnitude, or ſolidity.

In the ſtowage of different articles, as ballaſt, caſks, caſes, bales, and boxes, there are ſeveral general rules to be obſerved, according to the circumſtances or qualities of thoſe materials. The caſks which contain any liquid are, according to the ſea phraſe, to be *bung-up* and *bilge-free*, i. e. cloſely wedged up in an horizontal poſition, and reſting on their quarters: ſo that the bilges where they are thickeſt being entirely free all round, cannot rub againſt each other by the motion of the veſſel. Dry goods, or ſuch as may be damaged by the water, are to be carefully incloſed in caſks, bales, caſes, or wrappers; and wedged off from the bottom and ſides of the ſhip, as well as from the bow, maſts, and pump-well. Due attention muſt likewiſe be had to their diſpoſition with regard to each other, and to the trim and centre of gravity of the ſhip; ſo that the heavieſt may always be neareſt the keel, and the lighteſt gradually above them.

STRABISMUS, ſquinting. See MEDICINE *Index*.

STRABO, a celebrated Greek geographer, philoſopher, and hiſtorian, was born at Amaſia, and was deſcended from a family ſettled at Gnoſſus in Crete. He was the diſciple of Xenarchus, a Peripatetic philoſopher, and at length attached himſelf to the Stoics. He contracted a ſtrict friendſhip with Cornelius Gallus, governor of Egypt, and travelled into ſeveral countries to obſerve the ſituation of places, and the cuſtoms of nations. He flouriſhed under Auguſtus, and died under Tiberius about the year 25, in a very advanced age.—He compoſed ſeveral works, all of which are loſt except his Geography in 17 books; which are juſtly eſteemed very precious remains of antiquity. The two firſt books are employed in ſhowing, that the ſtudy of geography is not only worthy of, but even neceſſary to, a philoſopher; the third deſcribes Spain; the fourth, Gaul and the Britannic iſles; the fifth and ſixth, Italy and the adjacent iſles; the ſeventh, which is imperfect at the end, Germany, the countries of the Getæ and Illyrii, Taurica Cherſoneſus, and Epirus; the eighth, ninth, and tenth, Greece with the neighbouring iſles; the four following, Aſia within Mount Taurus; the fifteenth and ſixteenth, Aſia without Taurus, India, Perſia, Syria, Arabia; and the ſeventeenth, Egypt, Ethiopia, Carthage, and other places of Africa. Strabo's work was publiſhed with a Latin verſion by Xylander, and notes by Iſaac Caſaubon (or rather by Henry Scrimzeer, from whom Caſaubon chiefly ſtole them), at Paris, 1620, in folio. But the beſt edition is that of Amſterdam in 1707, in two volumes folio, by the learned Theodore Janſonius ab Almelooveen, with the entire notes of Xylander, Caſaubon, Meurſius, Cluver, Holſtenius, Salmaſius, Bochart, Ez. Spanheim, Cellarius, and others. To this edition is ſubjoined the *Chreſtomathiæ*, or epitome of Strabo; which according to Mr Dodwell, who has written a very elaborate and learned diſſertation about it, was made by ſome unknown perſon between the years of Chriſt 676 and 996. It has been found of ſome uſe, not

not only in helping to correct the original, but in ſupplying in ſome meaſure the defect in the ſeventh book. Mr Dodwell's diſſertation is prefixed to this edition.

STRADA, Famianus, a very ingenious and learned Jeſuit, was born at Rome in the latter end of the 16th century, and taught rhetoric there, in a public manner, for fifteen years. He wrote ſeveral pieces upon the art of oratory, and publiſhed ſome orations with a view of illuſtrating by example what he had inculcated by precept But his *Proluſiones Academicæ* and his *Hiſtoria de Bello Belgico* are the works which raiſed his reputation, and have preſerved his memory. His hiſtory of the war of Flanders was publiſhed at Rome; the firſt decad in 1640, the ſecond in 1647; the whole extending from the death of Charles V. which happened in 1558, to the year 1590. It is written in good Latin, as all allow; but its merit in other reſpects has been variouſly determined. His *Proluſiones Academicæ* ſhow great ingenuity, and a maſterly ſkill in claſſical literature; that proluſion eſpecially in which he introduces Lucan, Lucretius, Claudian, Ovid, Statius, and Virgil, each of them verſifying according to his own ſtrain. They have been often printed. We know not the year of Strada's birth or of his death.

STRAHAN, William, an eminent printer, was born at Edinburgh in the year 1715. His father, who had a ſmall appointment in the cuſtoms, gave his ſon the education which every one of decent rank then received in a country where the avenues to learning were eaſy, and open to men of the moſt moderate circumſtances. After having paſſed through the tuition of a grammar ſchool, he was put apprentice to a printer; and when a very young man, removed to a wider ſphere in that line of buſineſs, and went to follow his trade in London. Sober, diligent, and attentive, while his emoluments were for ſome time very ſcanty, he contrived to live rather within than beyond his income; and though he married early, and without ſuch a proviſion as prudence might have looked for in the eſtabliſhment of a family, he continued to thrive, and to better his circumſtances. This he would often mention as an encouragement to early matrimony; and uſed to ſay, that he never had a child born that Providence did not ſend ſome increaſe of income to provide for the increaſe of his houſehold. With ſufficient vigour of mind, he had that happy flow of animal ſpirits that is not eaſily diſcouraged by unpromiſing appearances.

His abilities in his profeſſion, accompanied with perfect integrity and unabating diligence, enabled him, after the firſt difficulties were overcome, to advance with rapid ſucceſs. And he was one of the moſt flouriſhing men of the trade, when, in the year 1770, he purchaſed a ſhare of the patent for king's printer of Mr Eyre, with whom he maintained the moſt cordial intimacy during the reſt of his life. Beſide the emoluments ariſing from this appointment, as well as from a very extenſive private buſineſs, he now drew largely from a field which required ſome degree of ſpeculative ſagacity to cultivate, on account of the great literary property which he acquired by purchaſing the copy-rights of the moſt celebrated authors of the time. In this his liberality kept pace with his prudence, and in ſome caſes went perhaps rather beyond it. Never had ſuch rewards been given to the labours of literary men as now were received from him and his aſſociates in thoſe purchaſes of copy-rights from authors.

Having now attained the firſt great object of buſineſs, wealth, Mr Strahan looked with a very allowable ambition on the ſtations of political rank and eminence. Politics had long occupied his active mind, which he had for many years purſued as his favourite amuſement, by correſponding on that ſubject with ſome of the firſt characters of the age. Mr Strahan's queries to Dr Franklin in the year 1769, reſpecting the diſcontents of the Americans, publiſhed in the London Chronicle of 28th July 1778, ſhow the juſt conception he entertained of the important conſequences of that diſpute, and his anxiety as a good ſubject to inveſtigate, at that early period, the proper means by which their grievances might be removed, and a permanent harmony reſtored between the two countries. In the year 1775 he was elected a member of parliament for the borough of Malmſbury in Wiltſhire, with a very illuſtrious colleague, the Hon. C. J. Fox; and in the ſucceeding parliament, for Wootton Baſſet, in the ſame county. In this ſtation, applying himſelf with that induſtry which was natural to him, he was a uſeful member, and attended the houſe with a ſcrupulous punctuality. His talents for buſineſs acquired the conſideration to which they were intitled, and were not unnoticed by the miniſter.

In his political connection he was conſtant to the friends to whom he had firſt been attached. He was a ſteady ſupporter of that party who were turned out of adminiſtration in ſpring 1784, and loſt his ſeat in the houſe of commons by the diſſolution of parliament with which that change was followed: a ſituation which he did not ſhew any deſire to reſume on the return of the new parliament; ariſing from a feeling of ſome decline in his health, which had rather ſuffered from the long ſittings and late hours with which the political warfare in the preceding had been attended. Without any fixed diſeaſe, his ſtrength viſibly declined; and though his ſpirits ſurvived his ſtrength, yet the vigour and activity of his mind were conſiderably impaired. Both continued gradually to decline till his death, which happened on the 9th of July 1785 in the 71ſt year of his age.

Endued with much natural ſagacity, and an attentive obſervation of life, he owed his riſe to that ſtation of opulence and reſpect which he attained, rather to his own talents and exertion, than to any accidental occurrence of favourable or fortunate circumſtances. His mind was not uninformed by letters; and from a habit of attention to ſtyle, he acquired a conſiderable portion of critical acuteneſs in the diſcernment of its beauties and defects? In one branch of writing he particularly excelled—the epiſtolary; in which he not only ſhowed the preciſion and clearneſs of buſineſs, but poſſeſſed a neatneſs as well as a fluency of expreſſion which few letter-writers have been known to ſurpaſs. Letter-writing was one of his favourite amuſements; and among his correſpondents were men of ſuch eminence and talents as well repaid his endeavours to entertain them. Among theſe, as before mentioned, was the juſtly celebrated Dr Franklin, originally a printer like Mr Strahan, whoſe friendſhip and correſpondence, notwithſtanding the difference of their ſentiments in political matters, he continued to enjoy till his death. One of the lateſt letters which he received from his illuſtrious and venerable friend contained a humorous allegory of the ſtate of politics in Britain, drawn from the profeſſion of printing; of which, though the doctor had quitted the exerciſe, he had not forgotten the terms.

The judicious diſpoſition which Mr Strahan made of his property, affords an evident proof of his good ſenſe and propriety. After providing munificently for his widow and children, his principal ſtudy ſeems to have been to mitigate the affliction of thoſe (and many there were) who would more immediately have felt his loſs, by bequeathing them liberal annuities for their lives; and (recollecting that all of a profeſſion are not equally provident) he left 1000l. to the Company of Stationers, the intereſt to be divided among infirm old printers.

As the virtuous connections of the life and the heart are always pleaſing to trace,—of Mr Strahan it may briefly be ſaid, that his capacity, diligence, and probity, raiſed him to the head of his profeſſion. The good humour and obliging diſpoſition which he owed to nature, he cultivated with care, and confirmed by habit. His ſympathetic heart beat time to the joy and ſorrow of his friends. His advice was always ready to direct youth, and his purſe open to relieve indigence. Living in times not the pureſt in the Engliſh annals, he eſcaped unſullied through the artifices of trade and the corruption of politics. In him a ſtrong natural ſagacity, improved by an extenſive knowledge of the world, ſerved only to render reſpectable his unaffected ſimplicity of manners, and to make his Chriſtian philanthropy more diſcerning and uſeful. The uninterrupted health and happineſs which accompanied him for half a century in the capital, proves honeſty to be the beſt policy, temperance the greateſt luxury, and the eſſential duties of life its moſt agreeable amuſement. In his elevated fortune, none of his former acquaintance ever accuſed him of neglect. He attained proſperity without envy, enjoyed wealth without pride, and diſpenſed bounty without oſtentation.

STRAIKS, in the military art, are ſtrong plates of iron, ſix in number, fixed with large nails called *ſtraik-nails*, on the circumference of a cannon-wheel, over the joints of the fellows; both to ſtrengthen the wheel, and to ſave the fellows from wearing on hard ways or ſtreets.

STRAIN, a pain occaſioned by the violent extenſion of ſome membranous or tendinous part.

STRAIN, Streſs, in *Mechanics*, are terms indiſcriminately uſed to expreſs the force which is *excited* in any part of a machine or ſtructure of any kind tending to break it in that part. Thus every part of a rope is *equally* ſtrained by the weight which it ſuſpends. Every part of a pillar is *equally* ſtrained by the load which it ſupports. A mill axle is *equally* twiſted and ſtrained in every part which lies between the part of the wheel actuated by the moving power and the part which is reſiſted by the work to be performed. Every part of a lever or joiſt is *differently* ſtrained by a force acting on a diſtant part.

It is evident that we cannot make the ſtructure fit for its purpoſe, unleſs the ſtrength at every part be at leaſt equal to the ſtreſs laid on, or the ſtrain excited in that part. It is no leſs plain, that if we are ignorant of the principles which determine this ſtrain, both in intenſity and direction, in relation to the magnitude and the ſituation of its remote cauſe, the only ſecurity we have for ſucceſs is to give to every part of the aſſemblage ſuch ſolidity that we can leave no doubt of its ſufficiency. But daily experience ſhows us that this vague ſecurity is in many caſes uncertain, if we are thus ignorant. In all caſes it is ſlovenly, unlike an artiſt, attended with uſeleſs expence, and in machines is attended with a loſs of power which is waſted in changing the motions of a needleſs load of matter.

It muſt therefore greatly tend to the improvement of all profeſſions occupied in the erection or employment of ſuch ſtructures, to have a diſtinct notion of the ſtrains to which theſe parts are expoſed. Frequently, nay generally, theſe ſtrains are not immediate, but ariſe from the action of forces on diſtant parts, by which the aſſemblage is ſtrained, and there is a tendency to rupture in every part. This ſtrain is *induced* on every part, and is there modified by fixed mechanical laws. Theſe it is our buſineſs to learn; but our chief object in this inveſtigation is to determine the ſtrength of materials which it is neceſſary to oppoſe in every part to this ſtrain; and how to oppoſe this ſtrength in ſuch a manner that it ſhall be exerted to the beſt advantage. The notions of ſtrain and ſtrength therefore hardly admit of ſeparation; for it is even by means of the ſtrength of the intermediate parts that the ſtrain is propagated to, or excited in, the part under conſideration. It is proper therefore to conſider the whole together under the article *STRENGTH of Materials* in mechanics.

STRAINING, is the clarification of a liquor, by paſſing it through a ſieve or filter. The word is derived from the French, *eſtreindre;* which is formed from *ex*, "out of," and *ſtringere*, "to preſs."

STRAIT, a narrow channel or arm of the ſea, ſhut up between lands on either ſide, and affording a paſſage out of one great ſea into another.

There are three kinds of ſtraits. 1. Such as join one ocean to another. Of this kind are the ſtraits of Magellan and Le Maire. 2. Thoſe which join the ocean to a gulf: the ſtraits of Gibraltar and Babelmandel are of this kind, the Mediterranean and Red ſea being only large gulfs. 3. Thoſe which join one gulf to another; as the ſtraits of Caffa, which join the Palus Mæotis to the Euxine or Black ſea. The paſſage of ſtraits is commonly dangerous, on account of the rapidity and oppoſite motion of currents. The moſt celebrated ſtrait in the world is that of Gibraltar, which is about from 24 to 36 miles long, and from 15 to 24 broad, joining the Mediterranean ſea with the Atlantic ocean. The ſtraits of Magellan, diſcovered in 1520 by F. Magellan, were uſed ſome time as a paſſage out of the North into the South ſea; but ſince the year 1616, that the ſtrait of Le Maire has been diſcovered, the former has been diſuſed; both becauſe of its length, which is full three hundred miles, and becauſe the navigation thereof is very dangerous, from the waves of the North and South ſeas meeting in it and claſhing. The ſtrait at the entrance of the Baltic is called the *Sound;* that between England and France, *Le pas de Calais*, or the *Channel*. There are alſo the ſtraits of Weigats, of Jeſſo, of Anian, of Davis, and Hudſon, &c.

STRAKES, or STREAKS, in a ſhip, the uniform ranges of planks on the bottom and ſides of a ſhip, or the continuation of planks joined to the ends of each other,

other, and reaching from the ſtem to the ſtern-poſt and faſhion-pieces; the loweſt of theſe, which is called the *garboard ſtreak*, is let into the keel below, and into the ſtem and ſtern-poſt. They ſay alſo a ſhip *heels a ſtrake*, that is, hangs or inclines to one ſide the quantity of a whole plank's breadth.

STRAKES, or *Streks*, in mining, are frames of boards fixed on or in the ground, where they waſh and dreſs the ſmall ore in a little ſtream of water, hence called *ſtraked ore*.

STRALSUND, a ſtrong and rich ſea-port town of Germany, in Hither Pomerania, formerly an important trading-place. In 1678 it was forced to ſurrender to the elector of Brandenburg, after 1800 houſes had been burnt to aſhes in one night's time. After this the Swedes defended it to the laſt extremity; and Chas. XII. in 1714, came hither after his return out of Turkey. But the throne of Sweden not being able to hold out againſt five great powers, it was forced to ſubmit in 1715. In 1720 it was rendered back to Sweden, but in a very poor condition. It is almoſt ſurrounded by the ſea and the lake Franeen, and has a harbour ſeparated from the iſle of Rugen by a narrow ſtrait. It is 15 miles north-weſt of Grippſwald, and 40 north-eaſt of Guſtrow. E. Long. 13. 28. N. Lat. 54. 17.

STRAMONIUM, a ſpecies of plant. See DATURA, BOTANY *Index*.

STRAND (*Saxon*), any ſhore or bank of a ſea or great river. Hence the ſtreet in the weſt ſuburbs of London, which lay next the ſhore or bank of the Thames, was called the *Strand*. An immunity from cuſtom, and all impoſitions upon goods or veſſels by land or water, was uſually expreſſed by *ſtrand* or *ſtream*.

STRANDED (from the Saxon *ſtrand*), is when a ſhip is by tempeſt, or by ill ſteerage, run on ground, and ſo periſhes. Where a veſſel is ſtranded, juſtices of the peace, &c. ſhall command conſtables near the ſea-coaſts to call aſſiſtance for the preſervation of the ſhip; and officers of men of war are to be aiding and aſſiſting thereto.

STRANGE, SIR ROBERT, an eminent engraver, who carried the art to great perfection in this country, and was diſtinguiſhed not only as an artiſt, but highly reſpected and beloved on account of his private virtues and domeſtic habits. Modeſt as he was ingenious, he uſed to ſay that the works of an artiſt ſhould ſerve for his life and monument. His works no doubt will perpetuate his name whilſt any taſte for the fine arts remains.

Sir Robert Strange was born in the iſland of Pomona in Orkney, July the 14th 1721; and died at London July the 5th 1792. He was lineally deſcended from David Strange or Strang, a younger ſon of the family of the Stranges or Strangs of Balcaſky, in the county of Fife, who ſettled in Orkney at the time of the Reformation. But as there were no males remaining of the elder branch of the Stranges of Balcaſky, Sir Robert became the male repreſentative of it, and was found by a legal inveſtigation to have a right to the armorial bearings and every other mark of honour belonging to that ancient family.

He received his claſſical education at Kirkwall in Orkney, under the care of a learned, worthy, and much reſpected gentleman, Mr Murdoch Mackenzie, who has rendered infinite ſervice to his country by the accurate ſurveys and charts he has given of the iſlands of Orkney, and of the Britiſh and Iriſh coaſts.

Originally intended for the law, Mr Strange ſoon became tired of that profeſſion, and perceived that his genius deciſively led him to the arts of drawing and engraving. For this purpoſe he was introduced to the late Mr Richard Cooper at Edinburgh, the only perſon there who had then any taſte in that line of the fine arts. He was bound with him as an apprentice for ſix years; during which time he made ſuch progreſs in his new profeſſion, that his friends entertained the higheſt expectation of his ſucceſs; nor were they diſappointed.

In the year 1747 he married Iſabella, only daughter of William Lumſden, ſon of Biſhop Lumſden; and ſoon after his marriage he went to France, where with the moſt ardent application he proſecuted his ſtudies, chiefly at Paris, under the direction of the celebrated Le Bas, who engraved many excellent prints from the Dutch painters. It was from Le Bas he had the firſt hint of the uſe of the inſtrument commonly called the *dry needle;* but which he afterwards greatly improved by his own genius, and which has added ſuch ſuperior beauties to his engravings.

In the year 1751 Mr Strange removed with his family from Edinburgh and ſettled at London, where he engraved ſeveral fine hiſtorical prints, which juſtly acquired to him great reputation. At this period hiſtorical engraving had made little progreſs in Britain, and he may be properly conſidered as its father.

The admiration he always had for the works of the great Italian painters made him long deſire to viſit Italy, the ſeat of the fine arts; and the farther he advanced in life, he became the more perſuaded that a journey to that country was eſſential to an artiſt who had the laudable ambition to excel in his profeſſion. He therefore undertook this journey in the year 1760. In Italy he made many admirable drawings, ſeveral of which he afterwards engraved. Theſe drawings are now in the poſſeſſion of Lord Dundas.

Everywhere in Italy ſingular marks of attention were beſtowed on Mr Strange; not only by great perſonages, but by the principal academies of the fine arts in that country. He was made a member of the academies of Rome, Florence, and Bologna, and profeſſor in the royal academy at Parma.

To ſhow the eſtimation in which his talents were held at Rome, we cannot but record the following anecdote. The ceiling of the room of the Vatican library, in which the collection of engravings is kept, is elegantly painted by Signor Rotfanelli. It repreſents the progreſs of engraving; and the portraits of the moſt eminent artiſts in that line are there introduced, among which is that of our artiſt. Under his arm he holds a portfolio, on which his name is inſcribed. He is the only Britiſh artiſt on whom this honour has been conferred.

In France, where he reſided many years at different periods, his talents likewiſe received every mark of attention that could be beſtowed on a foreigner. He was made a member of the royal academy of painting at Paris.

His majeſty King George III. ever attentive to the progreſs of the fine arts in Britain, and ſenſible of the advantages of which engraving particularly has been to this

this country, even in a commercial light; and deſirous to give a mark of his royal approbation of the merit of Mr Strange, whom he conſidered as at the head of his profeſſion and the great improver of it—was graciouſly pleaſed to confer the honour of knighthood on him the 5th of January 1787.

Such was Sir Robert Strange as an artiſt; nor was he leſs diſtinguiſhed by his truly amiable moral qualities, which endeared him to all who had the happineſs to know him.

With regard to his works, he left fifty capital plates, ſtill in good condition, which are carefully preſerved in his family. They are engraved from pictures by the moſt celebrated painters of the Roman, Florentine, Lombard, Venetian, and other ſchools. They are hiſtorical, both ſacred and profane, poetical, allegorical.

From his earlieſt eſtabliſhment in life, Sir Robert carefully preſerved about eighty copies of the fineſt and moſt choice impreſſions of each plate he engraved; which, from length of time, have acquired a beauty, mellowneſs, and brilliancy, eaſier ſeen than deſcribed. He did this with a view of preſenting them to the public at a period when age ſhould diſable him from adding to their number. Theſe he collected into as many volumes, and arranged them in the order in which they were engraved. To each volume he prefixed two portraits of himſelf, on the ſame plate, the one an etching, the other a finiſhed proof, from a drawing by John Baptiſte Greuſe. This is the laſt plate which he engraved; and is a proof that neither his eyes nor hand were impaired by age. It likewiſe ſhows the uſe he made both of aquafortis and the graver. Each volume, beſides a dedication to the king, contains an introduction on the progreſs of engraving, and critical remarks on the pictures from which his engravings are taken. Theſe volumes were ready to be given to the public, when Sir Robert's death delayed this magnificent publication; a publication which does ſo much honour to the artiſt, and to the country which gave him birth. He died at London 5th July 1792.

The following is an authentic catalogue of his works. Plate 1. Two Heads of the author—one an etching, the other a finiſhed proof, from a drawing by John Baptiſte Greuſe; 2. The Return from Market, by Wouvermans; 3. Cupid, by Vanloo; 4. Mary Magdalen, by Guido; 5. Cleopatra, by the ſame; 6. The Madonna, by the ſame; 7. The Angel Gabriel, by the ſame; 8. The Virgin, holding in her hand a book, and attended by angels, by Carlo Maratt; 9. The Virgin with the Child aſleep, by the ſame; 10. Liberality and Modeſty, by Guido; 11. Apollo rewarding Merit and puniſhing Arrogance, by Andrea Sacchi; 12. The Finding of Romulus and Remus, by Pietro da Cortona; 13. Cæſar repudiating Pompeia, by the ſame; 14. Three Children of King Charles I. by Vandyke; 15. Beliſarius, by Salvator Roſa; 16. St Agnes, by Dominichino; 17. The Judgment of Hercules, by Nicolas Pouſſin; 18. Venus attired by the Graces, by Guido; 19. and 20. Juſtice and Meekneſs, by Raphael; 21. The Offspring of Love, by Guido; 22. Cupid Sleeping, by the ſame; 23. Abraham giving up the Handmaid Hagar, by Guercino; 24. Eſther a Suppliant before Ahaſuerus, by the ſame; 25. Joſeph and Potiphar's Wife, by Guido; 26. Venus Blinding Cupid, by Titian; 27. Venus, by the ſame; 28. Danae, by the ſame; 29. Portrait of King Charles I. by Vandyke; 30. The Madonna, by Correggio; 31. St Cæcilia, by Raphael; 32. Mary Magdalen, by Guido; 33. Our Saviour appearing to his Mother after his Reſurrection, by Guercino; 34. A Mother and Child, by Parmegiano; 35. Cupid Meditating, by Schidoni; 36. Laomedon King of Troy detected by Neptune and Apollo, by Salvator Roſa; 37. The Death of Dido, by Guercino; 38. Venus and Adonis, by Titian; 39. Fortune, by Guido; 40. Cleopatra, by the ſame; 41. Two Children at School, by Schidoni; 42. Mary Magdalen, by Correggio; 43. Portrait of King Charles I. attended by the marquis of Hamilton, by Vandyke; 44. Queen Henrietta, attended by the Prince of Wales, and holding in her arms the Duke of York, by the ſame; 45. Apotheoſis of the Royal Children, by Weſt; 46. The Annunciation, by Guido; 47. Portrait of Raphael Sancio D'Urbino, by himſelf; 48. Sappho, by Carlo Dolci; 49. Our Saviour aſleep, by Vandyke; 50. St John in the Deſert, by Murillo.

STRANGER, in *Law*, denotes a perſon who is not privy or party to an act. Thus a ſtranger to a judgement is he to whom a judgment does not belong; in which ſenſe the word ſtands directly oppoſed to party or privy.

STRANGLES, in *Farriery*. See that article, N° 481.

STRANGURY, a ſuppreſſion of urine. See MEDICINE *Index*.

STRAP, among ſurgeons, a ſort of band uſed to ſtretch out limbs in the ſetting of broken or disjointed bones.

STRAP, in a ſhip, the rope which is ſpliced about any block, and made with an eye to faſten it anywhere on occaſion.

STRAPS, in the manege. The ſtraps of a ſaddle are ſmall leather ſtraps, nailed to the bows of the ſaddle, with which we make the girths faſt to the ſaddle.

STRAPADO, or STRAPPADO, a kind of military puniſhment, wherein the criminal's hands being tied behind him, he is hoiſted up with a rope to the top of a long piece of wood, and let fall again almoſt to the ground; ſo that, by the weight of his body in the ſhock, his arms are diſlocated. Sometimes he is to undergo three ſtrapadoes or more.

STRASBURG, an ancient, large, handſome, and ſtrong city of France, in Alſace, with a population of 40,000. It contains about 200 ſtreets, part of which are very narrow, and moſt of the houſes are built after the ancient taſte. However, there are a great number of handſome buildings, ſuch as the hotel of the marſhal of France, who is commander of the city; the hotel of the cardinal of Rouen, the biſhop's palace, the Jeſuits college, the royal hoſpital, the hotel of Heſſe-Darmſtadt, the arſenal, the town-houſe, and the cathedral. It has a wooden bridge over the Rhine, which is thought to be one of the fineſt in Europe; as is likewiſe the cathedral church, whoſe tower is the handſomeſt in Germany, and the clock is greatly admired by all travellers. Some look upon it as one of the wonders of the world, and the ſteeple is allowed to be the higheſt in Europe. The clock not only ſhows the hours of the day, but the motion of the ſun, moon, and ſtars. Among other things there is an angel, which turns an hour-glaſs every hour; and the twelve apoſtles proclaim noon, by each of them ſtriking a blow with a hammer on a bell. There is likewiſe a cock, which is a piece of clock-work, that crows every hour. There are 700 ſteps up to the tower or ſteeple, it being 500 feet high. It was a free and imperial city; but the king of France became maſter of it in 1681, and greatly augmented the fortifications, though before it had 365 cannon. The inhabitants were formerly Proteſtants, and carried on a great trade; but moſt of them have been obliged to embrace the Romiſh ſuperſtition, though there is ſtill a ſort of toleration. Such was Straſburg before the French revolution; what it is now we have not leiſure to inquire. It is ſeated on the river Ill, 55 miles north of Baſil, 112 ſouth-weſt of Mentz, and 255 eaſt of Paris. E. Long. 7. 51. N. Lat. 48. 35.

STRATA, in *Natural Hiſtory*, the ſeveral beds or layers of different matters whereof the earth is compoſed. See GEOLOGY.

The ſtrata whereof the earth is compoſed are ſo very different in different countries, that it is impoſſible to ſay any thing concerning them that may be generally applicable: and indeed the depths to which we can penetrate are ſo ſmall, that only a very few can be known to us at any rate; thoſe that lie near the centre, or even a great way from it, being for ever hid. One reaſon why we cannot penetrate to any great depth is, that as we go down the air becomes foul, loaded with pernicious vapours, inflammable air, fixed air, &c. which deſtroy the miners, ſo that there is no poſſibility of going on. In many places, however, theſe vapours become pernicious much ſooner than in others, particularly where ſulphureous minerals abound, as in mines of metal, coal, &c.

But however great differences there may be among the under ſtrata, the upper one is in ſome reſpects the ſame all over the globe, at leaſt in this reſpect, that it is fit for the ſupport of vegetables, which the others are not, without long expoſure to the air. Properly ſpeaking, indeed, the upper ſtratum of the earth all round, is compoſed of the pure vegetable mould, though in many places it is mixed with large quantities of other ſtrata, as clay, ſand, gravel, &c.; and hence proceed the differences of ſoils ſo well known to thoſe who practiſe agriculture.

It has been ſuppoſed, by ſome naturaliſts, that the different ſtrata of which the earth is compoſed were originally formed at the creation, and have continued in a manner immutable ever ſince: but this cannot poſſibly have been the caſe, ſince we find that many of the ſtrata are ſtrangely intermixed with each other; the bones of animals both marine and terreſtrial are frequently found at great depths in the earth; beds of oyſter-ſhells are found of immenſe extent in ſeveral countries; and concerning theſe and other ſhell fiſh, it is remarkable, that they are generally found much farther from the ſurface than the bones or teeth either of marine or terreſtrial animals. Neither are the ſhells or other remains of fiſh found in thoſe countries adjoining to the ſeas where they grow naturally, but in the moſt diſtant regions. Mr Whitehurſt, in his Inquiry into the Original State and Formation of the Earth, has given the following account of many different kinds of animals, whoſe ſhells and other remains or *exuviæ* are found in England; though at preſent the living animals are not to be found except in the Eaſt and Weſt Indies.

A CATALOGUE *of* EXTRANEOUS FOSSILS, *ſhowing where they were dug up; alſo their native Climates. Moſtly ſelected from the curious Cabinet of Mr* NEILSON, *in* King-ſtreet, Red-Lion Square.

Their names, and Places where found.	Native Climates.
CHAMBERED NAUTILUS. Sheppy iſland; Richmond in Surrey; Sherbone in Dorſetſhire, -	*Chineſe Ocean, and other Parts of that great ſea.*
TEETH OF SHARKS. Sheppy iſland, Oxfordſhire, Middleſex, Surrey, Northamptonſhire, - - -	*Eaſt and Weſt Indies.*
SEA-TORTOISE, ſeveral kinds; the *Hawkſbill*, *Loggerhead*, and *Green* ſpecies. Sheppy iſland,	*Weſt Indies.*
MANGROVE TREE OYSTERS. Sheppy iſland, - -	*Weſt Indies.*
COXCOMB TREE OYSTERS. Oxfordſhire, Glouceſterſhire, Dorſetſhire, and Hanover, -	*Coaſt of Guinea.*
VERTEBRÆ *and* PALATES *of the* ORBES. Sheppy iſland, and many other parts of England,	*Eaſt and Weſt Indies.*
CROCODILE. Germany, Derbyſhire, Nottinghamſhire, Oxfordſhire, and Yorkſhire, -	
ALLIGATOR'S TEETH. Oxfordſhire, Sheppy iſland, -	*Eaſt and Weſt Indies.*
The BANDED BUCCINUM. Oxfordſhire, and the Alps, -	*Weſt Indies.*
The DIPPING-SNAIL, and STAR-FISH. Sheppy iſland, -	*Weſt Indies.*
TAIL BUCCINUM. Sheppy iſland, Hordel Cliff, Hampſhire, -	*Eaſt Indies.*

Nothing has more perplexed thoſe who undertake to form theories of the earth than theſe appearances. Some have at once boldly aſſerted, from theſe and other phenomena, that the world is eternal. Others have had recourſe to the univerſal deluge. Some, among whom is the Count de Buffon, endeavour to prove that the ocean and dry land are perpetually changing places; that for many ages the higheſt mountains have been covered with water, in conſequence of which the marine animals juſt mentioned were generated in ſuch vaſt quantities; that the waters will again cover theſe mountains, the habitable part of the earth become ſea, and the ſea become dry land as before, &c. Others have imagined that they might be occaſioned by volcanoes, earthquakes, &c. which confound the different ſtrata, and often intermix the productions of the ſea with thoſe of the dry land.

But for a view of the different ſtrata ſo far as they are known, as well as for a view of ſome of the theories which have been propoſed to account for the formation and changes of the earth, ſee GEOLOGY.

Mr Forſter has given an account of ſome of the ſtrata of the South-ſea iſlands, the ſubſtance of which may be ſeen in the following table.

SOUTH GEORGIA.

1. No ſoil, except in a few crevices of the rocks.

2. Ponderous ſlate, with ſome irony particles, in horizontal ſtrata, perpendicularly interſected with veins of quartz.

Southern Iſle of NEW ZEALAND.

1. Fine light black mould, in ſome places nine inches deep, but generally not ſo much.
2. An argillaceous ſubſtance, nearly related to the claſs of TALCONS, turned into earth by the action of the air.
3. The ſame ſubſtance farther indurated, in oblique ſtrata, generally dipping to the ſouth.

EASTER ISLAND.

1. Reddiſh-brown duſty mould, looking as if it had been burnt.
2. Burnt rocks, reſembling ſlags or droſs and other volcanic matters.

MARQUESAS.

1. Clay mixed with mould.
2. An earthy argillaceous ſubſtance mixed with tarras and puzzolana.

OTAHEITE.

The ſhores are coral rock, extending from the reef encircling theſe iſles to the very high water-mark. There begins the ſand, formed in ſome places from ſmall ſhells and rubbed pieces of coral; but in others the ſhores are covered with blackiſh ſand, conſiſting of the former ſort mixed with black, ſometimes glittering, particles of mica, and here and there ſome particles of the refractory iron ores called in England SKIM, the *ferrum micaceum* of Linnæus, and KALL, the *molybdænum ſpuma lupi* of the ſame author. The plains from the ſhores to the foot of the hills are covered with a very fine thick ſtratum of black mould, mixed with the above-mentioned ſand, which the natives manure with ſhells. The firſt and lower range of hills are formed of a red ochreous earth, ſometimes ſo intenſely red, that the natives uſe it to paint their canoes and cloth. The higher hills conſiſt of a hard, compact, and ſtiff clayey ſubſtance, hardening into ſtone when out of the reach of the ſun and air. At the top of the valleys, along the banks of the rivers, are large maſſes of coarſe granite ſtones of various mixtures; in one place are pillars of a gray, ſolid baſaltes; and, in ſeveral others, fragments of black baſaltes.

FRIENDLY ISLANDS and NEW HEBRIDES.

The ſame with the above.

MALLICOLLO.

Yellowiſh clay mixed with common ſand.

TANNA, *a Volcanic Iſland.*

The chief ſtrata here are clay mixed with aluminous earth, interſperſed with lumps of pure chalk. The ſtrata of the clay are about ſix inches, deviating very little from the horizontal line.

NEW CALEDONIA and the *adjacent Iſles.*

The ſhores conſiſt of ſhell-ſand, and particles of quartz; the ſoil in the plains a black mould mixed with this ſand. The ſides of the hills compoſed of a yellow ochreous clay, richly ſpangled with ſmall particles of cat-ſilver, or a whitiſh kind of daze, the *mica argentea* of Linnæus. The higher parts of the hills conſiſt of a ſtone called by the German miners *geſtelſtein*, compoſed of quartz and great lumps of the above cat-ſilver. The latter is ſometimes of an intenſely red or orange colour, by means of an iron ochre.

"From the above account, ſays Mr Forſter, it appears, I think, evidently, that all the high tropical iſles of the South ſea have been ſubject to the action of volcanoes. Pyritical and ſulphureous ſubſtances, together with a few iron-ſtones, and ſome veſtiges of copper, are no doubt found in ſeveral of them: but the mountains of New Caledonia are the moſt likely to contain the richeſt metallic veins; and the ſame opinion, I ſuſpect, may be formed of the mountains in New Zealand."

In the city of Modena in Italy, and for ſome miles round that place, there is the moſt ſingular arrangement of ſtrata perhaps in the whole world. From the ſurface of the ground to the depth of 14 feet, they meet with nothing but the ruins of an ancient city. Being come to that depth, they find paved ſtreets, artificers ſhops, floors of houſes, and ſeveral pieces of inlaid work. After theſe ruins they find a very ſolid earth, which one would think had never been removed; but a little lower they find it black and marſhy, and full of briars. Signior Ramazzini in one place found a heap of wheat entire at the depth of 24 feet; in another, he found filbert-trees with their nuts. At the depth of about 28 feet, they find a bed of chalk, about 11 feet deep, which cuts very eaſily; after this a bed of marſhy earth of about two feet, mixed with ruſhes, leaves, and branches. After this bed comes another of chalk, nearly of the ſame thickneſs; and which ends at the depth of 42 feet. This is followed by another bed of marſhy earth like the former; after which comes a new chalk-bed, but thinner, which alſo has a marſhy bed underneath it. This ends at the depth of 63 feet; after which they find ſand mingled with ſmall gravel, and ſeveral marine ſhells. This ſtratum is uſually about five feet deep, and underneath it is a vaſt reſervoir of water. It is on account of this water that the ſoil is ſo frequently dug, and the ſtrata ſo well known in this part of the world. After coming to the ſandy bottom above mentioned, the workmen pierce the ground with a terebra or augre, when the water immediately ſprings up with great force, and fills the well to the brim. The flow is perpetual, and neither increaſes by rain, nor decreaſes by drought. Sometimes the augre meets with great trees, which give the workmen much trouble; they alſo ſometimes ſee at the bottom of theſe wells great bones, coals, flints, and pieces of iron.

It has been aſſerted by ſome, that the ſpecific gravity of the ſtrata conſtantly increaſed with the depth from the ſurface. But Dr Leigh, in his Natural Hiſtory of Lancaſhire, ſpeaking of the coal-pits, denies the ſtrata to lie according to the laws of gravitation; obſerving, that the ſtrata there are firſt a bed of marle, then free-ſtone, next iron-ſtone, then coal, or channel mire, then ſome other ſtrata, then coal again, &c. This determined Mr Derham to make a nicer inquiry into the matter: accordingly, in 1712, he cauſed divers places to be bored, laying the ſeveral ſtrata by themſelves; and afterwards determined very carefully their ſpecific gravity. The reſult was, that in his yard the ſtrata were gradually ſpecifically heavier and heavier the lower and lower they went; but in another place in his fields, he could not perceive any difference in the ſpecific gravities.

Acquainting the Royal Society therewith, their operator Mr Hauksbee was ordered to try the ſtrata of a coal pit, which he did to the depth of 30 ſtrata: the thickneſs and ſpecific gravity of each whereof he gives us in a table in the Philoſophical Tranſactions; and from the whole makes this inference, that it evidently appears the gravities of the ſeveral ſtrata are in no manner of order, but purely caſual, as if mixed by chance.

Vol. xxvii. p. 541.

STRATAGEM, in the art of war, any device for deceiving and ſurpriſing an enemy. The ancients dealt very much in ſtratagems: the moderns wage war more openly, and on the ſquare. Frontinus has made a collection of the ancient ſtratagems of war.

STRATEGUS, ϛρατηγος, in antiquity, an officer among the Athenians, whereof there were two choſen yearly, to command the troops of the ſtate.

Plutarch ſays, there was one choſen from out of each tribe; but Pollux ſeems to ſay they were choſen indifferently out of the people. The people themſelves made the choice; and that on the laſt day of the year, in a place called *Pnyx*. The two *ſtrategi* did not command together, but took their turns day by day; as we find from Herodotus and Cornelius Nepos. Sometimes indeed, as when a perſon was found of merit vaſtly ſuperior, and exceedingly famed in war, the command was given to him alone: but it was ever a rule not to put any perſon in the office but whoſe eſtate was in Attica, and who had children, that there might be ſome hoſtages and ſecurities for his conduct and fidelity. Conſtantine the Great, beſides many other privileges granted to the city of Athens, honoured its chief magiſtrate with the title of Μεγας Στρατηγος, *Magnus Dux*.

STRATH, in the Scottiſh language, ſignifies a long narrow valley, with a river running along the bottom.

STRATHEARN, a beautiful and extenſive valley in Perthſhire, bounded on the north by the lofty ridge of mountains called the *Grampians*, and on the ſouth by the Ochils, which are rounded on the tops and covered with verdure. It is called *Strathearn* from the river Earn, which runs through the middle of it from weſt to eaſt for about 30 miles. On each ſide of the banks of this beautiful ſtream are many villages and country-ſeats diſtinguiſhed for romantic ſituations. Were we to ſingle out any of the villages, we would mention Crieff, which ſtands on a fine ſloping ground on the north ſide of the Earn, and has been much admired by travellers for its ſituation, and the variety, contraſt, ſingularity, and beauty of the proſpect which it affords.

STRATHNAVER, a ſubdiviſion or diſtrict of the county of Sutherland in Scotland; bounded on the north by the ocean, on the eaſt by Caithneſs, on the ſouth by Sutherland properly ſo called, and on the weſt partly by Roſs and partly by the ocean.

STRATIOTES, WATER-SOLDIER, a genus of plants belonging to the claſs polyandria. See BOTANY *Index*.

STRATO, a philoſopher of Lampſacus, diſciple and ſucceſſor in the ſchool of Theophraſtus, about 248 years before the Chriſtian era. He applied himſelf with uncommon induſtry to the ſtudy of nature; and after the moſt mature inveſtigations, he ſupported that nature was inanimate, and that there was no god but nature. (See *PLASTIC Nature*). He was appointed preceptor to Ptolemy Philadelphus, who not only revered his abilities and learning, but alſo rewarded his labours with unbounded liberality. He wrote different treatiſes, all now loſt.

STRAWBERRY. See FRAGARIA, BOTANY *Index*.

STRAWBERRY-Tree. See ARBUTUS, BOTANY *Index*.

1 Importance of the ſubject.

STRENGTH OF MATERIALS, in *Mechanics*, is a ſubject of ſo much importance, that in a nation ſo eminent as this for invention and ingenuity in all ſpecies of manufactures, and in particular ſo diſtinguiſhed for its improvements in machinery of every kind, it is ſomewhat ſingular that no writer has treated it in the detail which its importance and difficulty demands. The man of ſcience who viſits our great manufactories is delighted with the ingenuity which he obſerves in every part, the innumerable inventions which come even from individual artiſans, and the determined purpoſe of improvement and refinement which he ſees in every workſhop. Every cotton mill appears an academy of mechanical ſcience; and mechanical invention is ſpreading from theſe fountains over the whole kingdom: But the philoſopher is mortified to ſee this ardent ſpirit ſo cramped by ignorance of principle, and many of theſe original and brilliant thoughts obſcured and clogged with needleſs and even hurtful additions, and a complication of machinery which checks improvement even by its appearance of ingenuity. There is nothing in which this want of ſcientific education, this ignorance of principle, is ſo frequently obſerved as in the injudicious proportion of the parts of machines and other mechanical ſtructures; proportions and forms of parts in which the ſtrength and poſition are nowiſe regulated by the ſtrains to which they are expoſed, and where repeated failures have been the only leſſons.

It cannot be otherwiſe. We have no means of inſtruction, except two very ſhort and abſtracted treatiſes of the late Mr Emerſon on the ſtrength of materials. We do not recollect a performance in our language from which our artiſts can get information. Treatiſes written expreſsly on different branches of mechanical arts are totally ſilent on this, which is the baſis and *only principle* of their performances. Who would imagine that PRICE'S BRITISH CARPENTER, the work of the firſt reputation in this country, and of which the ſole aim is to teach the carpenter to erect ſolid and durable ſtructures, does not contain one propoſition or one reaſon by which one form of a thing can be ſhown to be ſtronger or weaker than another? We doubt very much if one carpenter in an hundred can give a reaſon to convince his own mind that a joiſt is ſtronger when laid on its edge than when laid on its broad ſide. We ſpeak in this ſtrong manner in hopes of exciting ſome man of ſcience to publiſh a ſyſtem of inſtruction on this ſubject. The limits of our Work will not admit of a detail: but we think it neceſſary to point out the leading principles, and to give the traces of that ſyſtematic connection by which all the knowledge already poſſeſſed of this ſubject may be brought

brought together and properly arranged. This we ſhall now attempt in as brief a manner as we are able.

2
Strength of materials ariſes from coheſion.

3
Experiments to aſcertain it.

THE ſtrength of materials ariſes immediately or ultimately from the coheſion of the parts of bodies. Our examination of this property of tangible matter has as yet been very partial and imperfect, and by no means enables us to apply mathematical calculations with preciſion and ſucceſs. The various modifications of coheſion, in its different appearances of perfect ſoftneſs, plaſticity, ductility, elaſticity, hardneſs, have a mighty influence on the ſtrength of bodies, but are hardly ſuſceptible of meaſurement. Their texture alſo, whether uniform like glaſs and ductile metals, cryſtallized or granulated like other metals and freeſtone, or fibrous like timber, is a circumſtance no leſs important; yet even here, although we derive ſome advantage from remarking to which of theſe forms of aggregation a ſubſtance belongs, the aid is but ſmall. All we can do in this want of general principles is to make experiments on every claſs of bodies. Accordingly philoſophers have endeavoured to inſtruct the public in this particular. The Royal Society of London at its very firſt inſtitution made many experiments at their meetings, as may be ſeen in the firſt regiſters of the Society *. Several individuals have added their experiments. The moſt numerous collection in detail is by Muſchenbroek, profeſſor of natural philoſophy at Leyden. Part of it was publiſhed by himſelf in his *Eſſais de Phyſique*, in two vols. 4to; but the full collection is to be found in his Syſtem of Natural Philoſophy, publiſhed after his death by Lulofs, in three vols. 4to. This was tranſlated from the Low Dutch into French by Sigaud de la Fond, and publiſhed at Paris in 1760, and is a prodigious collection of phyſical knowledge of all kinds, and may almoſt ſuffice for a library of natural philoſophy. But this collection of experiments on the coheſion of bodies is not of that value which one expects. We preſume that they were carefully made and faithfully narrated; but they were made on ſuch ſmall ſpecimens, that the unavoidable natural inequalities of growth or texture produced irregularities in the reſults which bore too great a proportion to the whole quantities obſerved. We may make the ſame remark on the experiments of Couplet, Pitot, De la Hire, Du Hamel, and others of the French academy. In ſhort, if we except the experiments of Buffon on the ſtrength of timber, made at the public expence on a large ſcale, there is nothing to be met with from which we can obtain abſolute meaſures which may be employed with confidence; and there is nothing in the Engliſh language except a ſimple liſt by Emerſon, which is merely a ſet of affirmations, without any narration of circumſtances, to enable us to judge of the validity of his concluſions: but the character of Mr Emerſon, as a man of knowledge and of integrity, gives even to theſe aſſertions a conſiderable value.

4
Rendered uſeful by generalization.

But to make uſe of any experiments, there muſt be employed ſome general principle by which we can generalize their reſults. They will otherwiſe be only narrations of detached facts. We muſt have ſome notion of that intermedium, by the intervention of which an external force applied to one part of a lever, joiſt, or pillar, occaſions a ſtrain on a diſtant part. This can be nothing but the coheſion between the parts. It is this connecting force which is brought into action, or, as we more ſhortly expreſs it, excited. This action is modified in every part by the laws of mechanics. It is this action which is what we call the *ſtrength* of that part, and its effect is the ſtrain on the adjoining parts; and thus it is the ſame force, differently viewed, that conſtitutes both the ſtrain and the ſtrength. When we conſider it in the light of a reſiſtance to fracture, we call it *ſtrength*.

5
Strength defined.

6
Causes known only from their effects.

We call every thing a *force* which we obſerve to be ever accompanied by a change of motion; or, more ſtrictly ſpeaking, we infer the preſence and agency of a force wherever we obſerve the ſtate of things in reſpect of motion different from what we know to be the reſult of the action of all the forces which we know to act on the body. Thus when we obſerve a rope prevent a body from falling, we infer a moving force inherent in the rope with as much confidence as when we obſerve it drag the body along the ground. The *immediate action* of this force is undoubtedly exerted between the immediately adjoining parts of the rope. The immediate effect is the keeping the particles of the rope together. They ought to ſeparate by any external force drawing the ends of the rope contrarywiſe; and we aſcribe their not doing ſo to a mechanical force really oppoſing this external force. When deſired to give it a name, we name it from what we conceive to be its effect, and therefore its characteriſtic, and we call it COHESION. This is merely a name for the fact; but it is the ſame thing in all our denominations. We know nothing of the cauſes but in the effects; and our name for the cauſe is in fact the name of the effect, which is COHESION. We mean nothing elſe by gravitation or magnetiſm. What do we mean when we ſay that Newton underſtood thoroughly the nature of gravitation, of the force of gravitation; or that Franklin underſtood the nature of the electric force? Nothing but this: Newton conſidered with patient ſagacity the general facts of gravitation, and has deſcribed and claſſed them with the utmoſt preciſion. In like manner, we ſhall underſtand the nature of coheſion when we have diſcovered with equal generality the laws of coheſion, or general facts which are obſerved in the appearances, and when we have deſcribed and claſſed them with equal accuracy.

Let us therefore attend to the more ſimple and obvious phenomena of coheſion, and mark with care every circumſtance of reſemblance by which they may be claſſed. Let us receive theſe as the laws of coheſion, characteriſtic of its ſuppoſed cauſe, the force of coheſion. We cannot pretend to enter on this vaſt reſearch. The modifications are innumerable: and it would require the penetration of more than Newton to detect the circumſtance of ſimilarity amidſt millions of diſcriminating circumſtances. Yet this is the only way of diſcovering which are the primary facts characteriſtic of the force, and which are the modifications. The ſtudy is immenſe, but it is by no means deſperate; and we entertain great hopes that it will ere long be ſucceſsfully proſecuted: but, in our particular predicament, we muſt content ourſelves with ſelecting ſuch general laws as ſeem to give us the moſt immediate information of the circumſtances that muſt be attended to by the mechanician in his conſtructions, that he may unite ſtrength with ſimplicity, economy, and energy.

1. Then, it is a matter of fact that all bodies are in a

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* See Birche's *Hiſtory*, and Hooke's *Mathematical Collections*.

7 All bodies elaſtic.

certain degree perfectly elaſtic; that is, when their form or bulk is changed by certain moderate compreſſions or diſtractions, it requires the continuance of the changing force to continue the body in this new ſtate; and when the force is removed, the body recovers its original form. We limit the aſſertion to *certain moderate* changes: For inſtance, take a lead wire of one fifteenth of an inch in diameter and ten feet long; fix one end firmly to the ceiling, and let the wire hang perpendicular; affix to the lower end an index like the hand of a watch; on ſome ſtand immediately below let there be a circle divided into degrees, with its centre correſponding to the lower point of the wire: now turn this index twice round, and thus twiſt the wire. When the index is let go, it will turn backwards again, by the wire's untwiſting itſelf, and make almoſt four revolutions before it ſtops; after which it twiſts and untwiſts many times, the index going backwards and forwards round the circle, diminiſhing however its arch of twiſt each time, till at laſt it ſettles preciſely in its original poſition. This may be repeated for ever. Now, in this motion, every part of the wire partakes equally of the twiſt. The particles are ſtretched, require force to keep them in their ſtate of extenſion, and recover completely their relative poſitions. Theſe are all the characters of what the mechanician calls *perfect* elaſticity. This is a quality quite familiar in many caſes; as in glaſs, tempered ſteel, &c. but was thought incompetent to lead, which is generally conſidered as having little or no elaſticity. But we make the aſſertion in the moſt general terms, with the limitation to moderate derangement of form. We have made the ſame experiment on a thread of pipe-clay, made by forcing ſoft clay through the ſmall hole of a ſyringe by means of a ſcrew; and we found it more elaſtic than the lead wire: for a thread of one-twentieth of an inch diameter and ſeven feet long allowed the index to make two turns, and yet completely recovered its firſt poſition.

8 What is meant by a *ſet.*

9 Ductility.

10 Viſcidity.

2. But if we turn the index of the lead wire four times round, and let it go again, it untwiſts again in the ſame manner, but it makes little more than four turns back again; and after many oſcillations it finally ſtops in a poſition almoſt two revolutions removed from its original poſition. It has now acquired a new arrangement of parts, and this new arrangement is permanent like the former; and, what is of particular moment, it is perfectly elaſtic. This change is familiarly known by the denomination of a SET. The wire is ſaid to have TAKEN A SET. When we attend minutely to the procedure of nature in this phenomenon, we find that the particles have as it were ſlid on each other, ſtill cohering, and have taken a new poſition, in which their connecting forces are in equilibrio: and in this change of relative ſituation, it appears that the connecting forces which maintained the particles in their firſt ſituation were not in equilibrio in ſome poſition intermediate between that of the firſt and that of the laſt form. The force required for changing this firſt form augmented with the change, but only to a certain degree; and during this proceſs the connecting forces always tended to the recovery of this firſt form. But after the change of mutual poſition has paſſed a certain magnitude, the union has been partly deſtroyed, and the particles have been brought into new ſituations; ſuch, that the forces which now connect each with its neighbour tend, not to the recovery of the firſt arrangement, but to puſh them farther from it, into a new ſituation, to which they now verge, and require force to prevent them from acquiring. The wire is now in fact again perfectly elaſtic; that is, the forces which now connect the particles with their neighbours augment to a certain degree as the derangement from this new poſition augments. This is not reaſoning from any theory. It is narrating facts, on which a theory is to be founded. What we have been juſt now ſaying is evidently a deſcription of that ſenſible form of tangible matter which we call *ductility*. It has every gradation of variety, from the ſoftneſs of butter to the firmneſs of gold. All theſe bodies have ſome elaſticity; but we ſay they are not perfectly elaſtic, becauſe they do not completely recover their original form when it has been greatly damaged. The whole gradation may be moſt diſtinctly obſerved in a piece of glaſs or hard ſealing wax. In the ordinary form glaſs is perhaps the moſt completely elaſtic body that we know, and may be bent till juſt ready to ſnap, and yet completely recovers its firſt form, and takes no ſet whatever; but when heated to ſuch a degree as juſt to be viſible in the dark, it loſes its brittleneſs, and becomes ſo tough that it cannot be broken by any blow; but it is no longer elaſtic, takes any ſet, and keeps it. When more heated, it becomes as plaſtic as clay; but in this ſtate is remarkably diſtinguiſhed from clay by a quality which we may call VISCIDITY, which is ſomething like elaſticity, of which clay and other bodies purely plaſtic exhibit no appearance. This is the joint operation of ſtrong adheſion and ſoftneſs. When a rod of perfectly ſoft glaſs is ſuddenly ſtretched a little, it does not at once take the ſhape which it acquires after ſome little time. It is owing to this, that in taking the impreſſion of a ſeal, if we take off the ſeal while the wax is yet very hot, the ſharpneſs of the impreſſion is deſtroyed immediately. Each part drawing its neighbour, and each part yielding, the prominent parts are pulled down and blunted, and the ſharp hollows are pulled upwards and alſo blunted. The ſeal muſt be kept on till all has become not only ſtiff but hard.

11 Obſerved in all homogeneous plaſtic bodies.

This viſcidity is to be obſerved in all plaſtic bodies which are homogeneous. It is not obſerved in clay, becauſe it is not homogeneous, but conſiſts of hard particles of argillaceous earth ſticking together by their attraction for water. Something like it might be made of finely powdered glaſs and a clammy fluid ſuch as turpentine. Viſcidity has all degrees of ſoftneſs till it degenerates to ropy fluidity like that of olive oil. Perhaps ſomething of it may be found even in the moſt perfect fluid that we are acquainted with, as we obſerved in the experiments for aſcertaining ſpecific gravity.

There is in a late volume of the Philoſophical Tranſactions a narrative of experiments, by which it appears that the thread of the ſpider is an exception to our firſt general law, and that it is perfectly ductile. It is there aſſerted, that a long thread of goſſamer, furniſhed with an index, takes any poſition whatever; and that though the index be turned round any number of times (even many hundreds), it has no tendency to recover its firſt form. The thread takes completely any ſet whatever. We have not had an opportunity of repeating this experiment, but we have diſtinctly obſerved a phenomenon totally inconſiſtent with it. If a fibre of goſſamer about an inch long be held by the end horizontally, it bends downward in a curve like a ſlender ſlip of whalebone or a hair. If totally devoid of elaſticity, and perfectly indifferent to any ſet, it would hang down perpendicularly without any curvature.

When ductility and elaſticity are combined in different proportions, an immenſe variety of ſenſible modes of aggregation may be produced. Some degree of both are probably to be obſerved in all bodies of complex conſtitution; that is, which conſiſt of particles made up of many different kinds of atoms. Such a conſtitution of a body muſt afford many ſituations permanent, but eaſily deranged.

In all theſe changes of diſpoſition which take place among the particles of a ductile body, the particles are at ſuch diſtance that they ſtill cohere. The body may be ſtretched a little; and on removing the extending force, the body ſhrinks into its firſt form. It alſo reſiſts moderate compreſſions; and when the compreſſing force is removed, the body ſwells out again. 12 Particles acted on by attractions and repulſions. Now the corpuſcular *fact* here is, that the particles are acted on by attractions and repulſions, which balance each other when no external force is acting on the body, and which augment as the particles are made, by any external cauſe, to recede from this ſituation of mutual inactivity; for ſince force is requiſite to produce either the dilatation or the compreſſion, and to maintain it, we are obliged, by the conſtitution of our minds, to infer that it is oppoſed by a force accompanying or inherent in every particle of dilatable or compreſſible matter; and as this neceſſity of employing force to produce a change indicates the agency of theſe corpuſcular forces, and marks their kind, according as the tendencies of the particles appear to be toward each other in dilatation, or from each other in compreſſion; ſo it alſo meaſures the degrees of their intenſity. Should it require three times the force to produce a double compreſſion, we muſt reckon the mutual repulſions triple when the compreſſion is doubled; and ſo in other inſtances. We ſee from all this that the phenomena of coheſion indicate ſome relation between the centres of the particles. 13 The great problem in corpuſcular mechaniſm. To diſcover this relation is the great problem in corpuſcular mechaniſm, as it was in the Newtonian inveſtigation of the force of gravitation. Could we diſcover this law of action between the corpuſcles with the ſame certainty and diſtinctneſs, we might with equal confidence ſay what will be the reſult of any poſition which we give to the particles of bodies; but this is beyond our hopes. The law of gravitation is ſo ſimple, that the diſcovery or detection of it amid the variety of celeſtial phenomena required but one ſtep; and in its own nature its poſſible combinations ſtill do not greatly exceed the powers of human reſearch. One is almoſt diſpoſed to ſay that the Supreme Being has exhibited it to our reaſoning powers as ſufficient to employ with ſucceſs our utmoſt efforts, but not ſo abſtruſe as to diſcourage us from the noble attempt. It ſeems to be otherwiſe with reſpect to coheſion. Mathematics informs us, that if it deviates ſenſibly from the law of gravitation, the ſimpleſt combinations will make the joint action of ſeveral particles an almoſt impenetrable myſtery. We muſt therefore content ourſelves, for a long time to come, with a careful obſervation of the ſimpleſt caſes that we can propoſe, and with the diſcovery of ſecondary laws of action, in which many particles combine their influence. In purſuance of this plan, we obſerve,

14 Particles kept in their places by a balance of forces.

3. That whatever is the ſituation of the particles of a body with reſpect to each other, when in a quieſcent ſtate, they are kept in theſe ſituations by the balance of oppoſite forces. This cannot be refuſed, nor can we form to ourſelves any other notion of the ſtate of the particles of a body. Whether we ſuppoſe the ultimate particles to be of certain magnitudes and ſhapes, touching each other in ſingle points of coheſion; or whether we (with Boſcovich) conſider them as at a diſtance from each other, and acting on each other by attractions and repulſions—we muſt acknowledge, in the firſt place, that the centres of the particles (by whoſe mutual diſtances we muſt eſtimate the diſtance of the particles) may and do vary their diſtances from each other. What elſe can we ſay when we obſerve a body increaſe in length, in breadth, and thickneſs, by heating it, or when we ſee it diminiſh in all theſe dimenſions by an external compreſſion? A particle, therefore, ſituated in the midſt of many others, and remaining in that ſituation, muſt be conceived as maintained in it by the mutual balancing of all the forces which connect it with its neighbours. 15 Illuſtration of this propoſition. It is like a ball kept in its place by the oppoſite action of two ſprings. This illuſtration merits a more particular application. Suppoſe a number of balls ranged on the table in the angles of equilateral triangles, and that each ball is connected with the ſix which lie around it by means of an elaſtic wire curled like a cork-ſcrew; ſuppoſe ſuch another ſtratum of balls above this, and parallel to it, and ſo placed that each ball of the upper ſtratum is perpendicularly over the centre of the equilateral triangle below, and let theſe be connected with the balls of the under ſtratum by ſimilar ſpiral wires. Let there be a third and a fourth, and any number of ſuch ſtrata, all connected in the ſame manner. It is plain that this may extend to any ſize and fill any ſpace.—Now let this aſſemblage of balls be firmly contemplated by the imagination, and be ſuppoſed to ſhrink continually in all its dimenſions, till the balls, and their diſtances from each other, and the connecting wires, all vaniſh from the ſight as diſcrete individual objects. All this is very conceivable. It will now appear like a ſolid body, having length, breadth, and thickneſs; it may be compreſſed, and will again reſume its dimenſions; it may be ſtretched, and will again ſhrink; it will move away when ſtruck; in ſhort, it will not differ in its ſenſible appearance from a ſolid elaſtic body. Now when this body is in a ſtate of compreſſion, for inſtance, it is evident that any one of the balls is at reſt, in conſequence of the mutual balancing of the actions of all the ſpiral wires which connect it with thoſe around it. It will greatly conduce to the full underſtanding of all that follows to recur to this illuſtration. The analogy or reſemblance between the effects of this conſtitution of things and the effects of the corpuſcular forces is very great; and wherever it obtains, we may ſafely draw concluſions from what we know would be the condition of a body of common tangible matter. 16 By example. We ſhall juſt give one inſtructive example, and then have done with this hypothetical body. We can ſuppoſe it of a long ſhape, reſting on one point; we can ſuppoſe two weights A, B, ſuſpended at the extremities, and the whole in equilibrio. We commonly expreſs this ſtate of things by ſaying that A and B are in equilibrio. This is very inaccurate. A is in fact in equilibrio with the united action of all the ſprings which connect the ball to which it is applied

with the adjoining balls. Theſe ſprings are brought into action, and each is in equilibrio with the joint action of all the reſt. Thus through the whole extent of the hypothetical body, the ſprings are brought into action in a way and in a degree which mathematics can eaſily inveſtigate. We need not do this: it is enough for our purpoſe that our imagination readily diſcovers that ſome ſprings are ſtretched, others are compreſſed, and that a preſſure is excited on the middle point of ſupport, and the ſupport exerts a reaction which preciſely balances it; and the other weight is, in like manner, in immediate equilibrio with the equivalent of the actions of all the ſprings which connect the laſt ball with its neighbours. Now take the analogical or reſembling caſe, an oblong piece of ſolid matter, reſting on a fulcrum, and loaded with two weights in equilibrio. For the actions of the connecting ſprings ſubſtitute the corpuſcular forces, and the reſult will reſemble that of the hypotheſis.

Plate DXI. fig. 1.

17
How Boſcovich repreſents the action of corpuſcular forces.

Now as there is ſomething that is at leaſt analogous to a change of diſtance of the particles, and a concomitant change of the intenſity of the connecting forces, we may expreſs this in the ſame way that we are accuſtomed to do in ſimilar caſes. Let A and B (fig. 1.) repreſent the centres of two particles of a coherent elaſtic body in their quieſcent inactive ſtate, and let us conſider only the mechanical condition of B. The body may be ſtretched. In this caſe the diſtance AB of the particles may become AC. In this ſtate there is ſomething which makes it neceſſary to employ a force to keep the particles at this diſtance. C has a tendency towards A, or we may ſay that A attracts C. We may repreſent the magnitude of this tendency of C *towards* A, or this attraction of A, by a line C *c* perpendicular to AC. Again, the body may be compreſſed, and the diſtance AB may become AD. Something obliges us to employ force to continue this compreſſion; and D tends *from* A, or A appears to *repel* D. The intenſity of this tendency or repulſion may be repreſented by another perpendicular D *d*; and, to repreſent the different directions of theſe tendencies, or the different nature of theſe actions, we may ſet D *d* on the oppoſite ſide of AB. It is in this manner that the Abbé Boſcovich has repreſented the actions of corpuſcular forces in his celebrated Theory of Natural Philoſophy. Newton had ſaid, that, as the great movements of the ſolar ſyſtem were regulated by forces operating at a diſtance, and varying with the diſtance, ſo he ſtrongly ſuſpected (*valde ſuſpicor*) that all the phenomena of coheſion, with all its modifications in the different ſenſible forms of aggregation, and in the phenomena of chemiſtry and phyſiology, reſulted from the ſimilar agency of forces varying with the diſtance of the particles. The learned Jeſuit purſued this thought; and has ſhown, that if we ſuppoſe an ultimate atom of matter endowed with powers of attraction and repulſion, varying, both in kind and degree, with the diſtance, and if this force be the ſame in every atom, it may be regulated by ſuch a relation to the diſtance from the neighbouring atom, that a collection of ſuch may have all the ſenſible appearance of bodies in their different forms of ſolids, liquids, and vapours, elaſtic or unelaſtic, and endowed with all the properties which we perceive, by whoſe immediate operation the phenomena of motion by impulſe, and all the phenomena of chemiſtry, and of animal and vegetable economy, may be produced. He ſhows, that notwithſtanding a perfect ſameneſs, and even a great ſimplicity in this atomical conſtitution, there will reſult from this union all that unſpeakable variety of form and property which diverſify and embelliſh the face of nature. We ſhall take another opportunity of giving ſuch an account of this celebrated work as it deſerves. We mention it only, by the bye, as far as a general notion of it will be of ſome ſervice on the preſent occaſion. For this purpoſe, we juſt obſerve that Boſcovich conceives a particle of any individual ſpecies of matter to conſiſt of an unknown number of particles of ſimpler conſtitution; each of which particles, in their turn, is compounded of particles ſtill more ſimply conſtituted, and ſo on through an unknown number of orders, till we arrive at the ſimpleſt poſſible conſtitution of a particle of tangible matter, ſuſceptible of length, breadth, and thickneſs, and neceſſarily conſiſting of four atoms of matter. And he ſhows that the more complex we ſuppoſe the conſtitution of a particle, the more muſt the ſenſible qualities of the aggregate reſemble the obſerved qualities of tangible bodies. In particular, he ſhows how a particle may be ſo conſtituted, that although it act on one other particle of the ſame kind through a conſiderable interval, the interpoſition of a third particle of the ſame kind may render it totally, or almoſt totally, inactive; and therefore an aſſemblage of ſuch particles would form ſuch a fluid as air. All theſe curious inferences are made with uncontrovertible evidence; and the greateſt encouragement is thus given to the mathematical philoſopher to hope, that by cautious and patient proceeding in this way, we may gradually approach to a knowledge of the laws of coheſion, that will not ſhun a compariſon even with the *Principia* of Newton. No ſtep can be made in this inveſtigation, but by obſerving with care, and generalizing with judgment, the phenomena, which are abundantly numerous, and much more at our command than thoſe of the great and ſenſible motions of bodies. Following this plan, we obſerve,

18
Every body compreſſible and dilatable.

19
Law of nature diſcovered by Dr Hooke.

4. It is matter of fact, that every body has ſome degree of compreſſibility and dilatability; and when the changes of dimenſion are ſo moderate that the body completely recovers its original dimenſions on the ceſſation of the changing force, the extenſions or compreſſions are ſenſibly proportional to the extending or compreſſing forces; and therefore *the connecting forces are proportional to the diſtances of the particles from their quieſcent, neutral, or inactive poſitions.* This ſeems to have been firſt viewed as a law of nature by the penetrating eye of Dr Robert Hooke, one of the moſt eminent philoſophers of the laſt century. He publiſhed a cipher, which he ſaid contained the theory of ſpringineſs and of the motions of bodies by the action of ſprings. It was this, *ceiiinosssttuu.*—When explained in his diſſertation, publiſhed ſome years after, it was *ut tenſio ſic vis.* This is preciſely the propoſition juſt now aſſerted as a general fact, a law of nature. This diſſertation is full of curious obſervations of facts in ſupport of his aſſertion. In his application to the motion of bodies he gives his noble diſcovery of the balance ſpring of a watch, which is founded on this law. The ſpring, as it is more and more coiled up, or unwound, by the motion of the balance, acts on it with a force proportional to the diſtance of the balance from its quieſcent poſition. The balance, therefore, is acted on by an accelerating force, which varies in the ſame manner as the force of gravity

gravity acting on a pendulum ſwinging in a cycloid. Its vibrations therefore muſt be performed in equal time, whether they are wide or narrow. In the ſame diſſertation Hooke mentions all the facts which John Bernoulli afterwards adduced in ſupport of Leibnitz's whimſical doctrine of the force of bodies in motion, or the doctrine of the *vires vivæ*; a doctrine which Hooke might juſtly have claimed as his own, had he not ſeen its futility.

20
And confirmed by the experiments of others.

Experiments made ſince the time of Hooke ſhow that this law is ſtrictly true in the extent to which we have limited it, viz. in all the changes of form which will be completely undone by the elaſticity of the body. It is nearly true to a much greater extent. James Bernoulli, in his diſſertation on the elaſtic curve, relates ſome experiments of his own, which ſeem to deviate conſiderably from it; but on cloſe examination they do not. The fineſt experiments are thoſe of Coulomb, publiſhed in ſome late volumes of the memoirs of the Academy of Paris. He ſuſpended balls by wires, and obſerved their motions of oſcillation, which he found accurately correſponding with this law.

This we ſhall find to be a very important fact in the doctrine of the ſtrength of bodies, and we deſire the reader to make it familiar to his mind. If we apply to this our manner of expreſſing theſe forces by perpendicular ordinates C *c*, D *d* (fig. 1.), we muſt take other ſituations E, F, of the particle B, and draw E *e*, F *f*; and we muſt have $D\,d : F\,f = BD : BF$, or $C\,c : E\,e = BC : BE$. In ſuch a ſuppoſition F *d* B *c e* muſt be a ſtraight line. But we ſhall have abundant evidence by and bye that this cannot be ſtrictly true, and that the line B *c e* which limits the ordinates expreſſing the attractive forces becomes concave towards the line ABE, and that the part B *d f* is convex towards it. All that can be ſafely concluded from the experiments hitherto made is, that *to a certain extent* the forces, both attractive and repulſive, are *ſenſibly* proportional to the dilatations and compreſſions. For,

21
When a ody is nuch diated, a mall adlition of orce will ncreaſe its lilatation.

5. It is univerſally obſerved, that when the dilatations have proceeded a certain length, a leſs addition of force is ſufficient to increaſe the dilatation in the ſame degree. This is always obſerved when the body has been ſo far ſtretched that it takes a ſet, and does not completely recover its form. The like may be generally obſerved in compreſſions. Moſt perſons will recollect, that in violently ſtretching an elaſtic cord, it becomes ſuddenly weaker, or more eaſily ſtretched. But theſe phenomena do not poſitively prove a diminution of the corpuſcular force acting on one particle: It more probably ariſes from the diſunion of ſome particles, whoſe action contributed to the whole or ſenſible effect. And in compreſſions we may ſuppoſe ſomething of the ſame kind; for when we compreſs a body in one direction, it commonly bulges out in another; and in caſes of very violent action ſome particles may be diſunited, whoſe tranſverſe action had formerly balanced *part* of the compreſſing force. For the reader will ſee on reflection, that ſince the compreſſion in one direction cauſes the body to bulge out in the tranſverſe direction; and ſince this bulging out is in oppoſition to the tranſverſe forces of attraction, it muſt employ ſome part of the compreſſing force. And the common appearances are in perfect uniformity with this conception of things. When we preſs a bit of dryiſh clay, it ſwells out and cracks tranſverſely. When a pillar of wood is overloaded, it ſwells out, and ſmall crevices appear in the direction of the fibres. After this it will not bear half of the load. This the carpenters call CRIPPLING; and a knowledge of the circumſtances which modify it is of great importance, and enables us to underſtand ſome very paradoxical appearances, as will be ſhown by and bye.

This partial diſuniting of particles formerly cohering is, we imagine, the chief reaſon why the totality of the forces which really oppoſe an external ſtrain does not increaſe in the proportion of the extenſions and compreſſions. But ſufficient evidence will alſo be given that the forces which would connect one particle with one other particle do not augment in the accurate proportion of the change of diſtance; that in extenſions they increaſe more ſlowly, and in compreſſions more rapidly.

22
Ductility another cauſe of deviation.

But there is another cauſe of this deviation perhaps equally effectual with the former. Moſt bodies manifeſt ſome degree of ductility. Now what is this? The fact is, that the parts have taken a new arrangement, in which they again cohere. Therefore, in the paſſage to this new arrangement, the ſenſible forces, which are the joint reſult of many corpuſcular forces, begin to reſpect this new arrangement inſtead of the former. This muſt change the ſimple law of corpuſcular force, characteriſtic of the particular ſpecies of matter under examination. It does not require much reflection to convince us that the poſſible arrangements which the particles of a body may acquire, without appearing to change their nature, muſt be more numerous according as the particles are of a more complex conſtitution; and it is reaſonable to ſuppoſe that the conſtitution even of the moſt ſimple kind of matter that we are acquainted with is exceedingly complex. Our microſcopes ſhow us animals ſo minute, that a heap of them muſt appear to the naked eye an uniform maſs with a grain finer than that of the fineſt marble or razor hone; and yet each of theſe has not only limbs, but bones, muſcular fibres, blood-veſſels, fibres, and a blood conſiſting, in all probability, of globules organiſed and complex like our own. The imagination is here loſt in wonder; and nothing is left us but to adore inconceivable art and wiſdom, and to exult in the thought that we are the only ſpectators of this beautiful ſcene who can derive pleaſure from the view. What is trodden under foot with indifference, even by the half-reaſoning elephant, may be made by us the ſource of the pureſt and moſt unmixed pleaſure. But let us proceed to obſerve,

23
The forces which connect the particles of tangible bodies change by a change of diſtance.

6. That the forces which connect the particles of tangible bodies change by a change of diſtance, not only in degree, but alſo in kind. The particle B (fig. 1.) is attracted by A when in the ſituation C or E. It is repelled by it when at D or F. It is not affected by it when in the ſituation B. The reader is requeſted carefully to remark, that this is not an inference founded on the authority of our mathematical figure. The figure is an expreſſion (to aſſiſt the imagination) of facts in nature. It requires no force to keep the particles of a body in their quieſcent ſituations: but if they are ſeparated by ſtretching the body, they endeavour (pardon the figurative expreſſion) to come together again. If they are brought nearer by compreſſion, they endeavour to recede. This endeavour is manifeſted by the neceſſity of employing force to maintain the extenſion or condenſation; and we repreſent this by the different poſition

of our lines. But this is not all: the particle B which is repelled by A when in the ſituation F or D, is neutral when at B, and is attracted when at C or E, may be placed at ſuch a diſtance AG from A greater than AB that it ſhall be again repelled, or at ſuch a diſtance AH that it ſhall again be attracted; and theſe alterations may be repeated again and again. This is curious and important, and requires ſomething more than a bare aſſertion for its proof.

24 Light alternately attracted and repelled.

In the article OPTICS we mentioned the moſt curious and valuable obſervations of Sir Iſaac Newton, by which it appears that light is thus alternately attracted and repelled by bodies. The rings of colour which appear between the object glaſſes of long teleſcopes ſhowed, that in the ſmall interval of $\frac{1}{1000}$th of an inch, there are at leaſt an hundred ſuch changes obſervable, and that it is highly probable that theſe alternations extend to a much greater diſtance. At one of theſe diſtances the light actually converges towards the ſolid matter of the glaſs, which we expreſs ſhortly, by ſaying that it is attracted by it, and that at the next diſtance it declines from the glaſs, or is repelled by it. The ſame thing is more ſimply inferred from the phenomena of light paſſing by the edges of knives and other opaque bodies. We refer the reader to the experiments themſelves, the detail being too long for this place; and we requeſt him to conſider them minutely and attentively, and to form diſtinct notions of the inferences drawn from them. And we deſire it to be remarked, that although Sir Iſaac, in his diſcuſſion, always conſiders light as a ſet of corpuſcles moving in free ſpace, and obeying the actions of external forces like any other matter, the particular concluſion in which we are juſt now intereſted does not at all depend on this notion of the nature of light. Should we, with Des Cartes or Huygens, ſuppoſe light to be the undulation of an elaſtic medium, the concluſion will be the ſame. The undulations at certain diſtances are diſturbed by forces directed towards the body, and at a greater diſtance, the diſturbing forces tend *from* the body.

25 The ſame alternations of attraction and repulſion obſervable in the particles of other bodies, as glaſs.

But the ſame alternations of attraction and repulſion may be obſerved between the particles of common matter. If we take a piece of very flat and well-poliſhed glaſs, ſuch as is made for the horizon glaſſes of a good Hadley's quadrant, and if we wrap round it a fibre of ſilk as it comes from the cocoon, taking care that the fibre nowhere croſs another, and then preſs this pretty hard on ſuch another piece of glaſs, it will lift it up and keep it ſuſpended. The particles therefore of the one do moſt certainly attract thoſe of the other, and this at a diſtance equal to the thickneſs of the ſilk fibre. This is nearly the limit; and it ſometimes requires a conſiderable preſſure to produce the effect. The preſſure is effectual only by compreſſing the ſilk fibre, and thus diminiſhing the diſtance between the glaſs plates. This adheſion cannot be attributed to the preſſure of the atmoſphere, becauſe there is nothing to hinder the air from infinuating itſelf between the plates, ſince they are ſeparated by the ſilk. Beſides, the experiment ſucceeds equally well under the receiver of an air-pump. This moſt valuable experiment was firſt made by Huygens, who reported it to the Royal Society. It is narrated in the Philoſophical Tranſactions, N° 86.

Here then is an attraction acting, like gravity, at a diſtance. But take away the ſilk fibre, and try to make the glaſſes touch each other, and we ſhall find a very great force neceſſary. By Newton's experiments it appears, that unleſs the priſmatic colours begin to appear between the glaſſes, they are at leaſt $\frac{1}{890}$th of an inch aſunder or more. Now we know that a very conſiderable force is neceſſary for producing theſe colours, and that the more we preſs the glaſſes together the more rings of colours appear. It alſo appears from Newton's meaſures, that the difference of diſtance between the glaſſes where each of theſe colours appear is about the 89,000th part of an inch. We know farther, that when we have produced the laſt appearance of a greaſy or pearly colour, and then augment the preſſure, making it about a thouſand pounds on the ſquare inch, all colours vaniſh, and the two pieces of glaſs ſeem to make one tranſparent undiſtinguiſhable maſs. They appear now to have no air between them, or to be in mathematical contact. But another fact ſhows this concluſion to be premature. The ſame circles of colours appear in the top of a ſoap bubble; and as it grows thinner at top, there appears an unreflecting ſpot in the middle. We have the greateſt probability therefore that the perfect tranſparency in the middle of the two glaſſes does not ariſe from their being in contact, but becauſe the thickneſs of air between them is too ſmall in that place for the reflection of light. Nay, Newton expreſsly found no reflection where the thickneſs was $\frac{2}{3}$ths or more of the $\frac{1}{89000}$th part of an inch.

All this while the glaſſes are ſtrongly repelling each other, for great preſſure is neceſſary for continuing the appearance of thoſe colours, and they vaniſh in ſucceſſion as the preſſure is diminiſhed. This vaniſhing of the colours is a proof that the glaſſes are moving off from each other, or repelling each other. But we can put an end to this repulſion by very ſtrong preſſure, and at the ſame time ſliding the glaſſes on each other. We do not pretend to account for this effect of the ſliding motion; but the fact is, that by ſo doing, the glaſſes will cohere with very great force, ſo that we ſhall break them by any attempt to pull them aſunder. It commonly happens (at leaſt it did ſo with us), that in this ſliding compreſſion of two ſmooth flat plates of glaſs they ſcratch and mutually deſtroy each other's ſurface. It is alſo worth remarking, that different kinds of glaſs exhibit different properties in this reſpect. Flint glaſs will attract even though a ſilk fibre lies double between them, and they much more readily cohere by this ſliding preſſure.

Here then are two diſtances at which the plates of glaſs attract each other; namely, when the ſilk fibre is interpoſed, and when they are forced together with this ſliding motion. And in any intermediate ſituation they repel each other. We ſee the ſame thing in other ſolid bodies.

26 Lead and iron.

Two pieces of lead made perfectly clean, may be made to cohere by grinding them together in the ſame manner. It is in this way that pretty ornaments of ſilver are united to iron. The piece is ſcraped clean, and a ſmall bit of ſilver like a fiſh ſcale is laid on. The die which is to ſtrike it into a flower or other ornament is then ſet on it, and we give it a ſmart blow, which forces the metals into contact as firm as if they were ſoldered together. It ſometimes happens that the die adheres to the coin ſo that they cannot be ſeparated: and it is found that this frequently happens, when the engraving is ſuch, that the raiſed figure is not completely

27 Probable cauſe why the die adheres to the coin.

ly ſurrounded with a ſmooth flat ground. The probable cauſe of this is curious. When the coin has a flat ſurface all around, this is produced by the moſt prominent part of the die. This applies to the metal, and completely confines the air which filled the hollow of the die. As the preſſure goes on, the metal is ſqueezed up into the hollow of the die; but there is ſtill air compreſſed between them, which cannot eſcape by any paſſage. It is therefore prodigiouſly condenſed, and exerts an elaſticity proportioned to the condenſation. This ſerves to ſeparate the die from the metal when the ſtroke is over. The hollow part of the die has not touched the metal all the while, and we may ſay that the impreſſion was made by air. If this air eſcape by any engraving reaching through the border, they cohere inſeparably.

We have admitted that the glaſs plates are in contact when they cohere thus firmly. But we are not certain of this: for if we take theſe cohering glaſſes, and touch them with water, it quickly inſinuates itſelf between them. Yet they ſtill cohere, but can now be pretty eaſily ſeparated.

28 Repulſion the cauſe of ſome bodies ſwimming in a fluid ſpecifically lighter than themſelves.

It is owing to this repulſion, exerted through its proper ſphere, that certain powders ſwim on the ſurface of water, and are wetted with great difficulty. Certain inſects can run about on the ſurface of water. They have bruſhy feet, which occupy a conſiderable ſurface; and if their ſteps are viewed with a magnifying glaſs, the ſurface of the water is ſeen depreſſed all around, reſembling the footſteps of a man walking on feather-beds. This is owing to a repulſion between the bruſh and the water. A common fly cannot walk in this manner on water. Its feet are wetted, becauſe they attract the water inſtead of repelling it. A ſteel needle, wiped very clean, will lie on the ſurface of water, making an impreſſion as a great bar would make on a feather bed; and its weight is leſs than that of the diſplaced water. A dew drop lies on the leaves of plants without touching them mathematically, as is plain from the extreme brilliancy of the reflection at the poſterior ſurface; nay, it may be ſometimes obſerved that the drops of rain lie on the ſurface of water, and roll about on it like balls on a table. Yet all theſe ſubſtances can be wetted; that is, water can be applied to them at ſuch diſtances that they attract it.

What we ſaid a little ago of water inſinuating itſelf between the glaſs plates without altogether deſtroying their coheſion, ſhows that this coheſion is not the ſame that obtains between the particles of one of the plates; that is, the two plates are not in the ſtate of one continued maſs. It is highly probable, therefore, that between theſe two ſtates there is an intermediate ſtate of repulſion, nay, perhaps many ſuch, alternated with attractive ſtates.

A piece of ice is elaſtic, for it rebounds and rings. Its particles, therefore, when compreſſed, reſile; and when ſtretched, contract again. The particles are therefore in the ſtate repreſented by B in figure 1. acted on by repulſive forces, if brought nearer; and by attractive forces, if drawn further aſunder. Ice expands, like all other bodies, by heat. It abſorbs a vaſt quantity of fire; which, by combining its attractions and repulſions with thoſe of the particles of ice, changes completely the law of action, without making any ſenſible change in the diſtance of the particles, and the ice becomes water. In this new ſtate the particles are again in limits between attractive and repulſive forces; for water has been ſhown, by the experiments of Canton and Zimmerman, to be elaſtic or compreſſible. It again expands by heat. It again abſorbs a prodigious quantity of heat, and becomes elaſtic vapour; its particles repelling each other at all diſtances yet obſerved. The diſtance between the particles of one plate of glaſs and thoſe of another which lies on it, and is carried by it, is a diſtance of repulſion; for the force which ſupports the upper piece is acting in oppoſition to its weight. This diſtance is leſs than that at which it would *ſuſpend* it below it with a ſilk fibre interpoſed; for no priſmatic colours appear between them when the ſilk fibre is interpoſed. But the diſtance at which glaſs attracts water is much leſs than this, for no colours appear when glaſs is wetted with water. This diſtance is leſs, and not greater, than the other; for when the glaſſes have water interpoſed between them inſtead of air, it is found, that when any particular colour appears, the thickneſs of the plate of water is to that of the plate of air which would produce the ſame colour nearly as 3 to 4. Now, if a piece of glaſs be wetted, and exhibit no colour, and another piece of glaſs be ſimply laid on it, no colour will appear; but if they are ſtrongly preſſed, the colours appear in the ſame manner as if the glaſſes had air between. Alſo, when glaſs is ſimply wetted, and the film of water is allowed to evaporate, when it is thus reduced to a proper thinneſs, the colours ſhow themſelves in great beauty.

29 Particles of matter connected by forces acting at a diſtance.

Theſe are a few of many thouſand facts, by which it is unqueſtionably proved that the particles of tangible matter are connected by forces acting at a diſtance, varying with the diſtance, and alternately attractive and repulſive. If we repreſent theſe forces as we have already done in fig. 1. by the ordinates C *c*, D *d*, E *e*, F *f*, &c. of a curve, it is evident that this curve muſt croſs the axis at all thoſe diſtances where the forces change from attractive to repulſive, and the curve muſt have branches alternately above and below the axis.

All theſe alternations of attraction and repulſion take place at ſmall and inſenſible diſtances. At all ſenſible diſtances the particles are influenced by the attraction of gravitation; and therefore this part of the curve muſt be a hyperbola whoſe equation is $y=\frac{a^3}{x^2}$. What is the form of the curve correſponding to the ſmalleſt diſtance of the particles? that is, what is the mutual action between the particles juſt before their coming into abſolute contact? Analogy ſhould lead us to ſuppoſe it to be repulſion; for ſolidity is the laſt and ſimpleſt form of bodies with which we are acquainted.—Fluids are more compounded, containing fire as an eſſential ingredient. We ſhould conclude that this ultimate repulſion is inſuperable, for the hardeſt bodies are the moſt elaſtic. We are fully entitled to ſay, that this repelling force exceeds all that we have ever yet applied to overcome it; nay, there are good reaſons for ſaying that this ultimate repulſion, by which the particles are kept from mathematical contact, is really inſuperable in its own nature, and that it is impoſſible to produce mathematical contact.

30 Mathematical contact impoſſible.

We ſhall juſt mention one of theſe, which we conſider as unanſwerable. Suppoſe two atoms, or ultimate particles of matter, A and B. Let A be at reſt, and B move up to it with the velocity 2; and let us ſuppoſe that it comes into mathematical contact, and impels it (according to the common acceptation of the word). Both move with the velocity 1. This is granted by all to be the final reſult of the colliſion. Now the inſtant of time in which this communication happens is no part either of the duration of the ſolitary motion of A, nor of the joint motion of A and B: It is the ſeparation or boundary between them. It is at once the end of the firſt, and the beginning of the ſecond, belonging equally to both. A was moving with the velocity 2. The diſtinguiſhing circumſtance therefore of its mechanical ſtate is, that it has a determination (however incomprehenſible) by which it would move for ever with the velocity 2, if nothing changed it. This it has during the whole of its ſolitary motion, and therefore in the laſt inſtant of this motion. In like manner, during the whole of the joint motion, and therefore in the firſt inſtant of this motion, the atom A has a determination by which it would move for ever with the velocity 1. In one and the ſame inſtant, therefore, the atom A has two incompatible determinations. Whatever notion we can form of this ſtate, which we call velocity, as a diſtinction of condition, the ſame impoſſibility of conception or the ſame abſurdity occurs. Nor can it be avoided in any other way than by ſaying, that this change of A's motion is brought about by inſenſible gradations; that is, that A and B influence each other preciſely as they would do if a ſlender ſpring were interpoſed. The reader is deſired to look at what we have ſaid in the article Physics, § 82.

The two magnets there ſpoken of are good repreſentatives of two atoms endowed with mutual powers of repulſion; and the communication of motion is accompliſhed in both caſes in preciſely the ſame manner.

If, therefore, we ſhall ever be ſo fortunate as to diſcover the law of variation of that force which connects one atom of matter with another atom, and which is therefore characteriſtic of matter, and the ultimate ſource of all its ſenſible qualities, the curve whoſe ordinates repreſent the kind and the intenſity of this atomical force will be ſomething like that ſketched in fig. 2. Fig. 2. The firſt branch *a n* B will have AK (perpendicular to the axis AH) for its aſſymptote, and the laſt branch *l m o* will be to all ſenſe a hyperbola, having AO for its aſſymptote; and the ordinates *l* L, *m* M, &c. will be proportional to $\frac{1}{AL^2}$, $\frac{1}{AM^2}$, &c. expreſſing the univerſal gravitation of matter. It will have many branches B *b* C, D *d* E, F *f* G, &c. expreſſing attractions, and alternate repulſive branches C *c* D, E *e* F, G *g* H, &c. All theſe will be contained within a diſtance AH, which does not exceed a very minute fraction of an inch.

31 The ſimpleſt extended particle conſiſts of four atoms.

The ſimpleſt particle which can be a conſtituent of a body having length, breadth, and thickneſs, muſt conſiſt of four ſuch atoms, all of which combine their influence on each atom of another ſuch particle. It is evident that the curve which expreſſes the force that connect two ſuch particles muſt be totally different from this original curve, this hylarchic principle. Suppoſing the laſt known, our mathematical knowledge is quite able to diſcover the firſt; but when we proceed to compoſe a body of particles, each of which conſiſts of four ſuch particles, we may venture to ſay, that the compound force which connects them is almoſt beyond our ſearch, and that the diſcovery of the primary force from an *accurate* knowledge of the corpuſcular forces of *this* particular matter is abſolutely out of our power.

All that we can learn is, the poſſibility, nay the certainty, of an innumerable variety of external ſenſible forms and qualities, by which different kinds of matter will be diſtinguiſhed, ariſing from the number, the order of compoſition, and the arrangement of the ſubordinate particles of which a particle of this or that kind of matter is compoſed. All theſe varieties will take place at thoſe ſmall and inſenſible diſtances which are between A and H, and may produce all that variety which we obſerve in the tangible or mechanical forms of bodies, ſuch as elaſticity, ductility, hardneſs, ſoftneſs, fluidity, vapour, and all thoſe unſeen motions or actions which we obſerve in fuſion and congelation, evaporation and condenſation, ſolution and precipitation, cryſtallization, vegetable and animal aſſimilation and ſecretion, &c. &c. &c. while all bodies muſt be, in a certain degree, elaſtic, all muſt gravitate, and all muſt be incompenetrable.

This general and ſatisfactory reſemblance between the appearance of tangible matter and the legitimate conſequence of this general hypothetical property of an atom of matter, affords a conſiderable probability that ſuch is the origin of all the phenomena. We earneſtly recommend to our readers a *careful* peruſal of Boſcovich's celebrated treatiſe. A careful peruſal is neceſſary for ſeeing its value; and nothing will be got by a haſty look at it. The reader will be particularly pleaſed with the facility and evidence with which the ingenious author has deduced all the ordinary principles of mechanics, and with the explanation which he has given of fluidity, and his deduction from thence of the laws of hydroſtatics. No part of the treatiſe is more valuable than the doctrine of the propagation of preſſure through ſolid bodies. This, however, is but juſt touched on in the courſe of the inveſtigation of the principles of mechanics. We ſhall borrow as much as will ſuffice for our preſent inquiry into the ſtrength of materials; and we truſt that our readers are not diſpleaſed with this general ſketch of the doctrine (if it may be ſo called) of the coheſion of bodies. It is curious and important in itſelf, and is the foundation of all the knowledge we can acquire of the preſent article. We are ſorry to ſay that it is as yet a new ſubject of ſtudy; but it is a very promiſing one, and we by no means deſpair of ſeeing the whole of chemiſtry brought by its means within the pale of mechanical ſcience. The great and diſtinguiſhing agent in chemiſtry is heat, or fire the cauſe of heat; and one of its moſt ſingular effects is the converſion of bodies into elaſtic vapour. We have the cleareſt evidence that this is brought about by mechanical forces: for it can be oppoſed or prevented by external preſſure, a very familiar mechanical force. We may perhaps find another mechanical force which will prevent fuſion.

32 The doctrine of coheſion yet a new ſubject.

Having now made our readers familiar with the mode of action in which coheſion operates in giving ſtrength to ſolid bodies, we proceed to conſider the ſtrains to which this ſtrength is oppoſed.

33 Strains to which ſtrength is oppoſed.

A piece of ſolid matter is expoſed to four kinds of ſtrains, pretty different in the manner of their operation.

1. It may be torn aſunder, as in the caſe of ropes, ſtretchers, king-poſts, tye-beams, &c.

2. It may be cruſhed, as in the caſe of pillars, poſts, and truſs beams.

3. It may be broken acroſs, as happens to a joiſt or lever of any kind.

4. It may be wrenched or twiſted, as in the caſe of the axle of a wheel, the nail of a preſs, &c.

I. It may be pulled asunder.

34 Matter may be pulled aſunder,

This is the ſimpleſt of all ſtrains, and the others are indeed modifications of it. To this the force of coheſion is *directly* oppoſed, with very little modification of its action by any particular circumſtances.

When a long cylindrical or priſmatic body, ſuch as a rod of wood or metal, or a rope, is drawn by one end, it muſt be reſiſted at the other, in order to bring its coheſion into action. When it is faſtened at one end, we cannot conceive it any other way than as equally ſtretched in all its parts; for all our obſervations and experiments on natural bodies concur in ſhowing us that the forces which connect their particles, in any way whatever, are equal and oppoſite. This is called the *third law of motion;* and we admit its univerſality, while we affirm that it is purely experimental (ſee Physics). Yet we have met with diſſertations by perſons of eminent knowledge, where propoſitions are maintained inconſiſtent with this. During the diſpute about the communication of motion, ſome of the ableſt writers have ſaid, that a ſpring compreſſed or ſtretched at the two ends was gradually leſs and leſs compreſſed or ſtretched from the extremities towards the middle: but the ſame writers acknowledged the univerſal equality of action and reaction, which is quite incompatible with this ſtate of the ſpring. No ſuch inequality of compreſſion or dilatation has ever been obſerved; and a little reflection will ſhow it to be impoſſible, in conſiſtency with the equality of action and reaction.

Since all parts are thus equally ſtretched, it follows, that the ſtrain in any tranſverſe ſection is the ſame, as alſo in every point of that ſection. If therefore the body be ſuppoſed of a homogeneous texture, the coheſion of the parts is equable; and ſince every part is equally ſtretched, the particles are drawn to equal diſtances from their quieſcent poſitions, and the forces which are thus excited, and now exerted in oppoſition to the ſtraining force, are equal. This external force may be increaſed by degrees, which will gradually ſeparate the parts of the body more and more from each other, and the connecting forces increaſe with this increaſe of diſtance, till at laſt the coheſion of ſome particles is overcome. This muſt be immediately followed by a rupture, becauſe the remaining forces are now weaker than before.

It is the united force of coheſion, immediately before the diſunion of the firſt particles, that we call the strength of the ſection. It may alſo be properly called its absolute strength, being exerted in the ſimpleſt form, and not modified by any relation to other circumſtances.

35 a circumſtance to be attended to in every conſtruction requiring ſtrength.

If the external force has not produced any permanent change on the body, and it therefore recovers its former dimenſions when the force is withdrawn, it is plain that this ſtrain may be repeated as often as we pleaſe, and the body which withſtands it once will always withſtand it. It is evident that this ſhould be attended to in all conſtructions, and that in all our inveſtigations on this ſubject this ſhould be kept ſtrictly in view. When we treat a piece of ſoft clay in this manner, and with this precaution, the force employed muſt be very ſmall. If we exceed this, we produce a permanent change. The rod of clay is not indeed torn aſunder; but it has become ſomewhat more ſlender: the number of particles in a croſs ſection is now ſmaller; and therefore, although it will again, in this new form, ſuffer, or allow an endleſs repetition of a *certain* ſtrain without any farther permanent change, this ſtrain is ſmaller than the former.

36 Great varieties in coheſion, but

Something of the ſame kind happens in all bodies which receive a sett by the ſtrain to which they are expoſed. All ductile bodies are of this kind. But there are many bodies which are not ductile. Such bodies break completely whenever they are ſtretched beyond the limit of their perfect elaſticity. Bodies of a fibrous ſtructure exhibit very great varieties in their coheſion. In ſome the fibres have no lateral coheſion, as in the caſe of a rope. The only way in which all the fibres can be made to unite their ſtrength is, to twiſt them together. This cauſes them to bind each other ſo faſt, that any one of them will break before it can be drawn out of the bundle. In other fibrous bodies, ſuch as timber, the fibres are held together by ſome cement or gluten. This is ſeldom as ſtrong as the fibre. Accordingly timber is much eaſier pulled aſunder in a direction tranſverſe to the fibres. There is, however, every poſſible variety in this particular.

In ſtretching and breaking fibrous bodies, the viſible extenſion is frequently very conſiderable. This is not ſolely the increaſing of the diſtance of the particles of the cohering fibre; the greateſt part chiefly ariſes from drawing the crooked fibre ſtraight. In this, too, there is great diverſity; and it is accompanied with important differences in their power of withſtanding a ſtrain. In ſome woods, ſuch as fir, the fibres on which the ſtrength moſt depends are very ſtraight. Such woods are commonly very elaſtic, do not take a ſett, and break abruptly when overſtrained: others, ſuch as oak and birch, have their reſiſting fibres very undulating and crooked, and ſtretch very ſenſibly by a ſtrain. They are very liable to take a ſett, and they do not break ſo ſuddenly, but give warning by *complaining*, as the carpenters call it; that is, by giving viſible ſigns of a derangement of texture. Hard bodies of an uniform glaſſy ſtructure, or granulated like ſtones, are elaſtic through the whole extent of their coheſion, and take no ſett, but break at once when overloaded.

Notwithſtanding the immenſe variety which nature exhibits in the ſtructure and coheſion of bodies, there are certain general facts of which we may now avail ourſelves with advantage. In particular,

37 the abſolute coheſion or ſtrength proportional to the area of the ſection perpendicular to the extending force.

The abſolute coheſion is proportional to the area of the ſection. This muſt be the caſe where the texture is perfectly uniform, as we have reaſon to think it is in glaſs and the ductile metals. The coheſion of each particle being alike, the whole coheſion muſt be proportional to their number, that is, to the area of the ſection. The ſame muſt be admitted with reſpect to bodies of a granulated texture, where the granulation is regular and uniform. The ſame muſt be admitted of fibrous bodies, if we ſuppoſe their fibres equally ſtrong, equally denſe, and ſimilarly diſpoſed through the whole ſection; and this we muſt either ſuppoſe, or muſt ſtate the diverſity, and meaſure the coheſion accordingly.

We may therefore aſſert, as a general propoſition on this ſubject, that the abſolute ſtrength in any part of a body by which it reſiſts being pulled aſunder, or the force which muſt be employed to tear it aſunder *in that part*, is proportional to the area of the ſection perpendicular to the extending force.

Therefore all cylindrical or priſmatical rods are equally ſtrong in every part, and will break alike in any part; and bodies which have unequal ſections will always break in the ſlendereſt part. The length of the cylinder or priſm has no effect on the ſtrength; and the vulgar notion, that it is eaſier to break a very long rope than a ſhort one, is a very great miſtake. Alſo the abſolute ſtrengths of bodies which have ſimilar ſections are proportional to the ſquares of their diameters or homologous ſides of the ſection.

38
Relative ſtrength.

The weight of the body itſelf may be employed to ſtrain it and to break it. It is evident, that a rope may be ſo long as to break by its own weight. When the rope is hanging perpendicularly, although it is equally ſtrong in every part, it will break towards the upper end, becauſe the ſtrain on any part is the weight of all that is below it. Its RELATIVE STRENGTH in any part, or power of withſtanding the ſtrain which is actually laid on it, is inverſely as the quantity below that part.

When the rope is ſtretched horizontally, as in towing a ſhip, the ſtrain ariſing from its weight often bears a very ſenſible proportion to its whole ſtrength.

Fig. 3.

Let AEB (fig. 3.) be any portion of ſuch a rope, and AC, BC be tangents to the curve into which its gravity bends it. Complete the parallelogram ACBD. It is well known that the curve is a catenaria, and that DC is perpendicular to the horizon; and that DC is to AC as the weight of the rope AEB to the ſtrain at A.

In order that a ſuſpended heavy body may be equally able in every part to carry its own weight, the ſection in that part muſt be proportional to the ſolid contents of all that is below it. Suppoſe it a conoidal ſpindle, formed by the revolution of the curve A *a e*

Fig. 4.

(fig. 4.) round the axis CE. We muſt have $AC^2 : ac^2 = AEB$ ſol. : *a* E *b* ſol. This condition requires the logarithmic curve for A *a e*, of which C *c* is the axis.

39
The coheſion of metals depends on various circumſtances.

Theſe are the chief general rules which can be ſafely deduced from our cleareſt notions of the coheſion of bodies. In order to make any practical uſe of them, it is proper to have ſome meaſures of the coheſion of ſuch bodies as are commonly employed in our mechanics, and other ſtructures where they are expoſed to this kind of ſtrain. Theſe muſt be deduced ſolely from experiment. Therefore they muſt be conſidered as no more than general values, or as the averages of many particular trials. The irregularities are very great, becauſe none of the ſubſtances are conſtant in their texture and firmneſs. Metals differ by a thouſand circumſtances unknown to us, according to their purity, to the heat with which they were melted, to the moulds in which they were caſt, and the treatment they have afterwards received, by forging, wire-drawing, tempering, &c.

It is a very curious and inexplicable fact, that by forging a metal, or by frequently drawing it through a ſmooth hole in a ſteel plate, its coheſion is greatly increaſed. This operation undoubtedly deranges the natural ſituation of the particles. They are ſqueezed cloſer together in one direction; but it is not in the direction in which they reſiſt the fracture. In this direction they are rather ſeparated to a greater diſtance. The general denſity, however, is augmented in all of them except lead, which grows rather rarer by wire-drawing: but its coheſion may be more than tripled by this operation. Gold, ſilver, and braſs, have their coheſion nearly tripled; copper and iron have it more than doubled. In this operation they alſo grow much harder. It is proper to heat them to redneſs after drawing a little. This is called *nealing* or *annealing*. It ſoftens the metal again, and renders it ſuſceptible of another drawing without the riſk of cracking in the operation.

We do not pretend to give any explanation of this remarkable and very important fact, which has ſomething reſembling it in woods and other fibrous bodies, as will be mentioned afterwards.

The varieties in the coheſion of ſtones and other minerals, and of vegetable and animal ſubſtances, are hardly ſuſceptible of any deſcription or claſſification.

40
Coheſion and ſtrength of different metals.

We ſhall take for the meaſure of coheſion the number of pounds avoirdupois which are juſt ſufficient to tear aſunder a rod or bundle of one inch ſquare. From this it will be eaſy to compute the ſtrength correſponding to any other dimenſion.

1*ſt*, METALS.

		lbs.
Gold, caſt,		20,000 24,000
Silver, caſt,		40,000 43,000
Copper, caſt,	Japan,	19,500
	Barbary,	22,000
	Hungary,	31,000
	Angleſea,	34,000
	Sweden,	37,000
Iron, caſt,		42,000 59,000
Iron, bar,	Ordinary,	68,000
	Stirian,	75,000
	Beſt Swediſh and Ruſſian,	84,000
	Horſe-nails,	71,000 (A)
Steel, bar,	Soft,	120,000
	Razor temper,	150,000
Tin, caſt,	Malacca,	3,100
	Banca,	3,600
	Block,	3,800
	Engliſh block,	5,200
	——— grain,	6,500
Lead, caſt,		860
Regulus of antimony,		1,000
Zinc,		2,600
Biſmuth,		2,900

(A) This was an experiment by Muſchenbroek, to examine the vulgar notion that iron forged from old horſe nails was ſtronger than all others, and ſhows its falſity.

41 Tenacity of metals increaſed by mixtures.

It is very remarkable that almoſt all the mixtures of metals are more tenacious than the metals themſelves. The change of tenacity depends much on the proportion of the ingredients, and the proportion which produces the moſt tenacious mixture is different in the different metals. We have ſelected the following from the experiments of Muſchenbroek. The proportion of ingredients here ſelected is that which produces the greateſt ſtrength.

Two parts of gold with one of ſilver	28,000
Five parts of gold with one of copper	50,000
Five parts of ſilver with one of copper	48,500
Four parts of ſilver with one of tin -	41,000
Six parts of copper with one of tin -	41,000
Five parts of Japan copper with one of Banca tin - - -	57,000
Six parts of Chili copper with one of Malacca tin - - -	60,000
Six parts of Swediſh copper with one of Malacca tin - - -	64,000
Braſs conſiſts of copper and zinc in an unknown proportion; its ſtrength is	51,000
Three parts of block tin with one part of lead - - -	10,200
Eight parts of block tin with one part of zinc - - -	10,000
Four parts of Malacca tin with one part of regulus of antimony - -	12,000
Eight parts of lead with one of zinc	4,500
Four parts of tin with one of lead and one of zinc - - -	13,000

Theſe numbers are of conſiderable uſe in the arts. The mixtures of copper and tin are particularly intereſting in the fabric of great guns. We ſee that, by mixing copper whoſe greateſt ſtrength does not exceed 37,000, with tin which does not exceed 6000, we produce a metal whoſe tenacity is almoſt double, at the ſame time that it is harder and more eaſily wrought. It is, however, more fuſible, which is a great inconvenience. We alſo ſee that a very ſmall addition of zinc almoſt doubles the tenacity of tin, and increaſes the tenacity of lead five times; and a ſmall addition of lead doubles the tenacity of tin. Theſe are economical mixtures. This is a very valuable information to the plumbers for augmenting the ſtrength of water-pipes.

By having recourſe to theſe tables, the engineer can proportion the thickneſs of his pipes (of whatever metal) to the preſſures to which they are expoſed.

2*d*, Woods.

We may premiſe to this part of the table the following general obſervations.

42 Tenacity or ſtrength of wood.

1. The wood immediately ſurrounding the pith or heart of the tree is the weakeſt, and its inferiority is ſo much more remarkable as the tree is older. In this aſſertion, however we ſpeak with ſome heſitation. Muſchenbroek's *detail* of experiments is decidedly in the affirmative. Mr Buffon, on the other hand, ſays, that his experience has taught him that the heart of a ſound tree is the ſtrongeſt; but he gives no inſtances. We are certain, from many obſervations of our own, on very *large* oaks and firs, that the heart is much weaker than the exterior parts.

2. The wood next the bark, commonly called the *white* or *blea*, is alſo weaker than the reſt; and the wood gradually increaſes in ſtrength as we recede from the centre to the blea.

3. The wood is ſtronger in the middle of the trunk than at the ſpringing of the branches or at the root; and the wood of the branches is weaker than that of the trunk.

4. The wood of the north ſide of all trees which grow in our European climates is the weakeſt, and that of the ſouth-eaſt ſide is the ſtrongeſt; and the difference is moſt remarkable in hedge-row trees, and ſuch as grow ſingly. The heart of a tree is never in its centre, but always nearer to the north ſide, and the annual coats of wood are thinner on that ſide. In conformity with this, it is a general opinion of carpenters that timber is ſtronger whoſe annual plates are thicker. The trachea or air-veſſels are weaker than the ſimple ligneous fibres. Theſe air-veſſels are the ſame in diameter and number of rows in trees of the ſame ſpecies, and they make the viſible ſeparation between the annual plates. Therefore when theſe are thicker, they contain a greater proportion of the ſimple ligneous fibres.

5. All woods are more tenacious while green, and loſe very conſiderably by drying after the trees are felled.

The only author who has put it in our power to judge of the propriety of his experiments is Muſchenbroek. He has deſcribed his method of trial minutely; and it ſeems unexceptionable. The woods were all formed into ſlips fit for his apparatus, and part of the ſlip was cut away to a parallelopiped of $\frac{1}{5}$th of an inch ſquare, and therefore $\frac{1}{25}$th of a ſquare inch in ſection. The abſolute ſtrengths of a ſquare inch were as follows:

43 Abſolute ſtrength of different kinds of wood,

	lib.		lib.
Locuſt tree,	20,100	Pomegranate,	9,750
Jujeb,	18,500	Lemon,	9,250
Beech, oak,	17,300	Tamarind,	8,750
Orange,	15,500	Fir, -	8,330
Alder,	13,900	Walnut,	8,130
Elm, -	13,200	Pitch pine,	7,650
Mulberry,	12,500	Quince,	6,750
Willow,	12,500	Cypreſs,	6,000
Aſh, -	12,000	Poplar,	5,500
Plum, -	11,800	Cedar,	4,880
Elder,	10,000		

Mr Muſchenbroek has given a very minute detail of the experiments on the aſh and the walnut, ſtating the weights which were required to tear aſunder ſlips taken from the four ſides of the tree, and on each ſide, in a regular progreſſion from the centre to the circumference. The numbers of this table correſponding to theſe two timbers may therefore be conſidered as the average of more than 50 trials made of each; and he ſays that all the others were made with the ſame care. We cannot therefore ſee any reaſon for not confiding in the reſults; yet they are conſiderably higher than thoſe given by ſome other writers. Mr Pitot ſays, on the authority of his own experiments, and of thoſe of Mr Parent, that 60 pounds will juſt tear aſunder a ſquare line of ſound oak, and that it will bear 50 with ſafety. This gives 8640 for the utmoſt ſtrength of a ſquare inch, which is much inferior to Muſchenbroek's valuation.

We may add to theſe,

44
and of other ſubſtances.

Ivory, - - -	16,270
Bone, - - -	5,250
Horn, - - -	8,750
Whalebone, - - -	7,500
Tooth of ſea-calf, - -	4,075

45
No ſubſtance to be ſtrained in architecture above one half its ſtrength.

The reader will ſurely obſerve, that theſe numbers expreſs ſomething more than the utmoſt coheſion; for the weights are ſuch as will very quickly, that is, in a minute or two, tear the rods aſunder. It may be ſaid in general, that two thirds of theſe weights will ſenſibly impair the ſtrength after a conſiderable while, and that one-half is the utmoſt that can remain ſuſpended at them without riſk for ever; and it is this laſt allotment that the engineer ſhould reckon upon in his conſtructions. There is, however, conſiderable difference in this reſpect. Woods of a very ſtraight fibre, ſuch as fir, will be leſs impaired by any load which is not ſufficient to break them immediately.

According to Mr Emerſon, the load which may be ſafely ſuſpended to an inch ſquare is as follows:

Iron, - - - -	76,400
Braſs, - - -	35,600
Hempen rope, - -	19,600
Ivory, - - -	15,700
Oak, box, yew, plum-tree, - -	7,850
Elm, aſh, beech, - -	6,070
Walnut, plum, - - -	5,360
Red fir, holly, elder, plane, crab, -	5,000
Cherry, hazel, - - -	4,760
Alder, aſp, birch, willow, - -	4,290
Lead, - - - -	430
Freeſtone, - - - -	914

He gives us a practical rule, that a cylinder whoſe diameter is *d* inches, loaded to one-fourth of its abſolute ſtrength, will carry as follows:

Iron, - -	135	Cwt.
Good rope, -	22	
Oak, - -	14	
Fir, - -	9	

The rank which the different woods hold in this liſt of Mr Emerſon's is very different from what we find in Muſchenbroek's. But preciſe meaſures muſt not be expected in this matter. It is wonderful that in a matter of ſuch unqueſtionable importance the public has not enabled ſome perſons of judgment to make proper trials. They are beyond the abilities of private perſons.

II. BODIES MAY BE CRUSHED.

46
It is of importance to know what will cruſh bodies.

It is of equal, perhaps greater, importance to know the ſtrain which may be laid on ſolid bodies without danger of cruſhing them. Pillars and poſts of all kinds are expoſed to this ſtrain in its ſimpleſt form; and there are caſes where the ſtrain is enormous, viz. where it ariſes from the oblique poſition of the parts; as in the ſtuts, braces, and truſſes, which occur very frequently in our great works.

It is therefore moſt deſirable to have ſome general knowledge of the principle which determines the ſtrength of bodies in oppoſition to this kind of ſtrain. But unfortunately we are much more at a loſs in this than in the laſt caſe. The mechaniſm of nature is much more complicated in the preſent caſe. It muſt be in ſome circuitous way that compreſſion can have any tendency to tear aſunder the parts of a ſolid body, and it is very difficult to trace the ſteps.

If we ſuppoſe the particles inſuperably hard and in contact, and diſpoſed in lines which are in the direction of the external preſſures, it does not appear how any preſſure can diſunite the particles; but this is a gratuitous ſuppoſition. There are infinite odds againſt this preciſe arrangement of the lines of particles; and the compreſſibility of all kinds of matter in ſome degree ſhows that the particles are in a ſituation equivalent to diſtance. This being the caſe, and the particles, with their intervals, or what is equivalent to intervals, being in ſituations that are oblique with reſpect to the preſſures, it muſt follow, that by ſqueezing them together in one direction, they are made to bulge out or ſeparate in other directions. This may proceed ſo far that ſome may be thus puſhed laterally beyond their limits of coheſion. The moment that this happens the reſiſtance to compreſſion is diminiſhed, and the body will now be cruſhed together. We may form ſome notion of this by ſuppoſing a number of ſpherules, like ſmall ſhot, ſticking together by means of a cement. Compreſſing this in ſome particular direction cauſes the ſpherules to act among each other like ſo many wedges, each tending to penetrate through between the three which lie below it: and this is the ſimpleſt, and perhaps the only diſtinct, notion we can have of the matter. We have reaſon to think that the conſtitution of very homogeneous bodies, ſuch as glaſs, is not very different from this. The particles are certainly arranged ſymmetrically in the angles of ſome regular ſolids. It is only ſuch an arrangement that is conſiſtent with tranſparency, and with the free paſſage of light in *every* direction.

47
Their ſtrength or power of reſiſtance to ſuch a force.

If this be the conſtitution of bodies, it appears probable that the ſtrength, or the reſiſtance which they are capable of making to an attempt to cruſh them to pieces, is proportional to the area of the ſection whoſe plane is perpendicular to the external force; for each particle being ſimilarly and equally acted on and reſiſted, the whole reſiſtance muſt be as their number; that is, as the extent of the ſection.

Accordingly this principle is aſſumed by the few writers who have conſidered this ſubject; but we confeſs that it appears to us very doubtful. Suppoſe a number of brittle or friable balls lying on a table uniformly arranged, but not cohering nor in contact, and that a board is laid over them and loaded with a weight; we have no heſitation in ſaying, that the weight neceſſary to cruſh the whole collection is proportional to their number or to the area of the ſection. But when they are in contact (and ſtill more if they cohere), we imagine that the caſe is materially altered. Any individual ball is cruſhed only in conſequence of its being bulged outwards in the direction perpendicular to the preſſure employed. If this could be prevented by a hoop put round the ball like an equator, we cannot ſee how any force can cruſh it. Any thing therefore which makes this bulging outwards more difficult, makes a greater force neceſſary. Now this effect will be produced by the mere contact of the balls before the preſſure is applied; for the central ball cannot ſwell outward laterally without puſhing away the balls on all ſides of it. This is prevented by the friction on the table and upper board,

board, which is at leaſt equal to one third of the preſſure. Thus any interior ball becomes ſtronger by the mere vicinity of the others; and if we farther ſuppoſe them to cohere laterally, we think that its ſtrength will be ſtill more increaſed.

The analogy between theſe balls and the cohering particles of a friable body is very perfect. We ſhould therefore expect that the ſtrength by which it reſiſts being cruſhed will increaſe in a greater ratio than that of the ſection, or the ſquare of the diameter of ſimilar ſections; and that a ſquare inch of any matter will bear a greater weight in proportion as it makes a part of a greater ſection. Accordingly this appears in many experiments, as will be noticed afterwards. Muſchenbroek, Euler, and ſome others, have ſuppoſed the ſtrength of columns to be as the biquadrates of their diameters. But Euler deduced this from formulæ which occurred to him in the courſe of his algebraic analyſis; and he boldly adopts it as a principle, without looking for its foundation in the phyſical aſſumptions which he had made in the beginning of his inveſtigation. But ſome of his original aſſumptions were as paradoxical, or at leaſt as gratuitous, as theſe reſults: and thoſe, in particular, from which this proportion of the ſtrength of columns was deduced, were almoſt foreign to the caſe; and therefore the inference was of no value. Yet it was received as a principle by Muſchenbroek and by the academicians of St Peterſburgh. We make theſe very few obſervations, becauſe the ſubject is of great practical importance; and it is a great obſtacle to improvements when deference to a great name, joined to incapacity or indolence, cauſes authors to adopt his careleſs reveries as principles from which they are afterwards to draw important conſequences. It muſt be acknowledged that we have not as yet eſtabliſhed the relation between the dimenſions and the ſtrength of a pillar on ſolid mechanical principles. Experience plainly contradicts the general opinion, that the ſtrength is proportional to the area of the ſection; but it is ſtill more inconſiſtent with the opinion, that it is in the quadruplicate ratio of the diameters of ſimilar ſections. It would ſeem that the ratio depends much on the internal ſtructure of the body; and experiment ſeems the only method for aſcertaining its general laws.

48
To be aſcertained only by experiment

If we ſuppoſe the body to be of a fibrous texture, having the fibres ſituated in the direction of the preſſure, and ſlightly adhering to each other by ſome kind of cement, ſuch a body will fail only by the bending of the fibres, by which they will break the cement and be detached from each other. Something like this may be ſuppoſed in wooden pillars. In ſuch caſes, too, it would appear that the reſiſtance muſt be as the number of equally reſiſting fibres, and as their mutual ſupport, jointly; and, therefore, as ſome function of the area of the ſection. The ſame thing muſt happen if the fibres are naturally crooked or undulated, as is obſerved in many woods, &c. provided we ſuppoſe ſome ſimilarity in their form. Similarity of ſome kind muſt always be ſuppoſed, otherwiſe we need never aim at any general inferences.

In all caſes therefore we can hardly refuſe admitting that the ſtrength in oppoſition to compreſſion is proportional to a function of the area of the ſection.

As the whole length of a cylinder or priſm is equally preſſed, it does not appear that the ſtrength of a pillar is at all affected by its length. If indeed it be ſuppoſed to bend under the preſſure, the caſe is greatly changed, becauſe it is then expoſed to a tranſverſe ſtrain; and this increaſes with the length of the pillar. But this will be conſidered with due attention under the next claſs of ſtrains.

Few experiments have been made on this ſpecies of ſtrength and ſtrain. Mr Petit ſays, that his experiments and thoſe of Mr Parent, ſhow that the force neceſſary for cruſhing a body is nearly equal to that which will tear it aſunder. He ſays that it requires ſomething more than 60 pounds on every ſquare line to cruſh a piece of ſound oak. But the rule is by no means general: Glaſs, for inſtance, will carry a hundred times as much as oak in this way, that is, reſting on it; but will not *ſuſpend* above four or five times as much. Oak will ſuſpend a great deal more than fir; but fir will carry twice as much as a pillar. Woods of a ſoft texture, although conſiſting of very tenacious fibres, are more eaſily cruſhed by their load. This ſoftneſs of texture is chiefly owing to their fibres not being ſtraight but undulated, and there being conſiderable vacuities between them, ſo that they are eaſily bent laterally and cruſhed. When a poſt is overſtrained by its load, it is obſerved to ſwell ſenſibly in diameter. Increaſing the load cauſes longitudinal cracks or ſhivers to appear, and it preſently after gives way. This is called *crippling*.

In all caſes where the fibres lie oblique to the ſtrain the ſtrength is greatly diminiſhed, becauſe the parts can then be made to ſlide on each other, when the coheſion of the cementing matter is overcome.

Muſchenbroek has given ſome experiments on this ſubject; but they are caſes of long pillars, and therefore do not belong to this place. They will be conſidered afterwards.

The only experiments of which we have ſeen any detail (and it is uſeleſs to inſert mere aſſertions) are thoſe of Mr Gauthey, in the 4th volume of Rozier's *Journal de Phyſique*. This engineer expoſed to great preſſures ſmall rectangular parallelopipeds, cut from a great variety of ſtones, and noted the weights which cruſhed them. The following table exhibits the medium reſults of many trials on two very uniform kinds of freeſtone, one of them among the hardeſt and the other among the ſofteſt uſed in building.

49
Experiments for this purpoſe made on freeſtone.

Column 1ſt expreſſes the length AB of the ſection in French lines or 12ths of an inch; column 2d expreſſes the breadth BC; column 3d is the area of the ſection in ſquare lines; column 4th is the number of ounces required to cruſh the piece; column 5th is the weight which was then borne by each ſquare line of the ſection; and column 6th is the round numbers to which Mr Gauthey imagines that thoſe in column 5th approximate.

Hard Stone.

	AB	BC	AB × BC	Weight	Force	
1	8	8	64	736	11.5	12
2	8	12	96	2625	27.3	24
3	8	16	128	4496	35.1	36

Soft Stone.

4	9	16	144	560	3.9	4.
5	9	18	162	848	5.3	4.5
6	18	18	324	2928	9	9
7	18	24	432	5296	12.2	12

Little

Little can be deduced from theſe experiments: The 1ſt and 3d, compared with the 5th and 6th, ſhould furniſh ſimilar reſults; for the 1ſt and 5th are reſpectively half of the 3d and 6th: but the 3d is three times ſtronger (that is, a line of the 3d) than the firſt, whereas the 6th is only twice as ſtrong as the 5th.

It is evident, however, that the ſtrength increaſes much faſter than the area of the ſection, and that a ſquare line can carry more and more weight, according as it makes a part of a larger and larger ſection. In the ſeries of experiments on the ſoft ſtone, the individual ſtrength of a ſquare line ſeems to increaſe nearly in the proportion of the ſection of which it makes a part.

Mr Gauthey deduces, from the whole of his numerous experiments, that a pillar of hard ſtone of Givry, whoſe ſection is a ſquare foot, will bear with perfect ſafety 664,000 pounds, and that its extreme ſtrength is 871,000, and the ſmalleſt ſtrength obſerved in any of his experiments was 460,000. The ſoft bed of Givry ſtone had for its ſmalleſt ſtrength 187,000, for its greateſt 311,000, and for its ſafe load 249,000. Good brick will carry with ſafety 320,000; chalk will carry only 9000. The boldeſt piece of architecture in this reſpect which he has ſeen is a pillar in the church of All-Saints at Angers. It is 24 feet long and 11 inches ſquare, and is loaded with 60,000, which is not one-ſeventh of what is neceſſary for cruſhing it.

50
not ſatisfactory.

We may obſerve here by the way, that Mr Gauthey's meaſure of the ſuſpending ſtrength of ſtone is vaſtly ſmall in proportion to its power of ſupporting a load laid above it. He finds that a priſm of the hard bed of Givry, of a foot ſection, is torn aſunder by 4600 pounds; and if it be firmly fixed horizontally in a wall, it will be broken by a weight of 56,000 ſuſpended a foot from the wall. If it reſt on two props at a foot diſtance, it will be broken by 206,000 laid on its middle. Theſe experiments agree ſo ill with each other, that little uſe can be made of them. The ſubject is of great importance, and well deſerves the attention of the patriotic philoſopher.

51
Good experiments much wanted.

A ſet of good experiments would be very valuable, becauſe it is againſt this kind of ſtrain that we muſt guard by judicious conſtruction in the moſt delicate and difficult problems which come through the hands of the civil and military engineer. The conſtruction of ſtone arches, and the conſtruction of great wooden bridges, and particularly the conſtruction of the frames of carpentry called *centres* in the erection of ſtone bridges, are the moſt difficult jobs that occur. In the centres on which the arches of the bridge of Orleans were built ſome of the pieces of oak were carrying upwards of two tons on every ſquare inch of their ſcantling. All who ſaw it ſaid that it was not able to carry the fourth part of the intended load. But the engineer underſtood the principles of his art, and ran the riſk: and the reſult completely juſtified his confidence; for the centre did not complain in any part, only it was found too ſupple; ſo that it went out of ſhape while the haunches only of the arch were laid on it. The engineer corrected this by loading it at the crown, and thus kept it completely in ſhape during the progreſs of the work.

In the Memoirs (old) of the Academy of Peterſburgh for 1778, there is a diſſertation by Euler on this ſubject, but particularly limited to the ſtrain on columns, in which the bending is taken into the account. Mr Fuſs has treated the ſame ſubject with relation to carpentry in a ſubſequent volume. But there is little in theſe papers beſides a dry mathematical diſquiſition, proceeding on aſſumptions which (to ſpeak favourably) are extremely gratuitous. The moſt important conſequence of the compreſſion is wholly overlooked, as we ſhall preſently ſee. Our knowledge of the mechaniſm of coheſion is as yet far too imperfect to entitle us to a confident application of mathematics. Experiments ſhould be multiplied.

52
How they are to be made uſeful.

The only way we can hope to make theſe experiments uſeful is to pay a careful attention to the *manner* in which the fracture is produced. By diſcovering the general reſemblances in this particular, we advance a ſtep in our power of introducing mathematical meaſurement. Thus, when a cubical piece of chalk is ſlowly cruſhed between the chaps of a vice, we ſee it uniformly ſplit in a ſurface oblique to the preſſure, and the two parts then ſlide along the ſurface of fracture. This ſhould lead us to examine mathematically what relation there is between this ſurface of fracture and the neceſſary force; then we ſhould endeavour to determine experimentally the poſition of this ſurface. Having diſcovered ſome general law or reſemblance in this circumſtance, we ſhould try what mathematical hypotheſis will agree with this. Having found one, we may then apply our ſimpleſt notions of coheſion, and compare the reſult of our computations with experiment. We are authoriſed to ſay, that a ſeries of experiments has been made in this way, and that their reſults have been very uniform, and therefore ſatisfactory, and that they will ſoon be laid before the public as the foundations of ſucceſsful practice in the conſtruction of arches.

III. A BODY MAY BE BROKEN ACROSS.

53
It is of importance to know what ſtrain will break a body tranſverſely.

The moſt uſual, and the greateſt ſtrain, to which materials are expoſed, is that which tends to break them tranſverſely. It is ſeldom, however, that this is done in a manner perfectly ſimple; for when a beam projects horizontally from a wall, and a weight is ſuſpended from its extremity, the beam is commonly broken near the wall, and the intermediate part has performed the functions of a lever. It ſometimes, though rarely, happens that the pin in the joint of a pair of pincers or ſciſſars is cut through by the ſtrain; and this is almoſt the only caſe of a ſimple tranſverſe fracture. Being ſo rare, we may content ourſelves with ſaying, that in this caſe the ſtrength of the piece is proportional to the area of the ſection.

54
Experiments made to aſcertain it.

Experiments were made for diſcovering the reſiſtances made by bodies to this kind of ſtrain in the following manner: Two iron bars were diſpoſed horizontally at an inch diſtance; a third hung perpendicularly between them, being ſupported by a pin made of the ſubſtance to be examined. This pin was made of a priſmatic form, ſo as to fit exactly the holes in the three bars, which were made very exact, and of the ſame ſize and ſhape. A ſcale was ſuſpended at the lower end of the perpendicular bar, and loaded till it tore out that part of the pin which filled the middle hole. This weight was evidently the meaſure of the lateral coheſion of two ſections. The ſide-bars were made to graſp the middle bar pretty ſtrongly between them, that there might be no diſtance impoſed between the oppoſite preſſures. This would have combined the energy of a lever with the purely tranſverſe preſſure. For the ſame reaſon it was neceſſary

ſary that the internal parts of the holes ſhould be no ſmaller than the edges. Great irregularities occurred in our firſt experiments from this cauſe, becauſe the pins were ſomewhat tighter within than at the edges; but when this was corrected they were extremely regular. We employed three ſets of holes, viz. a circle, a ſquare (which was occaſionally made a rectangle whoſe length was twice its breadth), and an equilateral triangle. We found in all our experiments the ſtrength exactly proportional to the area of the ſection, and quite independent of its figure or poſition, and we found it conſiderably above the direct coheſion; that is, it took conſiderably more than twice the force to tear out this middle piece than to tear the pin aſunder by a direct pull. A piece of fine freeſtone required 205 pounds to pull it directly aſunder, and 575 to break it in this way. The difference was very conſtant in any one ſubſtance, but varied from four-thirds to ſix-thirds in different kinds of matter, being ſmalleſt in bodies of a fibrous texture. But indeed we could not make the trial on any bodies of conſiderable coheſion, becauſe they required ſuch forces as our apparatus could not ſupport. Chalk, clay baked in the ſun, baked ſugar, brick, and freeſtone, were the ſtrongeſt that we could examine.

55 Their reſult.

But the more common caſe, where the energy of a lever intervenes, demands a minute examination.

56 The ſtrength of a lever. Fig. 5.

Let DABC (fig. 5.) be a vertical ſection of a priſmatic ſolid (that is, of equal ſize throughout), projecting horizontally from a wall in which it is firmly fixed: and let a weight P be hung on it at B, or let any power P act at B in a direction perpendicular to AB. Suppoſe the body of inſuperable ſtrength in every part except in the vertical ſection DA, perpendicular to its length. It muſt break in this ſection only. Let the coheſion be uniform over the whole of this ſection; that is, let each of the adjoining particles of the two parts cohere with an equal force f.

There are two ways in which it may break. The part ABCD may ſimply ſlide down along the ſurface of fracture, provided that the power acting at B is equal to the accumulated force which is exerted by every particle of the ſection in the direction AD.

But ſuppoſe this effectually prevented by ſomething that ſupports the point A. The action at P tends to make the body turn round A (or round a horizontal line paſſing through A at right angles to AB) as round a joint. This it cannot do without ſeparating at the line DA. In this caſe the adjoining particles at D or at E will be ſeparated horizontally. But their coheſion reſiſts this ſeparation. In order, therefore, that the fracture may happen, the energy or momentum of the power P, acting by means of the lever AB, muſt be ſuperior to the accumulated energies of the particles. The energy of each depends not only on its coheſive force, but alſo on its ſituation; for the ſuppoſed inſuperable firmneſs of the reſt of the body makes it a lever turning round the fulcrum A, and the coheſion of each particle, ſuch as D or E, acts by means of the arm DA or EA. The energy of each particle will therefore be had by multiplying the force exerted by it in the inſtant of fracture by the arm of the lever by which it acts.

Let us therefore firſt ſuppoſe, that in the inſtant of fracture every particle is exerting an equal force f. The energy of D will be $f \times \mathrm{DA}$, and that of E will be $f \times \mathrm{EA}$, and that of the whole will be the ſum of all theſe products. Let the depth DA of the ſection be called d, and let any undetermined part of it EA be called x, and then the ſpace occupied by any particle will be $\dot{x}$. The coheſion of this ſpace may be repreſented by $f\dot{x}$, and that of the whole by $f\,d$. The energy by which each element $\dot{x}$ of the line DA, or d, reſiſts the fracture, will be $f x \dot{x}$, and the whole accumulated energies will be $f \times \int x \dot{x}$. This we know to be $f \times \frac{1}{2} d^2$, or $f d \times \frac{1}{2} d$. It is the ſame therefore as if the coheſion $f d$ of the whole ſection had been acting at the point G, which is the middle of DA.

The reader who is not familiarly acquainted with this fluxionary calculus may arrive at the ſame concluſion in another way. Suppoſe the beam, inſtead of projecting horizontally from a wall, to be hanging from the ceiling, in which it is firmly fixed. Let us conſider how the equal coheſion of every part operates in hindering the lower part from ſeparating from the upper by opening round the joint A. The equal coheſion operates juſt as equal gravity would do, but in the oppoſite direction. Now we know, by the moſt elementary mechanics, that the effect of this will be the ſame as if the whole weight were concentrated in the centre of gravity G of the line DA, and that this point G is in the middle of DA. Now the number of fibres being as the length d of the line, and the coheſion of each fibre being $=f$, the coheſion of the whole line is $f \times d$ or $f d$.

The accumulated energy therefore of the coheſion in the inſtant of fracture is $f d \times \frac{1}{2} d$. Now this muſt be equal or juſt inferior to the energy of the power employed to break it. Let the length AB be called l; then $\mathrm{P} \times l$ is the correſponding energy of the power. This gives us $f d \frac{1}{2} d = p\,l$ for the equation of equilibrium correſponding to the vertical ſection ADCB.

Suppoſe now that the fracture is not permitted at DA, but at another ſection $\delta\alpha$ more remote from B. The body being priſmatic, all the vertical ſections are equal; and therefore $f d \frac{1}{2} d$ is the ſame as before. But the energy of the power is by this means increaſed, being now $= \mathrm{P} \times \mathrm{B}\alpha$, inſtead of $\mathrm{P} \times \mathrm{BA}$: Hence we ſee that when the priſmatic body is not inſuperably ſtrong in all its parts, but equally ſtrong throughout, it muſt break cloſe at the wall, where the ſtrain or energy of the power is greateſt. We ſee, too, that a power which is juſt able to break it at the wall is unable to break it anywhere elſe; alſo an abſolute coheſion $f d$, which can withſtand the power p in the ſection DA, will not withſtand it in the ſection $\delta\alpha$, and will withſtand more in the ſection $d' a'$.

This teaches us to diſtinguiſh between abſolute and relative ſtrength. The relative ſtrength of a ſection has a reference to the ſtrain actually exerted on that ſection. This relative ſtrength is properly meaſured by the power which is juſt able to balance or overcome it, when applied at its proper place. Now ſince we had $f d \frac{1}{2} d = p\,l$, we have $p = \frac{f d \frac{1}{2} d}{l}$ for the meaſure of the ſtrength of the ſection DA, in relation to the power applied at B.

If the ſolid is a rectangular beam, whoſe breadth is b, it is plain that all the vertical ſections are equal, and that AG or $\frac{1}{2} d$ is the ſame in all. Therefore the equation

tion expreſſing the equilibrium between the momentum of the external force and the accumulated momenta of coheſion will be $p\,l = f\,d\,b \times \frac{1}{2}\,d$.

The product $d\,b$ evidently expreſſes the area of the ſection of fracture, which we may call s, and we may expreſs the equilibrium thus, $p\,l = f\,s\,\frac{1}{2}\,d$, and $2\,l : d = f\,s : p$.

Now $f\,s$ is a proper expreſſion of the abſolute coheſion of the ſection of fracture, and p is a proper meaſure of its ſtrength in relation to a power applied at B. We may therefore ſay, that *twice the length of a rectangular beam is to the depth as the abſolute coheſion to the relative ſtrength.*

Since the action of equable coheſion is ſimilar to the action of equal gravity, it follows, that whatever is the figure of the ſection, the relative ſtrength will be the ſame as if the abſolute coheſion of all the fibres were acting at the centre of gravity of the ſection. Let g be the diſtance between the centre of gravity of the ſection and the axis of fracture, we ſhall have $p\,l = f\,s\,g$, and $l : g = f\,s : p$. It will be very uſeful to recollect this analogy in words: "*The length of a priſmatic beam of any ſhape is to the height of the centre of gravity above the lower ſide, as the abſolute coheſion to the ſtrength relative to this length.*"

Becauſe the relative ſtrength of a rectangular beam is $\frac{f\,b\,d\,\frac{1}{2}\,d}{l}$ or $\frac{f\,b\,d^2}{2\,l}$, it follows, that the relative ſtrengths of different beams are proportional to the abſolute coheſion of the particles, to the breadth, and to the ſquare of the depth directly, and to the length inverſely; alſo in priſms whoſe ſections are ſimilar, the ſtrengths are as the cubes of the diameters.

57 Aſcertained on the hypotheſis of equal coheſion;

Such are the more general reſults of the mechaniſm of this tranſverſe ſtrain, in the hypotheſis that all the particles are exerting equal forces in the inſtant of fracture. We are indebted for this doctrine to the celebrated Galileo; and it was one of the firſt ſpecimens of the application of mathematics to the ſcience of nature.

We have not included in the preceding inveſtigation that action of the external force by which the ſolid is drawn ſidewiſe, or tends to ſlide along the ſurface of fracture. We have ſuppoſed a particle E to be pulled only in the direction E e, perpendicular to the ſection of fracture, by the action of the crooked lever BAE. But it is alſo pulled in the direction EA; and its reaction is in ſome direction ε E, compounded of εf, by which it reſiſts being pulled outwards; and $\varepsilon\,e$ by which it reſiſts being pulled downwards. We are but imperfectly acquainted with the force $\varepsilon\,e$, and only know that their accumulated ſum is equal to the force p; but in all important caſes which occur in practice, it is unneceſſary to attend to this force; becauſe it is ſo ſmall in compariſon of the forces in the direction E e, as we eaſily conclude from the uſual ſmallneſs of AD in compariſon of AB.

58 but that hypotheſis not conformable to nature.

The hypotheſis of equal coheſion, exerted by all the particles in the inſtant of fracture, is not conformable to nature: for we know, that when a force is applied tranſverſely at B, the beam is bent downwards, becoming convex on the upper ſide; that ſide is therefore on the ſtretch. The particles at D are farther removed from each other than thoſe at E, and are therefore *actually exerting* greater coheſive forces. We cannot ſay with certainty and preciſion in what proportion each fibre is extended. It ſeems moſt probable that the extenſions are proportional to the diſtances from A. We ſhall ſuppoſe this to be really the caſe. Now recollect the general law which we formerly ſaid was *obſerved* in all moderate extenſions, viz. that the attractive forces exerted by the dilated particles were proportional to their dilatations. Suppoſe now that the beam is ſo much bent that the particles at D are exerting their utmoſt force, and that this fibre is juſt ready to break or actually breaks. It is plain that a total fracture muſt immediately enſue; becauſe the force which was ſuperior to the full coheſion of the particle at D, and a certain portion of the coheſion of all the reſt, will be more than ſuperior to the full coheſion of the particle next within D, and a ſmaller portion of the coheſion of the remainder.

Now let F repreſent, as before, the full force of the exterior fibre D, which is exerted by it in the inſtant of its breaking, and then the force exerted at the ſame inſtant by the fibre E will be had by this analogy, AD : AE, or $d : x = f : \frac{f\,x}{d}$, and the force really exerted by the fibre E is $f \times \frac{x}{d}$.

The force exerted by a fibre whoſe thickneſs is $\dot{x}$ is therefore $\frac{f\,x\,\dot{x}}{d}$; but this force reſiſts the ſtrain by acting by means of the lever EA or x. Its energy or momentum is therefore $\frac{f\,x^2\,\dot{x}}{d}$, and the accumulated momenta of all the fibres in the line AE will be $f \times$ ſum of $\frac{x^2\,\dot{x}}{d}$. This, when x is taken equal to d, will expreſs the momentum of the whole fibres in the line AD. This, therefore, is $f\,\frac{\frac{1}{3}\,d^3}{d}$, or $f\,\frac{1}{3}\,d^2$, or $f\,d \times \frac{1}{3}\,d$. Now $f\,d$ expreſſes the abſolute coheſion of the whole line AD. The accumulated momentum is therefore the ſame as if the abſolute coheſion of the whole line were exerted at one-third of AD from A.

59 The ſtrength aſcertained on other principles.

From theſe premiſes it follows that the equation expreſſing the equilibrium of the ſtrain and coheſion is $p\,l = f\,d \times \frac{1}{3}\,d$; and hence we deduce the analogy, "*As thrice the length is to the depth, ſo is the abſolute coheſion to the relative ſtrength.*"

This equation and this proportion will equally apply to rectangular beams whoſe breadth is b; for we ſhall then have $p\,l = f\,b\,d \times \frac{1}{3}\,d$.

We alſo ſee that the relative ſtrength is proportional to the abſolute coheſion of the particles, to the breadth, and to the ſquare of the depth directly, and to the length inverſely: for p is the meaſure of the force with which it is reſiſted, and $p = \frac{f\,b\,d\,\frac{1}{3}\,d}{l}, = \frac{f\,b\,d^2}{3\,l}$. In this reſpect therefore this hypotheſis agrees with the Galilean; but it aſſigns to every beam a ſmaller proportion of the abſolute coheſion of the ſection of fracture, in the proportion of three to two. In the Galilean hypotheſis this ſection has a momentum equal to one-half of its abſolute ſtrength, but in the other hypotheſis it is only one-third. In beams of a different form the proportion may be different.

As this is a moſt important propoſition, and the foundation

dation of many practical maxims, we are anxious to have it clearly comprehended, and its evidence perceived by all. Our better informed readers will therefore indulge us while we endeavour to preſent it in another point of view, where it will be better ſeen by thoſe who are not familiarly acquainted with the fluxionary calculus.

60
The ſame propoſition preſented in another point of view.
Fig. 6.

Fig. 6. A is a perſpective view of a three-ſided beam projecting horizontally from a wall, and loaded with a weight at B juſt ſufficient to break it. DABC is a vertical plane through its higheſt point D, in the direction of its length. $a D a$ is another vertical ſection perpendicular to AB. The piece being ſuppoſed of inſuperable ſtrength everywhere except in the ſection $a D a$, and the coheſion being alſo ſuppoſed inſuperable along the line $a A a$, it can break nowhere but in this ſection, and by turning round $a A a$ as round a hinge. Make $D d$ equal to AD, and let $D d$ repreſent the abſolute coheſion of the fibre at D, which abſolute coheſion we expreſſed by the ſymbol f. Let a plane $a d a$ be made to paſs through $a a$ and d, and let $d a' a'$ be another croſs ſection. It is plain that the priſmatic ſolid contained between the two ſections $a D a$ and $a' d a'$ will repreſent the full coheſion of the whole ſection of fracture; for we may conceive this priſm as made up of lines ſuch as $F f$, equal and parallel to $D d$, repreſenting the abſolute coheſion of each particle ſuch as F. The pyramidal ſolid $d D a a$, cut off by the plane $d a a$, will repreſent the coheſions *actually exerted* by the different fibres in the inſtant of fracture. For take any point E in the ſurface of fracture, and draw $E e$ parallel to AB, meeting the plane $a d a$ in e, and let e AE be a vertical plane. It is evident that $D d$ is to $E e$ as AD to AE; and therefore (ſince the forces exerted by the different fibres are as their extenſion, and their extenſion as their diſtances from the axis of fracture) $E e$ will repreſent the force actually exerted by the fibre in E, while D is exerting its full force $D d$. In like manner, the plane $FF f f$ expreſſes the coheſion exerted by all the fibres in the line FF, and ſo on the through the whole ſurface. Therefore the pyramid $d a a D$ expreſſes the accumulated exertion of the whole ſurface of fracture.

Farther, ſuppoſe the beam to be held perpendicular to the horizon with the end B uppermoſt, and that the weight of the priſm contained between the two ſections $a D a$ and $a' d a'$ (now horizontal) is juſt able to overcome the full coheſion of the ſection of fracture. The weight of the pyramid $d D a a$ will alſo be juſt able to overcome the coheſions *actually exerted* by the different fibres in the inſtant of fracture, becauſe the weight of each fibre, ſuch as $E e$, is juſt ſuperior to the coheſion actually exerted at E.

Let o be the centre of gravity of the pyramidal ſolid, and draw o O perpendicular to the plane $a D a$. The whole weight of the ſolid $d D a a$ may be conceived as accumulated in the point o, and as acting on the point O, and it will have the ſame tendency to ſeparate the two cohering ſurfaces as when each fibre is hanging by its reſpective point. For this reaſon the point O may be called the *centre of actual effort* of the unequal forces of coheſion. The momentum therefore, or energy by which the cohering ſurfaces are ſeparated, will be properly meaſured by the weight of the ſolid $d D a a$ multiplied by OA; and this product is equal to the product of the weight p multiplied by BA, or by l. Thus ſuppoſe that the coheſion along the line AD only is conſidered. The whole coheſion will be repreſented by a triangle $AD d$. $D d$ repreſents f, and AD is d, and AD is x. Therefore $AD d$ is $\frac{1}{2} f d$. The centre of gravity o of the triangle $AD d$ is in the interſection of a line drawn from A to the middle of $D d$ with a line drawn from d to the middle of AD; and therefore the line o O will make $AO = \frac{2}{3}$ of AD. Therefore the actual momentum of coheſion is $f \times \frac{1}{2} d \times \frac{2}{3} d, = f \times d \times \frac{1}{3} d, = f d \times \frac{1}{3} d$, or equal to the abſolute coheſion acting by means of the lever $\frac{d}{3}$. If the ſection of fracture is a rectangle, as in a common joiſt, whoſe breadth $a a$ is $= b$, it is plain that all the vertical lines will be repreſented by triangles like $AD d$; and the whole actual coheſion will be repreſented by a wedge whoſe baſes are vertical planes, and which is equal to half of the parallelopiped $AD \times D d \times a a$, and will therefore be $= \frac{1}{2} f b d$; and the diſtance AO of its centre of gravity from the horizontal line AA′ will be $\frac{2}{3}$ of AD. The momentum of coheſion of a joiſt will therefore be $\frac{1}{2} f b d \times \frac{2}{3} d$, or $f b d \frac{1}{3} d$, as we have determined in the other way.

The beam repreſented in the figure is a triangular priſm. The pyramid $D a a d$ is $\frac{1}{3}$ of the priſm $a a D d a' a'$. If we make s repreſent the ſurface of the triangle $a D a$, the pyramid is $\frac{1}{3}$ of $f s$. The diſtance AO of its centre of gravity from the horizontal line AA′ is $\frac{1}{2}$ of AD, or $\frac{1}{2} d$. Therefore the momentum of actual coheſion is $\frac{1}{3} f s \times \frac{1}{2} d, = f s \frac{1}{6} d$; that is, it is the ſame as if the full coheſion of all the fibres were accumulated at a point I whoſe diſtance from A is $\frac{1}{6}$th of AD or d; or (that we may ſee its value in every point of view) it is $\frac{1}{6}$th of the momentum of the full coheſion of all the fibres when accumulated at the point D, or acting at the diſtance $d = AD$.

This is a very convenient way of conceiving the momentum of actual coheſion, by comparing it with the momentum of abſolute coheſion applied at the diſtance AD from the axis of fracture. The momentum of the abſolute coheſion applied at D is to the momentum of actual coheſion in the inſtant of fracture as AD to AI. Therefore the length of AI, or its proportion to AD, is a ſort of index of the ſtrength of the beam. We ſhall call it the INDEX, and expreſs it by the ſymbol $\imath$.

Its value is eaſily obtained. The product of the abſolute coheſion by AI muſt be equal to that of the actual coheſion by AO. Therefore ſay, "as the priſmatic ſolid $a a D d a' a'$ is to the pyramidal ſolid $a a D d$, ſo is AO to AI." We are aſſiſted in this determination by a very convenient circumſtance. In this hypotheſis of the actual coheſions being as the diſtances of the fibres from A, the point O is the centre of oſcillation or percuſſion of the ſurface $D a a$ turning round the axis $a a$: for the momentum of coheſion of the line FF is $FF \times F f \times EA = FF \times EA^2$, becauſe $F f$ is equal to EA. Now AO, by the nature of the centre of gravity, is equal to the ſum of all theſe momenta divided by the pyramid $a a D d$; that is, by the ſum of all the $FF \times F f$; that is, by the ſum of all the $FF \times EA$. Therefore $AO = \frac{\text{ſum of } FF \times EA^2}{\text{ſum of } FF \times EA}$, which is juſt the value of the diſtance of the centre of percuſſion of the triangle $a a D$ from A: (See ROTATION). Moreover, if G be the centre of gravity of the triangle *a* D *a*, we ſhall have DA to GA as the abſolute coheſion to the ſum of the coheſions actually exerted in the inſtant of fracture; for, by the nature of this centre of gravity, AG is equal to $\frac{\text{ſum of FF} \times \text{EA}}{\text{ſum of FF}}$, and the ſum of FF × AG is equal to the ſum of FF × EA. But the ſum of all the lines FF is the triangle *a* D *a*, and the ſum of all the FF × EA is the ſum of all the rectangles FF *ff*; that is, the pyramid *d* D *a a*. Therefore a priſm whoſe baſe is the triangle *a* D *a*, and whoſe height is AG, is equal to the pyramid, or will expreſs the ſum of the actual coheſions; and a priſm, whoſe baſe is the ſame triangle, and whoſe height is D *d* or D *a*, expreſſes the abſolute coheſion. Therefore DA is to GA as the abſolute coheſion to the ſum of the actual coheſions.

Therefore we have DA : GA = OA : IA.

Therefore, whatever be the form of the beam, that is, whatever be the figure of its ſection, find the centre of oſcillation O, and the centre of gravity G of this ſection. Call their diſtances from the axis of fracture o and g. Then AI or $i = \frac{og}{d}$, and the momentum of coheſion is $fs \times \frac{og}{d}$, where s is the area of fracture.

This index is eaſily determined in all the caſes which generally occur in practice. In a rectangular beam AI is $\frac{1}{3}$d of AD; in a cylinder (circular or elliptic) AI is $\frac{5}{16}$ths of AD, &c. &c.

In this hypotheſis, that the coheſion actually exerted by each fibre is as its extenſion, and that the extenſions of the fibres are as their diſtances from A (fig. 5.), it is plain that the forces exerted by the fibres D, E, &c. will be repreſented by the ordinates D *d*, E *e*, &c. to a ſtraight line A *d*. And we learn from the principles of ROTATION that the centre of percuſſion O is in the ordinate which paſſes through the centre of gravity of the triangle AD *d*, or (if we conſider the whole ſection having breadth as well as depth) through the centre of gravity of the ſolid bounded by the planes DA, *d* A; and we found that this point O was the centre of effort of the coheſions *actually* exerted in the inſtant of fracture, and that I was the centre of an *equal* momentum, which would be produced if all the fibres were accumulated there and exerted their *full* coheſion.

This conſideration enables us to determine, with equal facility and neatneſs, the ſtrength of a beam in any hypotheſis of forces. The above hypotheſis was introduced with a cautious limitation to moderate ſtrains, which produced no permanent change of form, or no ſett as the artiſts call it: and this ſuffices for all purpoſes of practice, ſeeing that it would be imprudent to expoſe materials to more violent ſtrains. But when we compare this theory with experiments in which the pieces are really broken, conſiderable deviations may be expected, becauſe it is very probable that in the vicinity of rupture the forces are no longer proportional to the extenſions.

61
How the relative ſtrength may be determined by any other hypotheſis.

That no doubt may remain as to the juſtneſs and completeneſs of the theory, we muſt ſhow how the relative ſtrength may be determined in any other hypotheſis. Therefore ſuppoſe that it has been eſtabliſhed by experiment on any kind of ſolid matter, that the forces actually exerted in the inſtant of fracture by the fibres at D, E, &c. are as the ordinates D *d'*, E *e'*, &c. of any curve line A *e' d'*. We are ſuppoſed to know the form of this curve, and that of the ſolid which is bounded by the vertical plane through AD, and by the ſurface which paſſes through this curve A *e' d'* perpendicularly to the length of the beam. We know the place of the centre of gravity of this curve ſurface or ſolid, and can draw a line through it parallel to AB, and cutting the ſurface of fracture in ſome point O. This point is alſo the centre of effort of all the coheſions actually exerted; and the product of AO and of the ſolid which expreſſes the actual coheſions will give the momentum of coheſion equivalent to the former $fs\frac{og}{d}$. Or we may find an index AI, by making AI a fourth proportional to the full coheſion of the ſurface of fracture, to the accumulated actual coheſions, and to AO; and then $fs \times i$ (= AI) will be the momentum of coheſion; and we ſhall ſtill have I for the point in which all the fibres may be ſuppoſed to exert their full coheſion f, and to produce a momentum of coheſion equal to the real momentum of the coheſions actually exerted, and the relative ſtrength of the beam will ſtill be $p = \frac{fsi}{l}$ or $\frac{fsgo}{dl}$. Thus, if the forces be as the ſquares of the extenſions (ſtill ſuppoſed to be as the diſtances from A), the curve A *e' d'* will be a common parabola, having AB for its axis and AD for the tangent at its vertex. The area AD *d'* will be $\frac{1}{3}$d AD × D *d*; and in the caſe of a rectangular beam, AO will be $\frac{3}{4}$ths AD, and AI will be $\frac{1}{4}$th of AD.

We may obſerve here in general, that if the forces actually exerted in the inſtant of fracture be as any power q of the diſtance from A, the index AI will be $= \frac{\text{AD}}{q+2}$ for a rectangular beam, and the momentum of coheſion will always be (*cæteris paribus*) as the breadth and as the ſquare of the depth; nay, this will be the caſe whenever the action of the fibres D and E is expreſſed by any *ſimilar functions* of d and x. This is evident to every reader acquainted with the fluxionary calculus.

As far as we can judge from experience, no ſimple algebraic power of the diſtance will expreſs the actual coheſions of the fibres. No curve which has either AD or AB for its tangent will ſuit. The obſervations which we made in the beginning ſhow, that although the curve of fig. 2. muſt be ſenſibly ſtraight in the vicinity of the points of interſection with the axis, in order to agree with our obſervations which ſhow the moderate extenſions to be as the extending forces, the curve *muſt* be concave towards the axis in all its attractive branches, becauſe it cuts it again. Therefore the curve A *e' d'* of fig. 5. muſt make a finite angle with AD or AB, and it muſt, in all probability, be alſo concave towards AD in the neighbourhood of *d'*. It may however be convex in ſome part of the intermediate arch. We have made experiments on the extenſions of different bodies, and find great diverſities in this reſpect: But in all, the moderate extenſions were as the forces, and this with great accuracy till the body took a ſett, and remained longer than formerly when the extending force was removed.

We muſt now remark, that this correction of the Galilean hypotheſis of equal forces was ſuggeſted by the bending

bending which is obſerved in all bodies which are ſtrained tranſverſely. Becauſe they are bent, the fibres on the convex ſide have been extended. We cannot ſay in what proportion this obtains in the different fibres. Our moſt diſtinct notions of the internal equilibrium between the particles render it highly probable that their extenſion is proportional to their diſtance from that fibre which retains its former dimenſions. But by whatever law this is regulated, we ſee plainly that the actions of the ſtretched fibres muſt follow the proportions of ſome function of this diſtance, and that therefore the relative ſtrength of a beam is in all caſes ſuſceptible of mathematical determination.

62
Bernoulli's problem of the elaſtic curve.

We alſo ſee an intimate connection between the ſtrain and the curvature. This ſuggeſted to the celebrated James Bernoulli the problem of the Elastic Curve, i. e. the curve into which an extenſible rigid body will be bent by a tranſverſe ſtrain. His ſolution in the *Acta Lipſiæ* 1694 and 1695, is a very beautiful ſpecimen of mathematical diſcuſſion; and we recommend it to the peruſal of the curious reader. He will find it very perſpicuouſly treated in the firſt volume of his works, publiſhed after his death, where the wide ſteps which he had taken in his inveſtigation are explained ſo as to be eaſily comprehended. His nephew Daniel Bernoulli has given an elegant abridgment in the Peterſburg Memoirs for 1729. The problem is too intricate to be fully diſcuſſed in a work like ours; but it is alſo too intimately connected with our preſent ſubject to be entirely omitted. We muſt content ourſelves with ſhowing the leading mechanical properties of this curve, from which the mathematician may deduce all its geometrical properties.

63
Its leading mechanical property deſcribed.

When a bar of uniform depth and breadth, and of a given length, is bent into an arch of a circle, the extenſion of the outer fibres is proportional to the curvature; for, becauſe the curves formed by the inner and outer ſides of the beam are ſimilar, the circumferences are as the radii, and the radius of the inner circle is to the difference of the radii as the length of the inner circumference is to the difference of the circumferences. The difference of the radii is the depth of the beam, the difference of the circumferences is the extenſion of the outer fibres, and the inner circumference is ſuppoſed to be the primitive length of the beam. Now the ſecond and third quantities of the above analogy, viz. the depth and length of the beam, are conſtant quantities, as is alſo their product. Therefore the product of the inner radius and the extenſion of the outer fibre is alſo a conſtant quantity, and the whole extenſion of the outer fibre is inverſely as the radius of curvature, or is directly as the curvature of the beam.

The mathematical reader will readily ſee, that into whatever curve the elaſtic bar is bent, the whole extenſion of the outer fibre is equal to the length of a ſimilar curve, having the ſame proportion to the thickneſs of the beam that the length of the beam has to the radius of curvature.

Fig. 7.

Now let ADCB (fig. 7.) be ſuch a rod, of uniform breadth and thickneſs, firmly fixed in a vertical poſition, and bent into a curve AEFB by a weight W ſuſpended at B, and of ſuch magnitude that the extremity B has its tangent perpendicular to the action of the weight, or parallel to the horizon. Suppoſe too that the extenſions are proportional to the extending forces. From any two points E and F draw the horizontal ordinates EG, FH. It is evident that the exterior fibres of the ſections E *e* and F *f* are ſtretched by forces which are in the proportion of EG to FH (theſe being the long arms of the levers, and the equal thickneſſes E *e*, F *f* being the ſhort arms). Therefore (by the hypotheſis) their extenſions are in the ſame proportion. But becauſe the extenſions are proportional to ſome ſimilar functions of the diſtance from the axes of fracture E and F, the extenſion of any fibre in the ſection E *e* is to the contemporaneous extenſion of the ſimilarly ſituated fibre in the ſection F *f*, as the extenſion of the exterior fibre in the ſection E *e* is to the extenſion of the exterior fibre in the ſection F *f*: therefore the whole extenſion of E *e* is to the whole extenſion of F *f* as EG to FH, and EG is to FH as the curvature in E to the curvature in F.

Here let it be remarked, that this proportionality of the curvature to the extenſion of the fibres is not limited to the hypotheſis of the proportionality of the extenſions to the extending forces. It follows from the extenſion in the different ſections being as ſome ſimilar function of the diſtance from the axis of fracture; an aſſumption which cannot be refuſed.

This then is the fundamental property of the elaſtic curve, from which its equation, or relation between the abſciſſa and ordinate, may be deduced in the uſual forms, and all its other geometrical properties. Theſe are foreign to our purpoſe; and we ſhall notice only ſuch properties as have an immediate relation to the ſtrain and ſtrength of the different parts of a flexible body, and which in particular ſerve to explain ſome difficulties in the valuable experiments of M. Buffon on the Strength of Beams.

64
It is not a circle.

We obſerve, in the firſt place, that the elaſtic curve cannot be a circle, but is gradually more incurvated as it recedes from the point of application B of the ſtraining forces. At B it has no curvature; and if the bar were extended beyond B there would be no curvature there. In like manner, when a beam is ſupported at the ends and loaded in the middle, the curvature is greateſt in the middle; but at the props, or beyond them, if the beam extend farther, there is no curvature. Therefore when a beam projecting 20 feet from a wall is bent to a certain curvature at the wall by a weight ſuſpended at the end, and a beam of the ſame ſize projecting 20 feet is bent to the very ſame curvature at the wall by a greater weight at 10 feet diſtance, the figure and the mechanical ſtate of the beam in the vicinity of the wall is different in theſe two caſes, though the curvature at the very wall is the ſame in both. In the firſt caſe every part of the beam is incurvated; in the ſecond, all beyond the 10 feet is without curvature. In the firſt experiment the curvature at the diſtance of five feet from the wall is three-fourths of the curvature at the wall; in the ſecond, the curvature at the ſame place is but one-half of that at the wall. This muſt weaken the long beam in this whole interval of five feet, becauſe the greater curvature is the reſult of a greater extenſion of the fibres.

65
Every beam has a certain determinate curvature.

In the next place, we may remark, that there is a certain determinate curvature for every beam which cannot be exceeded without breaking it; for there is a certain ſeparation of two adjoining particles that puts an end to their coheſion. A fibre can therefore be extended only a certain proportion of its length. The ultimate extenſion of the outer fibres muſt bear a certain determinate proportion to its length, and this proportion is the ſame with that of the thickneſs (or what we have hitherto called the depth) to the radius of ultimate curvature, which is therefore determinate.

66
And when of uniform breadth and depth is moſt incurvated where the ſtrain is greateſt.

A beam of uniform breadth and depth is therefore moſt incurvated where the ſtrain is greateſt, and will break in the moſt incurvated part. But by changing its form, ſo as to make the ſtrength of its different ſections in the ratio of the ſtrain, it is evident that the curvature may be the ſame throughout, or may be made to vary according to any law. This is a remark worthy of the attention of the watchmaker. The moſt delicate problem in practical mechanics is ſo to taper the balance-ſpring of a watch that its wide and narrow vibrations may be iſochronous. Hooke's principle *ut tenſio ſic vis* is not ſufficient when we take the *inertia* and motion of the ſpring itſelf into the account. The figure into which it bends and unbends has alſo an influence. Our readers will take notice that the artiſt aims at an accuracy which will not admit an error of $\frac{1}{86400}$th, and that Harriſon and Arnold have actually attained it in ſeveral inſtances. The taper of a ſpring is at preſent a noſtrum in the hands of each artiſt, and he is careful not to impart his ſecret.

Again, ſince the depth of the beam is thus proportional to the radius of ultimate curvature, this ultimate or breaking curvature is inverſely as the depth. It may be expreſſed by $\frac{1}{d}$.

67
To what the curvature is proportional.

When a weight is hung on the end of a priſmatic beam, the curvature is nearly as the weight and the length directly, and as the breadth and the cube of the depth inverſely; for the ſtrength is $= f\frac{b\,d^2}{3\,l}$. Let us ſuppoſe that this produces the ultimate curvature $\frac{1}{d}$. Now let the beam be loaded with a ſmaller weight w, and let the curvature produced be C, we have this analogy $f\frac{b\,d^2}{3\,l} : w = \frac{1}{d} : C$, and $C = \frac{3\,l\,w}{f\,b\,d^3}$. It is evident that this is alſo true of a beam ſupported at the ends and loaded between the props; and we ſee how to determine the curvature in its different parts, whether ariſing from the load, or from its own weight, or from both.

68
Deflection.

When a beam is thus loaded at the end or middle, the loaded point is pulled down, and the ſpace through which it is drawn may be called the DEFLECTION. This may be conſidered as the ſubtenſe of the angle of contact, or as the verſed ſine of the arch into which the beam is bent, and is therefore as the curvature when the length of the arches is given (the flexure being moderate), and as the ſquare of the length of the arch when the curvature is given. The deflection therefore is as the curvature and as the ſquare of the length of the arch jointly; that is, as $\frac{3\,l\,w}{f\,b\,d^3} \times l^2$, or as $\frac{3\,l^3\,w}{f\,b\,d^3}$. The deflection from the primitive ſhape is therefore as the bending weight and the cube of the length directly, and as the breadth and cube of the depth inverſely.

In beams juſt ready to break, the curvature is as the depth inverſely, and the deflection is as the ſquare of the length divided by the depth; for the ultimate curvature at the breaking part is the ſame whatever is the length; and in this caſe the deflection is as the ſquare of the length.

69
The theorems reſulting from this ſubject afford the fineſt methods of examining the laws of corpuſcular action.

We have been the more particular in our conſideration of this ſubject, becauſe the reſulting theorems afford us the fineſt methods of examining the laws of corpuſcular action, that is, for diſcovering the variation of the force of coheſion by a change of diſtance. It is true it is not the atomical law, or HYLARCHIC PRINCIPLE as it may juſtly be called, which is thus made acceſſible, but the ſpecific law of the particles of the ſubſtance or kind of matter under examination. But even this is a very great point; and coincidences in this reſpect among the different kinds of matter are of great moment. We may thus learn the nature of the corpuſcular action of different ſubſtances, and perhaps approach to a diſcovery of the *mechaniſm* of chemical affinities. For that chemical actions are inſenſible caſes of local motion is undeniable, and local motion is the province of mechanical diſcuſſion; nay, we ſee that theſe hidden changes are produced by mechanical forces in many important caſes, for we ſee them promoted or prevented by means purely mechanical. The converſion of bodies into elaſtic vapour by heat can at all times be prevented by a *ſufficient* external preſſure. A ſtrong ſolution of Glauber's ſalt will congeal in an inſtant by agitation, giving out its latent heat; and it will remain fluid for ever, and retain its latent heat in a cloſe veſſel which it completely fills. Even water will by ſuch treatment freeze in an inſtant by agitation, or remain fluid for ever by confinement. We know that heat is produced or extricated by friction, that certain compounds of gold or ſilver with ſaline matters explode with irreſiſtible violence by the ſmalleſt preſſure or agitation. Such facts ſhould rouſe the mathematical philoſopher, and excite him to follow out the conjectures of the illuſtrious Newton, encouraged by the ingenious attempts of Boſcovich; and the proper beginning of this ſtudy is to attend to the laws of attraction and repulſion exerted by the particles of cohering bodies, diſcoverable by experiments made on their actual extenſions and compreſſions. The experiments of ſimple extenſions and compreſſions are quite inſufficient, becauſe the total ſtretching of a wire is ſo ſmall a quantity, that the miſtake of the 1000th part of an inch occaſions an irregularity which deranges any progreſſion ſo as to make it uſeleſs. But by the bending of bodies, a diſtenſion of $\frac{1}{100}$th of an inch may be eaſily magnified in the deflection of the ſpring ten thouſand times. We know that the inveſtigation is intricate and difficult, but not beyond the reach of our preſent mathematical attainments; and it will give very fine opportunities of employing all the addreſs of analyſis. In the 17th century and the beginning of the 18th this was a ſufficient excitement to the firſt geniuſes of Europe. The cycloid, the catenaria, the elaſtic curve, the velaria, the cauſtics, were reckoned an abundant recompenſe for much ſtudy; and James Bernoulli requeſted, as an honourable monument, that the logarithmic ſpiral might be inſcribed on his tombſtone. The reward for the ſtudy to which we now preſume to incite the mathematicians is the almoſt unlimited extenſion of natural ſcience, important in every particular branch. To go no further than our preſent ſubject, a great deal of important practical knowledge reſpecting the ſtrength of bodies is derived from the ſingle obſervation, that in the moderate extenſions which happen before the parts are overſtrained the forces are nearly in the proportion of the extenſions or ſeparations of the particles. To return to our ſubject.

70 Bernoulli calls in queſtion this law,

James Bernoulli, in his ſecond diſſertation on the elaſtic curve, calls in queſtion this law, and accommodates his inveſtigation to any hypotheſis concerning the relation of the forces and extenſions. He relates ſome experiments of lute ſtrings where the relation was conſiderably different. Strings of three feet long,

Stretched by	2,	4,	6,	8,	10 pds.
Were lengthened	9,	17,	23,	27,	30 lines.

But this is a moſt exceptionable form of the experiment. The ſtrings were twiſted, and the mechaniſm of the extenſions is here exceedingly complicated, combined with compreſſions and with tranſverſe twiſts, &c. We made experiments on fine ſlips of the gum caoutchouc, and on the juice of the berries of the white bryony, of which a ſingle grain will draw to a thread of two feet long, and again return into a perfectly round ſphere. We meaſured the diameter of the thread by a microſcope with a micrometer, and thus could tell in every ſtate of extenſion the proportional number of particles in the ſections. We found, that through the whole range in which the diſtance of the particles was changed in the proportion of 13 to 1, the extenſions did not *ſenſibly* deviate from the proportion of the forces. The ſame thing was obſerved in the caoutchouc as long as it perfectly recovered its firſt dimenſions. And it is on the authority of theſe experiments that we preſume to announce this as a law of nature.

71 which was firſt aſſumed by Dr Hooke.

Dr Robert Hooke was undoubtedly the firſt who attended to this ſubject, and aſſumed this as a law of nature. Mariotte indeed was the firſt who expreſsly uſed it for determining the ſtrength of beams: this he did about the 1679, correcting the ſimple theory of Galileo. Leibnitz indeed, in his diſſertation in the *Acta Eruditorum* 1684 *de Reſiſtentia Solidorum*, introduces this conſideration, and wiſhes to be conſidered as the diſcoverer; and he is always acknowledged as ſuch by the Bernoullis and others who adhered to his peculiar doctrines. But Marriotte had publiſhed the doctrine in the moſt expreſs terms long before; and Bulfinger, in the *Comment. Petropol.* 1729, completely vindicates his claim. But Hooke was unqueſtionably the diſcoverer of this law. It made the foundation of his theory of ſprings, announced to the Royal Society about the year 1661, and read in 1666. On this occaſion he mentions many things on the ſtrength of bodies as quite familiar to his thoughts, which are immediate deductions from this principle; and among theſe *all* the facts which John Bernoulli ſo vauntingly adduces in ſupport of Leibnitz's finical dogmas about the force of bodies in motion; a doctrine which Hooke might have claimed as his own, had he not perceived its frivolous inanity.

72 Though corrected by Mariotte, it does not properly explain the mechaniſm of tranſverſe ſtrain,

But even with this firſt correction of Marriotte, the mechaniſm of tranſverſe ſtrain is not fully nor juſtly explained. The force acting in the direction BP (fig. 5.), and bending the body ABCD, not only ſtretches the fibres on the ſide oppoſite to the axis of fracture, but compreſſes the ſide AB, which becomes concave by the ſtrain. Indeed it cannot do the one without doing the other: For in order to ſtretch the fibres at D, there muſt be ſome fulcrum, ſome ſupport, on which the virtual lever BAD may preſs, that it may tear aſunder the ſtretched fibres. This fulcrum muſt ſuſtain both the preſſure ariſing from the coheſion of the diſtended fibres, and alſo the action of the external force, which immediately tends to cauſe the prominent part of the beam to ſlide along the ſection DA. Let BAD (fig. 5.) be conſidered as a crooked lever, of which A is the fulcrum. Let an external force be applied at B in the direction BP, and let a force equal to the accumulated coheſion of AD be applied at O in the direction oppoſite to AB, that is, perpendicular to AO; and let theſe two forces be ſuppoſed to balance each other by the intervention of the lever. In the firſt place, the force at O muſt be to the force at B as AB to AO: Therefore, if we make AK equal and oppoſite to AO, and AL equal and oppoſite to AB, the common principles of mechanics inform us that the fulcrum A is affected in the ſame manner as if the two forces AK and AL were immediately applied to it, the force AK being equal to the weight P, and AL equal to the accumulated coheſion actually exerted in the inſtant of fracture. The fulcrum is therefore really preſſed in the direction AM, the diagonal of the parallelogram, and it muſt reſiſt in the direction and with the force MA; and this power of reſiſtance, this ſupport, muſt be furniſhed by the repulſive forces exerted by *thoſe particles only* which are in a ſtate of actual compreſſion. The force AK, which is equal to the external force P, muſt be reſiſted in the direction KA by the lateral coheſion of the whole particles between D and A (the particle D is not only drawn forward but downward). This prevents the part CDAB from ſliding down along the ſection DA.

73 as is fully verified by experiment.

This is fully verified by experiment. If we attempt to break a long ſlip of cork, or any ſuch very compreſſible body, we always obſerve it to bulge out on the concave ſide before it cracks on the other ſide. If it is a body of fibrous or foliated texture, it ſeldom fails ſplintering off on the concave ſide; and in many caſes this ſplintering is very deep, even reaching half way through the piece. In hard and granulated bodies, ſuch as a piece of freeſtone, chalk, dry clay, ſugar, and the like, we generally ſee a conſiderable ſplinter or ſhiver fly off from the hollow ſide. If the fracture be ſlowly made by a force at B gradually augmented, the formation of the ſplinter is very diſtinctly ſeen. It forms a triangular piece like *a*I*b*, which generally breaks in the middle. We doubt not but that attentive obſervation would ſhow that the direction of the crack on each ſide of I is not very different from the direction AM and its correſpondent on the other ſide. This is by no means a circumſtance of idle curioſity, but intimately connected with the mechaniſm of coheſion.

74 Conſequences reſulting from the ſtate of the caſe. Fig. 8.

Let us ſee what conſequences reſult from this ſtate of the caſe reſpecting the ſtrength of bodies. Let DΔKC (fig. 8.) repreſent a vertical ſection of a priſm of compreſſible materials, ſuch as a piece of timber. Suppoſe it loaded with a weight P hung at its extremity. Suppoſe it of ſuch a conſtitution that all the fibres in AD are in a ſtate of dilatation, while thoſe in AΔ are in a ſtate of compreſſion. In the inſtant of fracture the particles at D and E are withheld by forces D*d*, E*e*, and the particles at Δ and E repel, reſiſt, or ſupport, with forces Δδ, Eε.

Some line, ſuch as *de*Aεδ, will limit all theſe ordinates,

nates, which repreſent the forces actually exerted in the inſtant of fracture. If the forces be as the extenſions and compreſſions, as we have great reaſon to believe, *d e* A and A ε δ will be two ſtraight lines. They will form *one* ſtraight line *d* A δ, if the forces which reſiſt a certain dilatation are equal to the forces which reſiſt an equal compreſſion. But this is quite accidental, and is not ſtrictly true in any body. In moſt bodies which have any conſiderable firmneſs, the compreſſions made by any external force are not ſo great as the dilatations which the ſame force would produce; that is, the repulſions which are excited by any ſuppoſed degree of compreſſion are greater than the attractions excited by the ſame degree of dilatation. Hence it will generally follow, that the angle *d* AD is leſs than the angle δ A Δ, and the ordinates D *d*, E *e*, &c. are leſs than the correſponding ordinates Δ δ, E ε, &c.

But whatever be the nature of the line *d* A δ, we are certain of this, that the whole area AD *d* is equal to the whole area A Δ δ: for as the force at B is gradually increaſed, and the parts between A and D are more extended, and greater coheſive forces are excited, there is always ſuch a degree of repulſive forces excited in the particles between A and Δ that the one ſet preciſely balances the other. The force at B, acting perpendicularly to AB, has no tendency to puſh the whole piece cloſer on the part next the wall or to pull it away. The ſum of the attractive and repulſive forces actually excited muſt therefore be equal. Theſe ſums are repreſented by the two triangular areas, which are therefore equal.

The greater we ſuppoſe the repulſive forces correſponding to any degree of compreſſion, in compariſon with the attractive forces correſponding to the ſame degree of extenſion, the ſmaller will A Δ be in compariſon of AD. In a piece of cork or ſponge, A Δ may chance to be equal to AD, or even to exceed it; but in a piece of marble, A Δ will perhaps be very ſmall in compariſon of AD.

75
An important conſequence of the compreſſibility of body fully proved.

Now it is evident that the repulſive forces excited between A and Δ have no ſhare in preventing the fracture. They rather contribute to it, by furniſhing a fulcrum to the lever, by whoſe energy the coheſion of the particles in AD is overcome. Hence we ſee an important conſequence of the compreſſibility of the body. Its power of reſiſting this tranſverſe ſtrain is diminiſhed by it, and ſo much the more diminiſhed as the ſtuff is more compreſſible.

This is fully verified by ſome very curious experiments made by Du Hamel. He took 16 bars of willow 2 feet long and $\frac{1}{2}$ an inch ſquare, and ſupporting them by props under the ends, he broke them by weights hung on the middle. He broke 4 of them by weights of 40, 41, 47, and 52 pounds: the mean is 45. He then cut four of them $\frac{1}{3}$d through on the upper ſide, and filled up the cut with a thin piece of harder wood ſtuck in pretty tight. Theſe were broken by 48, 54, 50, and 52 pounds; the mean of which is 51. He cut other four $\frac{1}{2}$ through, and they were broken by 47, 49, 50, 46; the mean of which is 48. The remaining four were cut $\frac{2}{3}$ds; and their mean ſtrength was 42.

Another ſet of his experiments is ſtill more remarkable.

Six battens of willow 36 inches long and $1\frac{2}{2}$ ſquare were broken by 525 pounds at a medium.

Six bars were cut $\frac{1}{3}$d through, and the cut filled with a wedge of hard wood ſtuck in with a little force: theſe broke with 551.

Six bars were cut half through, and the cut was filled in the ſame manner: they broke with 542.

Six bars were cut $\frac{3}{4}$ths through: theſe broke with 530.

A batten cut $\frac{3}{4}$ths through, and loaded till nearly broken, was unloaded, and the wedge taken out of the cut. A thicker wedge was put in tight, ſo as to make the batten ſtraight again by filling up the ſpace left by the compreſſion of the wood: this batten broke with 577 pounds.

From this it is plain that more than $\frac{2}{3}$ds of the thickneſs (perhaps nearly $\frac{3}{4}$ths) contributed nothing to the ſtrength.

The point A is the centre of fracture in this caſe; and in order to eſtimate the ſtrength of the piece, we may ſuppoſe that the crooked lever virtually concerned in the ſtrain is DAB. We muſt find the point I, which is the centre of effort of all the attractive forces, or that point where the full coheſion of AD muſt be applied, ſo as to have a momentum equal to the accumulated momenta of all the variable forces. We muſt in like manner find the centre of effort *i* of the repulſive or ſupporting forces exerted by the fibres lying between A and Δ.

It is plain, and the remark is important, that this laſt centre of effort is the real fulcrum of the lever, although A is the point where there is neither extenſion nor contraction; for the lever is ſupported in the ſame manner as if the repulſions of the whole line A Δ were exerted at that point. Therefore let S repreſent the ſurface of fracture from A to D, and *f* repreſent the abſolute coheſion of a fibre at D in the inſtant of fracture. We ſhall have $fS \times \overline{I + i} = p\,l$, or $l : I + i = fS : p$; that is, the length AB is to the diſtance between the two centres of effort I and *i*, as the abſolute coheſion of the ſection between A and D is to the relative ſtrength of the ſection.

It would be perhaps more accurate to make AI and A*i* equal to the diſtances of A from the horizontal lines paſſing through the centres of gravity of the triangles *d* AD and δ A Δ. It is only in this conſtruction that the points I and *i* are the centres of real effort of the accumulated attractions and repulſions. But I and *i*, determined as we have done, are the points where the full, equal, actions may be all applied, ſo as to produce the ſame momenta. The final reſults are the ſame in both caſes. The attentive and duly informed reader will ſee that Mr Bulfinger, in a very elaborate diſſertation on the ſtrength of beams in the *Comment, Petropolitan.* 1729, has committed ſeveral miſtakes in his eſtimation of the actions of the fibres. We mention this becauſe his reaſonings are quoted and appealed to as authorities by Muſchenbroek and other authors of note. The ſubject has been conſidered by many authors on the continent. We recommend to the reader's peruſal the very minute diſcuſſions in the Memoirs of the Academy of Paris for 1702 by Varignon, the Memoirs for 1708 by Parent, and particularly that of Coulomb in the *Mem. par les Sçavans Etrangers*, tom. vii.

It is evident from what has been ſaid above, that if S and *s* repreſent the ſurfaces of the ſections above and below A, and if G and *g* are the diſtances of their centres of gravity from A, and O and *o* the diſtances of their centres of oſcillation, and D and d their whole depths, the momentum of coheſion will be $\frac{f\,S \cdot G \cdot O}{D} = \frac{f\,s \,.\, g \,.\, o}{d \,.}$ $= p\,l$.

If (as is moſt likely) the forces are proportional to the extenſions and compreſſions, the diſtances AI and Ai, which are reſpectively $= \frac{G \cdot O}{D}$ and $\frac{g \,.\, o}{d}$, are reſpectively $= \frac{1}{3}$ DA, and $\frac{1}{3}\Delta$ A; and when taken together are $= \frac{1}{3}$ D Δ. If, moreover, the extenſions are equal to the compreſſions in the inſtant of fracture, and the body is a rectangular priſm like a common joiſt or beam, then DA and Δ A are alſo equal; and therefore the momentum of coheſion is $f\,b \times \frac{1}{2}\,d \times \frac{1}{3}\,d, = \frac{f\,b\,d^2}{6}, = f\,b\,d \times \frac{1}{6}\,d = p\,l$. Hence we obtain this analogy, "Six times the length is to the depth as the abſolute coheſion of the ſection is to its relative ſtrength."

76
This conſequence farther explained.

Thus we ſee that the compreſſibility of bodies has a very great influence on their power of withſtanding a tranſverſe ſtrain. We ſee that in this moſt favourable ſuppoſition of equal dilatations and compreſſions, the ſtrength is reduced to one half of the value of what it would have been had the body been incompreſſible. This is by no means obvious; for it does not readily appear how compreſſibility, which does not diminiſh the coheſion of a ſingle fibre, ſhould impair the ſtrength of the whole. The reaſon, however, is ſufficiently convincing when pointed out. In the inſtant of fracture a ſmaller portion of the ſection is actually exerting coheſive forces, while a part of it is only ſerving as a fulcrum to the lever, by whoſe means the ſtrain on the ſection is produced. We ſee too that this diminution of ſtrength does not ſo much depend on the ſenſible compreſſibility, as on its proportion to the dilatability by equal forces. When this proportion is ſmall, A Δ is ſmall in compariſon of AD, and a greater portion of the whole fibre is exerting attractive forces. The experiments already mentioned, of Du Hamel de Monceau, on battens of willow, ſhow that its compreſſibility is nearly equal to its dilatability. But the caſe is not very different in tempered ſteel. The famous Harriſon, in the delicate experiments which he made while occupied in making his longitude watch, diſcovered that a rod of tempered ſteel was nearly as much diminiſhed in its length as it was augmented by the ſame external force. But it is not by any means certain that this is the proportion of dilatation and compreſſion which obtains in the very inſtant of fracture. We rather imagine that it is not. The forces are nearly as the dilatations till very near breaking; but we think that they diminiſh when the body is juſt going to break. But it ſeems certain that the forces which reſiſt compreſſion increaſe faſter than the compreſſions, even before fracture. We know inconteſtably that the ultimate reſiſtances to compreſſion are inſuperable by any force which we can employ. The repulſive forces therefore (in their whole extent) increaſe faſter than the compreſſions, and are expreſſed by an aſſymptotic branch of the Boſcovician curve formerly explained. It is therefore probable, eſpecially in the more ſimple ſubſtances, that they increaſe faſter, even in ſuch compreſſions as frequently obtain in the breaking of hard bodies. We are diſpoſed to think that this is always the caſe in ſuch bodies as do not fly off in ſplinters on the concave ſide; but this muſt be underſtood with the exception of the permanent changes which may be made by compreſſion, when the bodies are crippled by it. This always increaſes the compreſſion itſelf, and cauſes the neutral point to ſhift ſtill more towards D. The effect of this is ſometimes very great and fatal.

Experiment alone can help us to diſcover the proportion between the dilatability and compreſſibility of bodies. The ſtrain now under conſideration ſeems the beſt calculated for this reſearch. Thus if we find that a piece of wood an inch ſquare requires 12,000 pounds to tear it aſunder by a direct pull, and that 200 pounds will break it tranſverſely by acting 10 inches from the ſection of fracture, we muſt conclude that the neutral point A is in the middle of the depth, and that the attractive and repulſive forces are equal. Any notions that we can form of the conſtitution of ſuch fibrous bodies as timber, make us imagine that the *ſenſible* compreſſions, including what ariſes from the bending up of the compreſſed fibres, is much greater than the real corpuſcular extenſions. One may get a general conviction of this unexpected propoſition by reflecting on what muſt happen during the fracture. An undulated fibre can only be drawn ſtraight, and then the corpuſcular extenſion begins; but it may be bent up by compreſſion to any degree, the corpuſcular compreſſion being little affected all the while. This obſervation is very important; and though the forces of corpuſcular repulſion may be almoſt inſuperable by any compreſſion that we can employ, a *ſenſible* compreſſion may be produced by forces not enormous, ſufficient to cripple the beam. Of this we ſhall ſee very important inſtances afterwards.

77
The proportional ſtrengths of different pieces follow the ſame ratio.

It deſerves to be noticed, that although the relative ſtrength of a priſmatic ſolid is extremely different in the three hypotheſes now conſidered, yet the proportional ſtrengths of different pieces follow the ſame ratio; namely, the direct ratio of the breadth, the direct ratio of the ſquare of the depth, and the inverſe ratio of the length. In the firſt hypotheſis (of equal forces) the ſtrength of a rectangular beam was $\frac{f\,b\,d^2}{2\,l}$, in the ſecond (of attractive forces proportioned to the extenſions) it was $\frac{f\,b\,d^2}{3\,l}$; and in the third (equal attractions and repulſions proportional to the extenſions and compreſſions) it was $\frac{f\,b\,d^2}{6\,l}$, or more generally $\frac{f\,b\,d^2}{m\,l}$, where m expreſſes the unknown proportion between the attractions and repulſions correſponding to an equal extenſion and compreſſion.

78
The ſtrength of a piece depends chiefly on its depth.

Hence we derive a piece of uſeful information, which is confirmed by unexceptionable experience, that the ſtrength of a piece depends chiefly on its depth, that is, on that dimenſion which is in the direction of the ſtrain. A bar of timber of one inch in breadth and two inches in depth is four times as ſtrong as a bar of only one inch deep, and it is twice as ſtrong as a bar two inches broad and one deep; that is, a joiſt or lever is always ſtrongeſt when laid on its edge.

79
And therefore a choice in the manner in which the coheſion is oppoſed to the ſtrain.

There is therefore a choice in the manner in which the coheſion is oppoſed to the ſtrain. The general aim muſt be to put the centre of effort I as far from the fulcrum or the neutral point A as poſſible, ſo as to give the greateſt energy or momentum to the coheſion. Thus if a triangular bar projecting from a wall is loaded with a weight at its extremity, it will bear thrice as much when one of the ſides is uppermoſt as when it is undermoſt. The bar of fig. 6. would be three times as ſtrong if the ſide AB were uppermoſt and the edge DC undermoſt.

80
The ſtrongeſt joiſt has not the greateſt quantity of timber.
Fig. 9.

Hence it follows that the ſtrongeſt joiſt that can be cut out of a round tree is not the one which has the greateſt quantity of timber in it, but ſuch that the product of its breadth by the ſquare of its depth ſhall be the greateſt poſſible. Let ABCD (fig. 9.) be the ſection of this joiſt inſcribed in the circle, AB being the breadth and AD the depth. Since it is a rectangular ſection, the diagonal BD is a diameter of the circle, and BAD is a right-angled triangle. Let BD be called a, and BA be called x; then AD is $= \sqrt{a^2 - x^2}$. Now we muſt have AB $\times$ AD^2, or $x \times \overline{a^2 - x^2}$, or $a^2 x - x^3$, a maximum. Its fluxion $a^2 \dot{x} - 3 x^2 \dot{x}$ muſt be made $= 0$, or $a^2 = 3 x^2$, or $x^2 = \frac{a^2}{3}$. If therefore we make DE $= \frac{1}{3}$ DB, and draw EC perpendicular to BD, it will cut the circumference in the point C, which determines the depth BC and the breadth CD.

Becauſe BD : BC $=$ CD : CE, we have the area of the ſection BC·CD$=$BD·CE. Therefore the different ſections having the ſame diagonal BD are proportional to their heights CE. Therefore the ſection BCDA is leſs than the ſection BcDa, whoſe four ſides are equal. The joiſt ſo ſhaped, therefore, is both ſtronger, lighter, and cheaper.

81
A hollow tube ſtronger than a ſolid rod containing the ſame quantity of matter,
Fig. 10.

The ſtrength of ABCD is to that of aBcD as 10,000 to 9186, and the weight and expence as 10,000 to 10,607; ſo that ABCD is preferable to aBcD in the proportion of 10,607 to 9186, or nearly 115 to 100.

From the ſame principles it follows that a hollow tube is ſtronger than a ſolid rod containing the ſame quantity of matter. Let fig. 10. repreſent the ſection of a cylindric tube, of which AF and BE are the exterior and interior diameters, and C the centre. Draw BD perpendicular to BC, and join DC. Then, becauſe BD^2$=$CD^2$-$CB^2, BD is the radius of a circle containing the ſame quantity of matter with the ring. If we eſtimate the ſtrength by the firſt hypotheſis, it is evident that the ſtrength of the tube will be to that of the ſolid cylinder, whoſe radius is BD, as BD^2$\times$AC to BD^2$\times$BD; that is, as AC to BD: for BD^2 expreſſes the coheſion of the ring of the circle, and AC and BD are equal to the diſtances of the centres of effort (the ſame with the centres of gravity) of the ring and circle from the axis of the fracture.

The proportion of theſe ſtrengths will be different in the other hypotheſes, and is not eaſily expreſſed by a general formula; but in both it is ſtill more in favour of the ring or hollow tube.

The following very ſimple ſolution will be readily underſtood by the intelligent reader. Let O be the centre of oſcillation of the exterior circle, o the centre of oſcillation of the inner circle, and w the centre of oſcillation of the ring included between them. Let M be the quantity of ſurface of the exterior circle, m that of the inner circle, and μ that of the ring.

We have $\mathrm{F}w = \frac{\mathrm{M \cdot FO} - m.\mathrm{F}o}{\mu}, = \frac{5\,\mathrm{FC}^2 + \mathrm{EC}^2}{4\mathrm{FC}}$ and the ſtrength of the ring $= \frac{f\mu \times \mathrm{F}w}{2}$, and the ſtrength of the ſame quantity of matter in the form of a ſolid cylinder is $f\mu \times \frac{5}{8}$ BD; ſo that the ſtrength of the ring is to that of the ſolid rod of equal weight as Fw to $\frac{5}{4}$ BD, or nearly as FC to BD. This will eaſily appear by recollecting that FO is $= \frac{\text{ſum of } p.r^2}{m.\mathrm{FC}}$ (ſee ROTATION), and that the momentum of coheſion is $\frac{fm \cdot \mathrm{FC} \cdot \mathrm{C}a}{2\,\mathrm{FC}} = \frac{fm \cdot \mathrm{F}o}{2}$ for the inner circle, &c.

Emerſon has given a very inaccurate approximation to this value in his *Mechanics*, 4to.

82
and more ſtuff.

This property of hollow tubes is accompanied alſo with greater ſtiffneſs; and the ſuperiority in ſtrength and ſtiffneſs is ſo much the greater as the ſurrounding ſhell is thinner in proportion to its diameter.

83
Hence the wiſdom of God in forming the bones, &c. hollow.

Here we ſee the admirable wiſdom of the Author of nature in forming the bones of animal limbs hollow. The bones of the arms and legs have to perform the office of levers, and are thus oppoſed to very great tranſverſe ſtrains. By this form they become incomparably ſtronger and ſtiffer, and give more room for the inſertion of muſcles, while they are lighter and therefore more agile; and the ſame Wiſdom has made uſe of this hollow for other valuable purpoſes of the animal economy. In like manner the quills in the wings of birds acquire by their thinneſs the very great ſtrength which is neceſſary, while they are ſo light as to give ſufficient buoyancy to the animal in the rare medium in which it muſt live and fly about. The ſtalks of many plants, ſuch as all the graſſes, and many reeds, are in like manner hollow, and thus poſſeſs an extraordinary ſtrength. Our beſt engineers now begin to imitate nature by making many parts of their machines hollow, ſuch as their axles of caſt iron, &c.; and the ingenious Mr Ramſden now makes the axes and framings of his great aſtronomical inſtruments in the ſame manner.

Fig. 8.
84
How a ſtrong compound beam may be formed.

In the ſuppoſition of homogeneous texture, it is plain that the fracture happens as ſoon as the particles at D are ſeparated beyond their utmoſt limit of coheſion. This is a determined quantity, and the piece bends till this degree of extenſion is produced in the outermoſt fibre. It follows, that the ſmaller we ſuppoſe the diſtance between A and D, the greater will be the curvature which the beam will acquire before it breaks. Greater depth therefore makes a beam not only ſtronger but alſo ſtiffer. But if the parallel fibres can ſlide on each other, both the ſtrength and the ſtiffneſs will be diminiſhed. Therefore if, instead of one beam DΔKC (fig. 8.) we ſuppoſe two, DABC and AΔKB, not cohering, each of them will bend, and the extenſion of the fibres AB of the under beam will not hinder the compreſſion of the adjoining fibres AB of the upper beam. The two together therefore will not be more than twice as ſtrong as one of them (ſuppoſing DA$=$AΔ) inſtead of being four times as ſtrong; and they will bend as much as either of them alone would bend by half the load. This may be prevented, if it were poſſible to unite the two beams all along the ſeam AB, ſo that the one ſhall not ſlide on the other. This may be done in ſmall works, by gluing them together with a cement as ſtrong as the natural lateral coheſion of the fibres. If this cannot be done (as it cannot in large works), the ſliding is prevented by JOGGLING the beams together; that is, by cutting down ſeveral rectangular notches in the upper ſide of the lower beam, and making ſimilar notches in

Fig. 11.

Fig. 12.

in the under ſide of the upper beam, and filling up the ſquare ſpaces with pieces of very hard wood firmly driven in, as repreſented in fig. 11. Some employ iron bolts by way of joggles. But when the joggle is much harder than the wood into which it is driven, it is very apt to work looſe, by widening the hole into which it is lodged. The ſame thing is ſometimes done by ſcarfing the one upon the other, as repreſented in fig. 12.; but this waſtes more timber, and is not ſo ſtrong, becauſe the mutual hooks which this method forms on each beam are very apt to tear each other up. By one or other of theſe methods, or ſomething ſimilar, may a compound beam be formed, of any depth, which will be almoſt as ſtiff and ſtrong as an entire piece.

85
How ſtrength may be combined with pliableneſs.
Fig. 13.

On the other hand, we may combine ſtrength with pliableneſs, by compoſing our beam of ſeveral thin planks laid on each other, till they make a proper depth, and leaving them at full liberty to ſlide on each other. It is in this manner that coach-ſprings are formed, as is repreſented in fig. 13. In this aſſemblage there muſt be no joggles nor bolts of any kind put through the planks or plates; for this would hinder their mutual ſliding. They muſt be kept together by ſtraps which ſurround them, or by ſomething equivalent.

86
Maxims of conſtruction.

The preceding obſervations ſhow the propriety of ſome maxims of conſtruction, which the artiſts have derived from long experience.

Fig. 14. and 15.

Thus, if a mortiſe is to be cut out of a piece which is expoſed to a croſs ſtrain, it ſhould be cut out from that ſide which becomes concave by the ſtrain, as in fig. 14. but by no means as in fig. 15.

Fig. 16. and 17.

If a piece is to be ſtrengthened by the addition of another, the added piece muſt be joined to the ſide which grows convex by the ſtrain, as in fig. 16. and 17.

Fig. 17.

Before we go any farther, it will be convenient to recal the reader's attention to the analogy between the ſtrain on a beam projecting from a wall and loaded at the extremity, and a beam ſupported at both ends and loaded in ſome intermediate point. It is ſufficient on this occaſion to read attentively what is delivered in the article Roof, N° 19.—We learn there that the ſtrain on the middle point C (fig. 17. of the preſent article) of a rectangular beam AB, ſupported on props at A and B, is the ſame as if the part CA projected from a wall, and were loaded with the half of the weight W ſuſpended at A. The momentum of the ſtrain is therefore $\frac{1}{2}W\times\frac{1}{2}AB$, $=W\times\frac{1}{4}AB=p\frac{1}{4}l$, or $\frac{pl}{4}$. The momentum of coheſion muſt be equal to this in every hypotheſis.

Having now conſidered in ſufficient detail the circumſtances which affect the ſtrength of any ſection of a ſolid body that is ſtrained tranſverſely, it is neceſſary to take notice of ſome of the chief modifications of the ſtrain itſelf. We ſhall conſider only thoſe that occur moſt frequently in our conſtructions.

87
The ſtrain depends on the external force.

The ſtrain depends on the external force, and alſo on the lever by which it acts.

It is evidently of importance, that ſince the ſtrain is exerted in any ſection by means of the coheſion of the parts intervening between the ſection under conſideration and the point of application of the external force, the body muſt be able in all theſe intervening parts to propagate or excite the ſtrain in the remote ſection. In every part it muſt be able to reſiſt the ſtrain excited in that part. It ſhould therefore be equally ſtrong; and it is uſeleſs to have any part ſtronger, becauſe the piece will nevertheleſs break where it is not ſtronger throughout; and it is uſeleſs to make it ſtronger (relatively to its ſtrain) in any part, for it will nevertheleſs equally fail in the part that is too weak.

Fig. 18.

Suppoſe then, in the firſt place, that the ſtrain ariſes from a weight ſuſpended at one extremity, while the other end is firmly fixed in a wall. Suppoſing alſo the croſs ſections to be all rectangular, there are ſeveral ways of ſhaping the beam ſo that it ſhall be equally ſtrong throughout. Thus it may be equally deep in every part, the upper and under ſurfaces being horizontal planes. The condition will be fulfilled by making all the horizontal ſections triangles, as in fig. 18. The two ſides are vertical planes meeting in an edge at the extremity L. For the equation expreſſing the balance of ſtrain and ſtrength is $pl=fbd^2$. Therefore ſince d^2 is the ſame throughout, and alſo p, we muſt have $fb=l$, and b (the breadth AD of any ſection ABCD) muſt be proportional to l (or AL), which it evidently is.

Fig. 19.

Or, if the beam be of uniform breadth, we muſt have d^2 everywhere proportional to l. This will be obtained by making the depths the ordinates of a common parabola, of which L is the vertex and the length is the axis. The upper or under ſide may be a ſtraight line, as in fig. 19. or the middle line may be ſtraight, and then both upper and under ſurfaces will be curved. It is almoſt indifferent what is the ſhape of the upper and under ſurfaces, provided the diſtances between them in every part be as the ordinates of a common parabola.

Or, if the ſections are all ſimilar, ſuch as circles, ſquares, or any other ſimilar polygons, we muſt have d^3 or b^3 proportional to l, and the depths or breadths muſt be as the ordinates of a cubical parabola.

88
And on the form of the levers by which it acts.

It is evident that theſe are alſo the proper forms for a lever moveable round a fulcrum, and acted on by a force at the extremity. The force comes in the place of the weight ſuſpended in the caſes already conſidered; and as ſuch levers always are connected with another arm, we readily ſee that both arms ſhould be faſhioned in the ſame manner. Thus in fig. 18. the piece of timber may be ſuppoſed a kind of ſteelyard, moveable round a horizontal axis OP, in the front of the wall, and having the two weights P and π in equilibrio. The ſtrain occaſioned by each at the ſection in which the axis OP is placed muſt be the ſame, and each arm OL and O λ muſt be equally ſtrong in all its parts. The longitudinal ſections of each arm muſt be a triangle, a common parabola, or a cubic parabola, according to the conditions previouſly given.

And, moreover, all theſe forms are equally ſtrong: For any one of them is equally ſtrong in all its parts, and they are all ſuppoſed to have the ſame ſection at the front of the wall or at the fulcrum. They are not, however, equally ſtiff. The firſt, repreſented in fig. 18. will bend leaſt upon the whole, and the one formed by the cubic parabola will bend moſt. But their curvature at the very fulcrum will be the ſame in all.

It is alſo plain, that if the lever is of the ſecond or third kind, that is, having the fulcrum at one extremity, it muſt ſtill be of the ſame ſhape; for in abſtract mechanics it is indifferent which of the three points is conſidered as the axis of motion. In every lever the two forces at the extremities act in one direction, and the force in the middle acts in the oppoſite direction, and the great ſtrain is always at that point. Therefore a lever ſuch as fig. 18. moveable round an axis paſſing horizontally through λ, and acting againſt an obſtacle at OP, is equally able in all its parts to reſiſt the ſtrains excited in thoſe parts.

The ſame principles and the ſame conſtruction will apply to beams, ſuch as joiſts, ſupported at the ends L and λ (fig. 18.), and loaded at ſome intermediate part OP. This will appear evident by merely inverting the directions of the forces at theſe three points, or by recurring to the article Roofs, N° 19.

89
The external ſtraining force may be diſtributed over the beam.

Hitherto we have ſuppoſed the external ſtraining force as acting only in one point of the beam. But it may be uniformly diſtributed all over the beam. To make a beam in ſuch circumſtances equally ſtrong in all its parts, the ſhape muſt be conſiderably different from the former.

90
To make a beam ſtrong which projects from a wall.

Thus ſuppoſe the beam to project from a wall.

If it be of equal breadth throughout, its ſides being vertical planes parallel to each other and to the length, the vertical ſection in the direction of its length muſt be a triangle inſtead of a common parabola; for the weight uniformly diſtributed over the part lying beyond any ſection, is as the length beyond that ſection: and ſince it may all be conceived as collected at its centre of gravity, which is the middle of that length, the lever by which this load acts or ſtrains the ſection is alſo proportional to the ſame length. The ſtrain on the ſection (or momentum of the load) is as the ſquare of that length. The ſection muſt have ſtrength in the ſame proportion. Its ſtrength being as the breadth and the ſquare of the depth, and the breadth being conſtant, the ſquare of the depth of any ſection muſt be as the ſquare of its diſtance from the end, and the depth muſt be as that diſtance; and therefore the longitudinal vertical ſection muſt be a triangle.

But if all the tranſverſe ſections are circles, ſquares, or any other ſimilar figures, the ſtrength of every ſection, or the cube of the diameter, muſt be as the ſquare of the lengths beyond that ſection, or the ſquare of its diſtance from the end; and the ſides of the beam muſt be a ſemicubical parabola.

If the upper and under ſurfaces are horizontal planes, it is evident that the breadth muſt be as the ſquare of the diſtance from the end, and the horizontal ſections may be formed by arches of the common parabola, having the length for their tangent at the vertex.

By recurring to the analogy ſo often quoted between a projecting beam and a joiſt, we may determine the proper form of joiſts which are uniformly loaded through their whole length.

91
The ſtrain upon a beam ſupported at both ends.
Fig. 20.

This is a frequent and important caſe, being the office of joiſts, rafters, &c.; and there are ſome circumſtances which muſt be particularly noticed, becauſe they are not ſo obvious, and have been miſunderſtood. When a beam AB (fig. 20.) is ſupported at the ends, and a weight is laid on any point P, a ſtrain is excited in every part of the beam. The load on P cauſes the beam to preſs on A and B, and the props react with forces equal and oppoſite to theſe preſſures. The load at P is to the preſſures at A and B as AB to PB and PA, and the preſſure at A is to that at B as PB to PA; the beam therefore is in the ſame ſtate, with reſpect to ſtrain in every part of it, as if it were reſting on a prop at P, and were loaded at the ends with weights equal to the two preſſures on the props: and obſerve, theſe preſſures are ſuch as will balance each other, being inverſely as their diſtances from P. Let P repreſent the weight or load at P. The preſſure on the prop P muſt be $P \times \frac{PA}{AB}$. This is therefore the reaction of the prop B, and is the weight which we may ſuppoſe ſuſpended at B, when we conceive the beam reſting on a prop at P, and carrying the balancing weights at A and B.

The ſtrain occaſioned at any other point C, by the load P at P, is the ſame with the ſtrain at C, by the weight $P \times \frac{PA}{AB}$ hanging at B, when the beam reſts on P, in the manner now ſuppoſed; and it is the ſame if the beam, inſtead of being balanced on a prop at P, had its part AP fixed in a wall. This is evident. Now we have ſhown at length that the ſtrain at C, by the weight $P \times \frac{PA}{AB}$ hanging at B, is $P \times \frac{PA}{AB} \times BC$. We deſire it to be particularly remarked that the preſſure at A has no influence on the ſtrain at C, ariſing from the action of any load between A and C; for it is indifferent how the part AP of the projecting beam PB is ſupported. The weight at A juſt performs the ſame office with the wall in which we ſuppoſe the beam to be fixed. We are thus particular, becauſe we have ſeen even perſons not unaccuſtomed to diſcuſſions of this kind puzzled in their conceptions of this ſtrain.

Now let the load P be laid on ſome point p between C and B. The ſame reaſoning ſhows us that the point is (with reſpect to ſtrain) in the ſame ſtate as if the beam were fixed in a wall, embracing the part pB, and a weight $= P \times \frac{pB}{AB}$ were hung on at A, and the ſtrain at C is $P \times \frac{pB}{AB} \times AC$.

92
A general propoſition.

In general, therefore, the ſtrain on any point C, ariſing from a load P laid on another point P, is proportional to the rectangle of the diſtances of P and C from the ends neareſt to each. It is $P \times \frac{PA \times CB}{AB}$, or $P \times \frac{pB \times CA}{AB}$, according as the load lies between C and A or between C and B.

Cor. 1. The ſtrains which a load on any point P occaſions on the points C, *c*, lying on the ſame ſide of P, are as the diſtances of theſe points from the end B. In like manner the ſtrains on E and *e* are as EA and *e*A.

Cor. 2. The ſtrain which a load occaſions in the part on which it reſts is as the rectangle of the parts on each ſide. Thus the ſtrain occaſioned at C by a load is to that at D by the ſame load as AC × CB to AD × DB. It is therefore greateſt in the middle.

93
The ſtrain ariſing from a load diſtributed along the beam.

Let us now conſider the ſtrain on any point C ariſing from a load uniformly diſtributed along the beam. Let AP be repreſented by x, and Pp by $\dot{x}$, and the whole weight on the beam by a. Then

The weight on Pp is - $= a\frac{\dot{x}}{AB}$,

Preſſure

Preſſure on B by the weight on P $p = a \frac{\dot{x}}{AB} \times \frac{}{\overline{AB}}$

Or - - - - - $= a \frac{x\dot{x}}{AB^2}$.

Preſ. on B by whole wt. on $AC = a \frac{\frac{1}{2}AC^2}{AC^2} = a \frac{AC^2}{2\,AB^2}$.

Strain at C by the weight on $AC = a \frac{AC^2 \times BC}{2\,AB^2}$.

Strain at C by the weight on $BC = a \frac{BC^2 \times AC}{2\,AB^2}$.

Do. by whole wt. on $AB = a \frac{AC^2 \times BC + BC^2 \times AC}{2\,AB^2}$,

$= a \frac{AC \times BC \times \overline{AC + CB}}{2\,AB^2}, = a \frac{AC \times BC}{2\,AB}$.

Thus we ſee that the ſtrain is proportional to the rectangle of the parts, in the ſame manner as if the load *a* had been laid directly on the point C, and is indeed equal to one-half of the ſtrain which would be produced at C by the load *a* laid on there.

94
Miſtakes in this ſubject committed by authors of reputation.

It was neceſſary to be thus particular, becauſe we ſee in ſome elementary treatiſes of mechanics, publiſhed by authors of reputation, miſtakes which are very plauſible, and miſlead the learner. It is there ſaid, that the preſſure at B from a weight uniformly diffuſed along AB is the ſame as if it were collected at its centre of gravity, which would be the middle of AB; and then the ſtrain at C is ſaid to be this preſſure at B multiplied by BC. But ſurely it is not difficult to ſee the difference of theſe ſtrains. It is plain that the preſſure of gravity downwards on any point between the end A and the point C has no tendency to diminiſh the ſtrain at C, ariſing from the upward reaction of the prop B; whereas the preſſure of gravity between C and B is almoſt in direct oppoſition to it, and muſt diminiſh it. We may however avoid the fluxionary calculus with ſafety by the conſideration of the centre of gravity, by ſuppoſing the weights of AC and BC to be collected at their reſpective centres of gravity; and the reſult of this computation will be the ſame as above: and we may uſe either method, although the weight is not uniformly diſtributed, provided only that we know in what manner it is diſtributed.

This inveſtigation is evidently of importance in the practice of the engineer and architect, informing them what ſupport is neceſſary in the different parts of their conſtructions. We conſidered ſome caſes of this kind in the article ROOFS.

95
To form a joiſt which may have the ſame relative ſtrength in all its parts.

It is now eaſy to form a joiſt, ſo that it ſhall have the ſame relative ſtrength in all its parts.

I. To make it equally able in all its parts to carry a given weight laid on any point C taken at random, or uniformly diffuſed over the whole length, the ſtrength of the ſection at the point C muſt be as $AC \times CB$. Therefore

1. If the ſides are parallel vertical planes, the ſquare of the depth (which is the only variable dimenſion) or CD^2, muſt be as $AC \times CB$, and the depths muſt be ordinates of an ellipſe.

2. If the tranſverſe ſections are ſimilar, we muſt make CD^3 as $AC \times CB$.

3. If the upper and under ſurfaces are parallel, the breadth muſt be as $AC \times CB$.

II. If the beam is neceſſarily loaded at ſome given point C, and we would have the beam equally able in all its parts to reſiſt the ſtrain ariſing from the weight at C, we muſt make the ſtrength of every tranſverſe ſection between C and either end as its diſtance from that end. Therefore

1. If the ſides are parallel vertical planes, we muſt make $CD^2 : EF^2 = AC : AE$.

2. If the ſections are ſimilar, then $CD^3 : EF^3 = AC : AE$.

3. If the upper and under ſurfaces are parallel, then, breadth at C : breadth at E = AC : AE.

96
The ſtrain and ſtrength of ſquare or circular plates of different extent, but of equal thickneſs, may be determined from the ſame principles.

The ſame principles enable us to determine the ſtrain and ſtrength of ſquare or circular plates, of different extent, but equal thickneſs. This may be comprehended in this general propoſition.

Similar plates of equal thickneſs ſupported all round will carry the ſame abſolute weight, uniformly diſtributed, or reſting on ſimilar points, whatever is their extent.

Suppoſe two ſimilar oblong plates of equal thickneſs, and let their lengths and breadths be L, *l*, and B, *b*. Let their ſtrength or momentum of coheſion be C, *c*, and the ſtrains from the weights W, *w*, be S, *s*.

Suppoſe the plates ſupported at the ends only, and reſiſting fracture tranſverſely. The ſtrains, being as the weights and lengths, are as WL and wl, but their coheſions are as the breadths; and ſince they are of equal relative ſtrength, we have $WL : wl = B : b$, and $WLb = wlB$ and $L : l = wB : Wb$: but ſince they are of ſimilar ſhapes $L : l = B : b$, and therefore $w = W$.

The ſame reaſoning holds again when they are alſo ſupported along the ſides, and therefore holds when they are ſupported all round (in which caſe the ſtrength is doubled).

And if the plates are of any other figure, ſuch as circles or ellipſes, we need only conceive ſimilar rectangles inſcribed in them. Theſe are ſupported all around by the continuity of the plates, and therefore will ſuſtain equal weights; and the ſame may be ſaid of the ſegments which lie without them, becauſe the ſtrengths of any ſimilar ſegments are equal, their lengths being as their breadths.

Therefore the thickneſs of the bottoms of veſſels holding heavy liquors or grains ſhould be as their diameters, and as the ſquare root of their depths jointly.

Alſo the weight which a ſquare plate will bear is to that which a bar of the ſame matter and thickneſs will bear as twice the length of the bar to its breadth.

97
The ſtrain of a beam ariſing from its own weight.

There is yet another modification of the ſtrain which tends to break a body tranſverſely, which is of very frequent occurrence, and in ſome caſes muſt be very carefully attended to, viz. the ſtrain ariſing from its own weight.

When a beam projects from a wall, every ſection is ſtrained by the weight of all that projects beyond it. This may be conſidered as all collected at its centre of gravity. Therefore the ſtrain on any ſection is in the joint ratio of the weight of what projects beyond it, and the diſtance of its centre of gravity from the ſection.

The determination of this ſtrain and of the ſtrength neceſſary for withſtanding it muſt be more complicated than the former, becauſe the form of the piece which reſults from this adjuſtment of ſtrain and ſtrength influences

ences the ſtrain. The general principle muſt evidently be, that the ſtrength or momentum of coheſion of every ſection muſt be as the product of the weight beyond it multiplied by the diſtance of its centre of gravity. For example:

98
General principle reſpecting it.
Fig. 21.

Suppoſe the beam DLA (fig. 21.) to project from the wall, and that its ſides are parallel vertical planes, ſo that the depth is the only variable dimenſion. Let LB$=x$ and B$b=y$. The element B$b$$c$C is $=y.\dot{x}$. Let G be the centre of gravity of the part lying without Bb, and g be its diſtance from the extremity L. Then $x-g$ is the arm of the lever by which the ſtrain is excited in the ſection Bb. Let Bb or y be as ſome power m of LB; that is, let $y=x^m$. Then the contents of LBb is $\frac{x^{m+1}}{m+1}$. The momentum of gravity round a horizontal axis at L is $y x \dot{x}=x^{m+1}\dot{x}$, and the whole momentum round the axis is $\frac{x^{m+2}}{m+2}$. The diſtance of the centre of gravity from L is had by dividing this momentum by the whole weight which is $\frac{x^{m+1}}{m+1}$. The quotient or g is $\frac{x\times\overline{m+1}}{m+2}$. And the diſtance of the centre of gravity from the ſection Bb is $x-\frac{x\times m+1}{m+2}$, $=\frac{x\times\overline{m+2}-x\times\overline{m+1}}{m+2}$, $=\frac{x}{m+2}$. Therefore the ſtrain on the ſection Bb is had by multiplying $\frac{x^{m+1}}{m+1}$ by $\frac{x}{m+2}$. The product is $\frac{x^{m+2}}{\overline{m+2}\times\overline{m+1}}$. This muſt be as the ſquare of the depth, or as y^2. But y is as x^m, and y^2 as x^{2m}. Therefore we have $m+2=2m$, and $m=2$; that is, the depth muſt be as the ſquare of the diſtance from the extremity, and the curve LbA is a parabola touching the horizontal line in L.

99
A conoid equally able in every ſection to bear its own weight.

It is eaſy to ſee that a conoid formed by the rotation of this figure round DL will alſo be equally able in every ſection to bear its own weight.

We need not proſecute this farther. When the figure of the piece is given, there is no difficulty in finding the ſtrain; and the circumſtance of equal ſtrength to reſiſt this ſtrain is chiefly a matter of curioſity.

100
The more a beam projects, the leſs able it is to bear its own weight.

It is evident, from what has been already ſaid, that a projecting beam becomes leſs able to bear its own weight, as it projects farther. Whatever may be the ſtrength of the ſection DA, the length may be ſuch that it will break by its own weight. If we ſuppoſe two beams A and B of the ſame ſubſtance and ſimilar ſhapes, that is, having their lengths and diameters in the ſame proportion; and farther ſuppoſe that the ſhorter can juſt bear its own weight; then the longer beam will not be able to do the ſame: For the ſtrengths of the ſections are as the cubes of the diameters, while the ſtrains are as the biquadrates of the diameters; becauſe the weights are as the cubes, and the levers by which theſe weights act in producing the ſtrain are as the lengths or as the diameters.

101
Small bodies more able to withſtand the ſtrain produced by the weight of the machine than great bodies.

Theſe conſiderations ſhow us, that in all caſes where ſtrain is affected by the weight of the parts of the machine or ſtructure of any kind, the ſmaller bodies are more able to withſtand it than the greater; and there ſeems to be bounds ſet by nature to the ſize of machines conſtructed of any given materials. Even when the weight of the parts of the machine is not taken into the account, we cannot enlarge them in the ſame proportion in all their parts. Thus a ſteam-engine cannot be doubled in all its parts, ſo as to be ſtill efficient. The preſſure on the piſton is quadrupled. If the lift of the pump be alſo doubled in height while it is doubled in diameter, the load will be increaſed eight times, and will therefore exceed the power. The depth of lift therefore, muſt remain unchanged; and in this caſe the machine will be of the ſame relative ſtrength as before, independent of its own weight. For the beam being doubled in all its dimenſions, its momentum of coheſion is eight times greater, which is again a balance for a quadruple load acting by a double lever.—But if we now conſider the increaſe of the weight of the machine itſelf, which muſt be ſupported, and which muſt be put in motion by the intervention of its coheſion, we ſee that the large machine is weaker and leſs efficient than the ſmall one.

There is a ſimilar limit ſet by nature to the ſize of plants and animals formed of the ſame matter. The coheſion of an herb could not ſupport it if it were increaſed to the ſize of a tree, nor could an oak ſupport itſelf if 40 or 50 times bigger, nor could an animal of the make of a long-legged ſpider be increaſed to the ſize of a man; the articulations of its legs could not ſupport it.

102
Even ſmall animals are remarkable for ſtrength and agility.

Hence may be underſtood the prodigious ſuperiority of the ſmall animals both in ſtrength and agility. A man by falling twice his own height may break his firmeſt bones. A mouſe may fall 20 times its height without riſk; and even the tender mite or wood-louſe may fall unhurt from the top of a ſteeple. But their greateſt ſuperiority is in reſpect of nimbleneſs and agility. A flea can leap above 500 times its own length, while the ſtrength of the human muſcles could not raiſe the trunk from the ground on limbs of the ſame conſtruction.

The angular motions of ſmall animals (in which conſiſts their nimbleneſs or agility) muſt be greater than thoſe of large animals, ſuppoſing the force of the muſcular fibre to be the ſame in both. For ſuppoſing them ſimilar, the number of equal fibres will be as the ſquare of their linear dimenſions; and the levers by which they act are as their linear dimenſions. The energy therefore of the moving force is as the cube of theſe dimenſions. But the momentum of inertia, or $\int p.r^2$, is as the 4th power: Therefore the angular velocity of the greater animals is ſmaller. The number of ſtrokes which a fly makes with its wings in a ſecond is aſtoniſhingly great; yet, being voluntary, they are the effects of its agility.

We have hitherto confined our attention to the ſimpleſt form in which this tranſverſe ſtrain can be produced. This was quite ſufficient for ſhowing us the mechaniſm of nature by which the ſtrain is reſiſted; and a very ſlight attention is ſufficient for enabling us to reduce to this every other way in which the ſtrain can be produced. We ſhall not take up the reader's time with the application of the ſame principles to other caſes of this ſtrain, but refer him to what has been ſaid in the article ROOFS. In that article we have ſhown the analogy between the ſtrain on the ſection of a beam projecting from a wall and loaded at the extremity, and the ſtrain

Fig. 22.

103 Effects of the obliquity of the external force.

ſtrain on the ſame ſection of a beam ſimply reſting on ſupports at the ends, and loaded at ſome intermediate point or points. The ſtrain on the middle C of a beam AB (fig. 22.) ſo ſupported, ariſing from a weight laid on there, is the ſame with the ſtrain which half that weight hanging at B would produce on the ſame ſection C if the other end of the beam were fixed in a wall. If therefore 1000 pounds hung on the end of a beam projecting 10 feet from a wall will juſt break it at the wall, it will require 4000 pounds on its middle to break the ſame beam reſting on two props 10 feet aſunder. We have alſo ſhown in that article the additional ſtrength which will be given to this beam by extending both ends beyond the props, and there framing it firmly into other pillars or ſupports. We can hardly add any thing to what has been ſaid in that article, except a few obſervations on the effects of the obliquity of the external force. We have hitherto ſuppoſed it to act in the direction BP (fig. 8.) perpendicular to the length of the beam. Suppoſe it to act in the direction BP′, oblique to BA. In the article Roof we ſuppoſed the ſtrain to be the ſame as if the force *p* acted at the diſtance AB′, but ſtill perpendicular to AB: ſo it is. But the ſtrength of the ſection AΔ is not the ſame in both caſes; for by the obliquity of the action the piece DCKΔ is preſſed to the other. We are not ſufficiently acquainted with the corpuſcular forces to ſay preciſely what will be the effect of the preſſure ariſing from this obliquity; but we can clearly ſee, in general, that the point A, which in the inſtant of fracture is neither ſtretched nor compreſſed, muſt now be farther up, or nearer to D; and therefore the number of particles which are exerting coheſive forces is ſmaller, and therefore the ſtrength is diminiſhed. Therefore, when we endeavour to proportion the ſtrength of a beam to the ſtrain ariſing from an external force acting obliquely, we make too liberal allowance by increaſing this external force in the ratio of AB to AB. We acknowledge our inability to aſſign the proper correction. But this circumſtance is of very great influence. In many machines, and many framings of carpentry, this oblique action of the ſtraining force is unavoidable; and the moſt enormous ſtrains to which materials are expoſed are generally of this kind. In the frames ſet up for carrying the ringſtones of arches, it is hardly poſſible to avoid them: for although the judicious engineer diſpoſes his beams ſo as to ſuſtain only preſſures in the direction of their lengths, tending either to cruſh them or to tear them aſunder, it frequently happens that, by the ſettling of the work, the pieces come to check and bear on each other tranſverſely, tending to break each other acroſs. This we have remarked upon in the article Roofs, with reſpect to a truſs by Mr Price (ſee Roofs, N° 40, 41, 45.). Now when a croſs ſtrain is thus combined with an enormous preſſure in the direction of the length of the beam, it is in the utmoſt danger of ſnapping ſuddenly acroſs. This is one great cauſe of the carrying away of maſts. They are compreſſed in the direction of their length by the united force of the ſhrouds, and in this ſtate the tranſverſe action of the wind ſoon completes the fracture.

104 The ſtrain on columns.

When conſidering the compreſſing ſtrains to which materials are expoſed, we deferred the diſcuſſion of the ſtrain on columns, obſerving that it was not, in the caſes which uſually occur, a ſimple compreſſion, but was combined with a tranſverſe ſtrain, ariſing from the bending of the column. When the column ACB (fig. 23.) reſting on the ground at B, and loaded at top with a weight A, acting in the vertical direction AB, is bent into a curve ACB, ſo that the tangent at C is perpendicular to the horizon, its condition ſomewhat reſembles that of a beam firmly fixed between B and C, and ſtrongly pulled by the end A, ſo as to bend it between C and A. Although we cannot conceive how a force acting on a ſtraight column AB in the direction AB can bend it, we may ſuppoſe that the force acted firſt in the horizontal direction A *b* till it was bent to this degree, and that the rope was then gradually removed from the direction A *b* to the direction AB, increaſing the force as much as is neceſſary for preſerving the ſame quantity of flexure.

Fig. 23.

105 Obſervations on Euler's theory of the ſtrength of columns.

The firſt author (we believe) who conſidered this important ſubject with ſcrupulous attention was the celebrated Euler, who publiſhed in the Berlin Memoirs for 1757 his Theory of the Strength of Columns. The general propoſition eſtabliſhed by this theory is, that the ſtrength of priſmatical columns is in the direct quadruplicate ratio of their diameters, and the inverſe duplicate ratio of their lengths. He proſecuted this ſubject in the Peterſburgh Commentaries for 1778, confirming his former theory. We do not find that any other author has beſtowed much attention on it, all ſeeming to acquieſce in the determinations of Euler, and to conſider the ſubject as of very great difficulty, requiring the application of the moſt refined mathematics. Muſchenbrock has compared the theory with experiment; but the compariſon has been very unſatisfactory, the difference from the theory being ſo enormous as to afford no argument for its juſtneſs. But the experiments do not contradict it, for they are ſo anomalous as to afford no concluſion or general rule whatever.

To ſay the truth, the theory can be conſidered in no other light than as a ſpecimen of ingenious and very artful algebraic analyſis. Euler was unqueſtionably the firſt analyſt in Europe for reſource and addreſs. He knew this, and enjoyed his ſuperiority, and without ſcruple admitted any phyſical aſſumptions which gave him an opportunity of diſplaying his ſkill. The inconſiſtency of his aſſumptions with the known laws of mechaniſm gave him no concern; and when his algebraic proceſſes led him to any concluſion which would make his readers ſtare, being contrary to all our uſual notions, he frankly owned the paradox, but went on in his analyſis, ſaying, "*Sed analyſi magis fidendum.*" Mr Robins has given ſome very riſible inſtances of this confidence in his analyſis, or rather of his confidence in the indolent ſubmiſſion of his readers. Nay, ſo fond was he of this kind of amuſement, that after having publiſhed an untenable Theory of Light and Colours, he publiſhed ſeveral Memoirs, explaining the aberration of the heavenly bodies, and deducing ſome very wonderful conſequences, fully confirmed by experience, from the Newtonian principles, which were oppoſite and totally inconſiſtent with his own theory, merely becauſe the Newtonian theory gave him "*occaſionem analyſeos promovendæ.*" We are thus ſevere in our obſervations, becauſe his theory of the ſtrength of columns is one of the ſtrongeſt inſtances of this wanton kind of proceeding, and becauſe his followers in the Academy of St Peterſburgh, ſuch as Mr Fuſs, Lexill, and others, adopt his concluſions, and merely echo his words. Since the death of Daniel

Bernoulli

Bernoulli no member of that academy has controverted any thing advanced by their *Profeſſor ſublimis geometriæ*, to whom they had been indebted for their places and for all their knowledge, having been (moſt of them) his amanuenſes, employed by this wonderful man during his blindneſs to make his computations and carry on his algebraic inveſtigations. We are not a little ſurpriſed to ſee Mr Emerſon, a conſiderable mathematician, and a man of very independent ſpirit, haſtily adopting the ſame theory, of which we doubt not but our readers will eaſily ſee the falſity.

Fig. 23.

Euler conſiders the column ACB as in a condition preciſely ſimilar to that of an elaſtic rod bent into the curve by a cord AB connecting its extremities.—In this he is not miſtaken.—But he then draws CD perpendicular to AB, and conſiders the ſtrain on the ſection C as equal to the momentum or mechanical energy of the weight A acting in the direction DB upon the lever *x c* D, moveable round the fulcrum *c*, and tending to tear aſunder the particles which cohere along the ſection *c* C *x*. This is the ſame principle (as Euler admits) employed by James Bernoulli in his inveſtigation of the elaſtic curve ACB. Euler conſiders the ſtrain on the ſection *cx* as the ſame with what it would ſuſtain if the ſame power acted in the horizontal direction EF on a point E as far removed from C as the point D is. We reaſoned in the ſame manner (as has been obſerved) in the article ROOFS, where the obliquity of action was inconſiderable. But in the preſent caſe, this ſubſtitution leads to the greateſt miſtakes, and has rendered the whole of this theory falſe and uſeleſs. It would be juſt if the column were of materials which are incompreſſible. But it is evident, by what has been ſaid above, that by the compreſſion of the parts the real fulcrum of the lever ſhifts away from the point *c*, ſo much the more as the compreſſion is greater. In the great compreſſions of loaded columns, and the almoſt unmeaſurable compreſſions of the truſs beams in the centres of bridges, and other caſes of chief importance, the fulcrum is ſhifted far over towards *x*, ſo that very few fibres reſiſt the fracture by their coheſion; and theſe few have a very feeble energy or momentum, on account of the ſhort arm of the lever by which they act. This is a moſt important conſideration in carpentry, yet makes no element of Euler's theory. The conſequence of this is, that a very ſmall degree of curvature is ſufficient to cauſe the column or ſtrutt to ſnap in an inſtant, as is well known to every experienced carpenter. The experiment by Muſchenbroek, which Euler makes uſe of in order to obtain a meaſure of ſtrength in a particular inſtance, from which he might deduce all others by his theorem, is an inconteſtable proof of this. The force which broke the column is not the twentieth part of what is neceſſary for breaking it by acting at E in the direction EF. Euler takes no notice of this immenſe diſcrepancy, becauſe it muſt have cauſed him to abandon the ſpeculation with which he was then amuſing himſelf.

106
This theory falſe and uſeleſs.

The limits of this work do not afford room to enter minutely upon the refutation of this theory; but we can eaſily ſhow its uſeleſsneſs, by its total inconſiſtency with common obſervation. It reſults legitimately from this theory, that if CD have no magnitude, the weight A can have no momentum, and the column cannot be broken —True,—it cannot be broken in this way, ſnapped by a tranſverſe fracture, if it do not bend; but we know very well that it can be cruſhed or crippled, and we ſee this frequently happen. This circumſtance or event does not enter into Euler's inveſtigation, and therefore the theory is imperfect at leaſt and uſeleſs. Had this crippling been introduced in the form of a phyſical aſſumption, every topic of reaſoning employed in the proceſs muſt have been laid aſide, as the intelligent reader will eaſily ſee. But the theory is not only imperfect, but falſe. The ordinary reader will be convinced of this by another legitimate conſequence of it. Fig. 24. is the ſame with fig. 106. of *Emerſon's Mechanics*, where this ſubject is treated on Euler's principles, and repreſents a crooked piece of matter reſting on the ground at F, and loaded at A with a weight acting in the vertical direction AF. It reſults from Euler's theory that the ſtrains at *b*, B, D, E, &c. are as *bc*, BC, DI, EK, &c. Therefore the ſtrains at G and H are nothing; and this is aſſerted by Emerſon and Euler as a ſerious truth; and the piece may be thinned *ad infinitum* in theſe two places, or, even cut through, without any diminution of its ſtrength. The abſurdity of this aſſertion ſtrikes at firſt hearing. Euler aſſerts the ſame thing with reſpect to a point of contrary flexure. Farther diſcuſſion is (we apprehend) needleſs.

Fig. 24.

107
Yet Euler' diſſertations deſerve a peruſal.

This theory muſt therefore be given up. Yet theſe diſſertations of Euler in the Peterſburgh Commentaries deſerve a peruſal, both as very ingenious ſpecimens of analyſis, and becauſe they contain maxims of practice which are important. Although they give an erroneous meaſure of the comparative ſtrength of columns, they ſhow the immenſe importance of preventing all bendings, and point out with accuracy where the tendencies to bend are greateſt, and how this may be prevented by very ſmall forces, and what a prodigious acceſſion of force this gives the column. There is a valuable paper in the ſame volume by Fuſs *on the Strains on framed Carpentry*, which may alſo be read with advantage.

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A new theory cannot be ſubſtituted in place of Euler's, till many experiments be made.

It will now be aſked, what ſhall be ſubſtituted in place of this erroneous theory? what is the true proportion of the ſtrength of columns? We acknowledge our inability to give a ſatisfactory anſwer. Such can be obtained only by a previous knowledge of the proportion between the extenſions and compreſſions produced by equal forces, by the knowledge of the abſolute compreſſions producible by a given force, and by a knowledge of the degree of that derangement of parts which is termed crippling. Theſe circumſtances are but imperfectly known to us, and there lies before us a wide field of experimental inquiry. Fortunately the force requiſite for crippling a beam is prodigious, and a very ſmall lateral ſupport is ſufficient to prevent that bending which puts the beam in imminent danger. A judicious engineer will always employ tranſverſe bridles, as they are called, to ſtay the middle of long beams, which are employed as pillars, ſtrutts, or truſs beams, and are expoſed, by their poſition, to enormous preſſures in the direction of their lengths. Such ſtays may be obſerved, diſpoſed with great judgment and economy, in the centres employed by Mr Perronet in the erection of his great ſtone arches. He was obliged to correct this omiſſion made by his ingenious predeceſſor in the beautiful centres of the bridge of Orleans, which we have no heſitation in affirming to be the fineſt piece of carpentry in the world.

It

It only remains on this head to compare theſe theoretical deductions with experiment.

Experiments on the tranſverſe ſtrength of bodies are eaſily made, and accordingly are very numerous, eſpecially thoſe made on timber, which is the caſe moſt common and moſt intereſting. But in this great number of experiments there are very few from which we can draw much practical information. The experiments have in general been made on ſuch ſmall ſcantlings, that the unavoidable natural inequalities bear too great a proportion to the ſtrength of the whole piece. Accordingly, when we compare the experiments of different authors, we find them differ enormouſly, and even the experiments by the ſame author are very anomalous. The completeſt ſeries that we have yet ſeen is that detailed by Belidor in his *Science des Ingenieurs*. They are contained in the following table. The pieces were ſound, even-grained oak. The column *b* contains the breadths of the pieces in inches; the column *d* contains their depths; the column *l* contains their lengths; column *p* contains the weights (in pounds) which broke them when hung on their middles; and *m* is the column of averages or mediums.

109 Table of experiments made by Belidor.

N°	*b*	*d*	*l*	*p*	*m*	
1	1	1	18	400 415 405	406	The ends lying looſe.
2	1	1	18	600 600 624	608	The ends firmly fixed.
3	2	1	18	810 795 812	805	Looſe.
4	1	2	18	1570 1580 1590	1580	Looſe.
5	1	1	36	185 195 180	187	Looſe.
6	1	1	36	285 280 285	283	Fixed.
7	2	2	36	1550 1620 1585	1585	Looſe.
8	$2\frac{1}{3}$	$2\frac{1}{3}$	36	1665 1675 1640	1660	Looſe.

110 Corollaries deduced from them.

By comparing Experiments 1ſt and 3d, the ſtrength appears proportional to the breadth.

Experiments 3d and 4th ſhew the ſtrength proportional to the ſquare of the depth.

Experiments 1ſt and 5th ſhew the ſtrength nearly in the inverſe proportion of the lengths, but with a ſenſible deficiency in the longer pieces.

Experiments 5th and 7th ſhew the ſtrengths proportional to the breadths and the ſquare of the depth.

Experiments 1ſt and 7th ſhew the ſame thing, compounded with the inverſe proportion of the length: the deficiency relative to the length is not ſo remarkable here.

Experiments 1ſt and 2d, and experiments 5th and 6th ſhew the increaſe of ſtrength, by faſtening the ends, to be in the proportion of 2 to 3. The theory gives the proportion of 2 to 4. But a difference in the manner of fixing may produce this deviation from the theory, which only ſuppoſed them to be held down at places beyond the props, as when a joiſt is held in the walls, and alſo reſts on two pillars between the walls. (See what is ſaid on this ſubject in the article Roof, § 19.); where note, that there is a miſtake, when it is ſaid that a beam ſupported at both ends and loaded in the middle, will carry twice as much as if one end were fixed in the wall and the weight ſuſpended at the other end. The reaſoning employed there ſhows that it will carry four times as much.

The chief ſource of irregularity in ſuch experiments is the fibrous, or rather plated texture of timber. It conſiſts of annual additions, whoſe coheſion with each other is vaſtly weaker than that of their own fibres. Let fig. 25. repreſent the ſection of a tree, and ABCD, *a b c d* the ſection of two battens that are to be cut out of it for experiment, and let AD and *a d* be the depths, and DC, *d c* the breadths. The batten ABCD will be the ſtrongeſt, for the ſame reaſon that an aſſemblage of planks ſet edgewiſe will form a ſtronger joiſt than planks laid above each other like the plates of a coach-ſpring. M. Buffon found by many trials that the ſtrength of ABCD was to that of *a b c d* (in oak) nearly as 8 to 7. The authors of the different experiments were not careful that their battens had their plates all diſpoſed ſimilarly with reſpect to the ſtrain. But even with this precaution they would not have afforded ſure grounds of computation for large works; for great beams occupy much, if not the whole, of the ſection of the tree; and from this it has happened that their ſtrength is leſs than in proportion to that of a ſmall lath or batten. In ſhort, we can truſt no experiments but ſuch as have been made on large beams. Theſe muſt be very rare, for they are moſt expenſive and laborious, and exceed the abilities of moſt of thoſe who are diſpoſed to ſtudy this matter.

Fig. 25.

But we are not wholly without ſuch authority. M. Buffon and M. Du Hamel, two of the firſt philoſophers and mechanicians of the age, were directed by government to make experiments on this ſubject, and were ſupplied with ample funds and apparatus. The relation of their experiments is to be found in the Memoirs of the French Academy for 1740, 1741, 1742, 1768; as alſo in Du Hamel's valuable performances *ſur l'Exploitation des Arbres, et ſur la Conſervation et le Tranſport de Bois*. We earneſtly recommend theſe diſſertations to the peruſal of our readers, as containing much uſeful information relative to the ſtrength of timber, and the beſt methods of employing it. We ſhall here give an abſtract of M. Buffon's experiments.

111
Mr Buffon's experiments on bars of ſound oak.

He relates a great number which he had proſecuted during two years on ſmall battens. He found that the odds of a ſingle layer, or part of a layer, more or leſs, or even a different diſpoſition of them, had ſuch influence that he was obliged to abandon this method, and to have recourſe to the largeſt beams that he was able to break. The following table exhibits one ſeries of experiments on bars of ſound oak, clear of knots, and four inches ſquare. This is a ſpecimen of all the reſt.

Column 1ſt is the length of the bar in clear feet between the ſupports.

Column 2d is the weight of the bar (the 2d day after it was felled) in pounds. Two bars were tried of each length. Each of the firſt three pairs conſiſted of two cuts of the ſame tree. The one next the root was always found the heavieſt, ſtiffeſt, and ſtrongeſt. Indeed M. Buffon ſays that this was invariably true, that the heavieſt was always the ſtrongeſt; and he recommends it as a certain (or ſure) rule for the choice of timber. He finds that this is always the caſe when the timber has grown vigorouſly, forming very thick annual layers. But he alſo obſerves that this is only during the advances of the tree to maturity; for the ſtrength of the different circles approaches gradually to equality during the tree's healthy growth, and then it decays in theſe parts in a contrary order. Our tool-makers aſſert the ſame thing with reſpect to beech: yet a contrary opinion is very prevalent; and wood with a fine, that is, a ſmall grain, is frequently preferred. Perhaps no perſon has ever made the trial with ſuch minuteneſs as M. Buffon, and we think that much deference is due to his opinion.

Column 3d is the number of pounds neceſſary for breaking the tree in the courſe of a few minutes.

Column 4th is the inches which it bent down before breaking.

Column 5th is the time at which it broke.

1	2	3	4	5
7	60 56	5350 5275	3.5 4.5	29 22
8	68 63	4600 4500	3.75 4.7	15 13
9	77 71	4100 3950	4.85 5.5	14 12
10	84 82	3625 3600	5.83 6.5	15 15
12	100 98	3050 2925	7. 8.	

The experiments on other ſizes were made in the ſame way. A pair at leaſt of each length and ſize was taken. The mean reſults are contained in the following table. The beams were all ſquare, and their ſizes in inches are placed at the head of the columns, and their lengths in feet are in the firſt column.

	4	5	6	7	8	A
7	5312	11525	18950	32200	47649	11525
8	4550	9787	15525	26050	39750	10085
9	4025	8308	13150	22350	32800	8964
10	3612	7125	11250	19475	27750	8068
12	2987	6075	9100	16175	23450	6723
14		5300	7475	13225	19775	5763
16		4350	6362	11000	16375	5042
18		3700	5562	9245	13200	4482
20		3225	4950	8375	11487	4034
22		2975				3667
24		2162				3362
28		1775				2881

M. Buffon had found by numerous trials that oak-timber loſt much of its ſtrength in the courſe of drying or ſeaſoning; and therefore, in order to ſecure uniformity, his trees were all felled in the ſame ſeaſon of the year, were ſquared the day after, and tried the third day. Trying them in this green ſtate, gave him an opportunity of obſerving a very curious and unaccountable phenomenon. When the weights were laid briſkly on, nearly ſufficient to break the log, a very ſenſible ſmoke was obſerved to iſſue from the two ends with a ſharp hiſſing noiſe. This continued all the while the tree was bending and cracking. This ſhows that the log is affected or ſtrained through its whole length; indeed this muſt be inferred from its bending through its whole length. It alſo ſhows us the great effects of the compreſſion. It is a pity M. Buffon did not take notice whether this ſmoke iſſued from the upper or compreſſed half of the ſection only, or whether it came from the whole.

112
Obſervations on Mr Buffon's experiments.

We muſt now make ſome obſervations on theſe experiments, in order to compare them with the theory which we have endeavoured to eſtabliſh.

M. Buffon conſiders the experiments with the 5-inch bars as the ſtandard of compariſon, having both extended theſe to greater lengths, and having tried more pieces of each length.

Our theory determines the relative ſtrength of bars of the ſame ſection to be inverſely as their lengths. But (if we except the five experiments in the firſt column) we find a very great deviation from this rule. Thus the 5-inch bar of 28 feet long ſhould have half the ſtrength of that of 14 feet, or 2650; whereas it is but 1775. The bar of 14 feet ſhould have half the ſtrength of that of 7 feet, or 5762; whereas it is but 5300. In like manner, the fourth of 11525 is 2881; but the real ſtrength of the 28 feet bar is 1775. We have added a column A, which exhibits the ſtrength which each of the 5-inch bars ought to have by the theory. This deviation is moſt diſtinctly ſeen in fig. 26. where BK is the ſcale of lengths, B being at the point 7 of the ſcale, and K at 28. The ordinate CB is $=11525$, and the other ordinates DE, GK, &c. are reſpectively $=\frac{7\,CB}{\text{Length}}$. The lines DF, GH, &c. are made $=4350$, 1775, &c. expreſſing the ſtrengths given by experiment. The 10 feet bar and the 24 feet bar are remarkably anomalous. But all are deficient, and the defect has an evident progreſſion from the firſt to the laſt. The ſame thing may

Fig. 26.

be

be ſhown of the other columns, and even of the firſt, though it is very ſmall in that column. It may alſo be obſerved in the experiments of Belidor, and in all that we have ſeen. We cannot doubt therefore of its being a law of nature, depending on the true principles of coheſion, and the laws of mechanics.

But it is very puzzling, and we cannot pretend to give a ſatisfactory explanation of the difficulty. The only effect which we can conceive the length of a beam to have, is to increaſe the ſtrain at the ſection of fracture by employing the intervening beam as a lever. But we do not diſtinctly ſee what change this can produce in the mode of action of the fibres in this ſection, ſo as either to change their coheſion or the place of its centre of effort: yet ſomething of this kind muſt happen.

We ſee indeed ſome circumſtances which muſt contribute to make a ſmaller weight ſufficient, in Mr Buffon's experiments, to break a long beam, than in the exact inverſe proportion of its length.

In the firſt place, the weight of the beam itſelf augments the ſtrain as much as if half of it were added in form of a weight. Mr Buffon has given the weights of every beam on which he made experiments, which is very nearly 74 pounds per cubic foot. But they are much too ſmall to account for the deviation from the theory. The half weights of the 5-inch beams of 7, 14, and 28 feet length are only 45, 92, and 182 pounds; which makes the real ſtrains in the experiments 11560, 5390, and 1956; which are far from having the proportions of 4, 2, and 1.

Buffon ſays that healthy trees are univerſally ſtrongeſt at the root end; therefore, when we uſe a longer beam, its middle point, where it is broken in the experiment, is in a weaker part of the tree. But the trials of the 4-inch beams ſhow that the difference from this cauſe is almoſt inſenſible.

113
Probable that the relative ſtrength of beams decreaſes faſter than in the inverſe ratio of their length.

The length muſt have ſome mechanical influence which the theory we have adopted has not yet explained. It may not however be inadequate to the taſk. The very ingenious inveſtigation of the elaſtic curve by James Bernoulli and other celebrated mathematicians is perhaps as refined an application of mathematical analyſis as we know. Yet in this inveſtigation it was neceſſary, in order to avoid almoſt inſuperable difficulties, to take the ſimpleſt poſſible caſe, viz. where the thickneſs is exceedingly ſmall in compariſon with the length. If the thickneſs be conſiderable, the quantities neglected in the calculus are too great to permit the concluſion to be accurate, or very nearly ſo. Without being able to define the form into which an elaſtic body of conſiderable thickneſs will be bent, we can ſay with confidence, that in an extreme caſe, where the compreſſion in the concave ſide is very great, the curvature differs conſiderably from the Bernoullian curve. But as our inveſtigation is incomplete and very long, we do not offer it to the reader. The following more familiar conſiderations will, we apprehend, render it highly probable that the relative ſtrength of beams decreaſes faſter than in the inverſe ratio of their length. The curious obſervation by Mr Buffon of the vapour which iſſued with a hiſſing noiſe from the ends of a beam of green oak, while it was breaking by the load on its middle, ſhows that the whole length of the piece was affected: indeed it muſt be, ſince it is bent throughout. We have ſhown above, that a certain definite curvature of a beam of a given form is always accompanied by rupture. Now ſuppoſe the beam A of 10 feet long, and the beam B of 20 feet long, bent to the ſame degree, at the place of their fixture in the wall; the weight which hangs on A is nearly double of that which muſt hang on B. The form of any portion, ſuppoſe 5 feet, of theſe two beams, immediately adjoining to the wall, is conſiderably different. At the diſtance of 5 feet the curvature of A is $\frac{1}{2}$ of its curvature at the wall. The curvature of B in the correſponding point is $\frac{3}{4}$ths of the ſame curvature at the wall. Through the whole of the intermediate 5 feet, therefore, the curvature of B is greater than that of A. This muſt make it weaker throughout. It muſt occaſion the fibres to ſlide more on each other (that it may acquire *this* greater curvature), and thus affect their lateral union; and therefore thoſe which are ſtronger will not aſſiſt their weaker neighbours. To this we muſt add, that in the ſhorter beams the force with which the fibres are preſſed laterally on each other is double. This muſt impede the mutual ſliding of the fibres which we mentioned a little ago; nay, this lateral compreſſion may change the law of longitudinal coheſion (as will readily appear to the reader who is acquainted with Boſcovich's doctrines), and increaſe the ſtrength of the very ſurface of fracture, in the ſame way (however inexplicable) as it does in metals when they are hammered or drawn into wire.

The reader muſt judge how far theſe remarks are worthy of his attention. The engineer will carefully keep in mind the important fact, that a beam of quadruple length, inſtead of having $\frac{1}{4}$th of the ſtrength, has only about $\frac{1}{6}$th; and the philoſopher ſhould endeavour to diſcover the cauſe of this diminution, that he may give the artiſt a more accurate rule of computation.

114
We cannot diſcover the preciſe relation between the curvature and the momentum of coheſion.

Our ignorance of the law by which the coheſion of the particles changes by a change of diſtance, hinders us from diſcovering the preciſe relation between the curvature and the momentum of coheſion; and all we can do is to multiply experiments, upon which we may eſtabliſh ſome *empirical* rules for calculating the ſtrength of ſolids. Thoſe from which we muſt reaſon at preſent are too few and too anomalous to be the foundation of ſuch an empirical formula. We may, however, obſerve, that Mr Buffon's experiments give us conſiderable aſſiſtance in this particular: For if to each of the numbers of the column for the 5-inch beams, corrected by adding half the weight of the beam, we add the conſtant number 1245, we ſhall have a ſet of numbers which are very nearly reciprocals of the lengths. Let 1245 be called c, and let the weight which is known by experiment to be neceſſary for breaking the 5-inch beam of the length a be called P. We ſhall have $\frac{\overline{P+c}\times a}{l}-c=p$. Thus the weight neceſſary for breaking the 7-foot bar is 11560. This added to 1245, and the ſum multiplied by 7, gives $\overline{P+c}\times a=89635$. Let l be 18; then $\frac{89635}{18}-1245=3725,=p$, which differs not more than $\frac{1}{40}$th from what experiment gives us. This rule holds equally well in all the other lengths except the 10 and 24 foot beams, which are very anomalous. Such a formula is abundantly exact for practice, and will anſwer through a much greater variety of length, though it cannot be admitted as a true one; becauſe, in a certain very great length, the ſtrength will be nothing. For other ſizes the conſtant number muſt change in the proportion of d^3, or perhaps of p.

115
Relation between the ſtrength and the ſquare of the depth of the ſection.

The next compariſon which we have to make with the theory is the relation between the ſtrength and the ſquare of the depth of the ſection. This is made by comparing with each other the numbers in any horizontal line of the table. In making this compariſon we find the numbers of the five-inch bars uniformly greater than the reſt. We imagine that there is ſomething peculiar to theſe bars: They are in general heavier than in the proportion of their ſection, but not ſo much ſo as to account for all their ſuperiority. We imagine that this ſet of experiments, intended as a ſtandard for the reſt, has been made at one time, and that the ſeaſon has had a conſiderable influence. The fact however is, that if this column be kept out, or uniformly diminiſhed about one-ſixteenth in their ſtrength, the different ſizes will deviate very little from the ratio of the ſquare of the depth, as determined by theory. There is however a ſmall deficiency in the bigger beams.

We have been thus anxious in the examination of theſe experiments, becauſe they are the only ones which have been related in ſufficient detail, and made on a proper ſcale for giving us data from which we can deduce confidential maxims for practice. They are ſo troubleſome and expenſive that we have little hopes of ſeeing their number greatly increaſed; yet ſurely our navy board would do an unſpeakable ſervice to the public by appropriating a fund for ſuch experiments under the management of ſome man of ſcience.

116
Proportion between the abſolute coheſion and the relative ſtrength.

There remains another compariſon which is of chief importance, namely, the proportion between the ABSOLUTE COHESION and the RELATIVE STRENGTH. It may be gueſſed, from the very nature of the thing, that this muſt be very uncertain. Experiments on the abſolute ſtrength muſt be confined to very ſmall pieces, by reaſon of the very great forces which are required for tearing them aſunder. The values therefore deduced from them muſt be ſubject to great inequalities. Unfortunately we have got no detail of any experiments; all that we have to depend on is two paſſages of Muſchenbroek's *Eſſais de Phyſique;* in one of which he ſays, that a piece of ſound oak $\frac{27}{100}$ths of an inch ſquare is torn aſunder by 1150 pounds; and in the other, that an oak plank 12 inches broad and one thick will juſt ſuſpend 189163 pounds. Theſe give for the coheſion of an inch ſquare 15,755 and 15,763 pounds. Bouguer, in his *Traité du Navire*, ſays that it is very well known that a rod of ſound oak one-fourth of an inch ſquare will be torn aſunder by 1000 pounds. This gives 16000 for the coheſion of a ſquare inch. We ſhall take this as a round number, eaſily uſed in our computations. Let us compare this with M. Buffon's trials of beams four inches ſquare.

The abſolute coheſion of this ſection is $16,000 \times 16 = 256,000$. Did every fibre exert its whole force in the inſtant of fracture, the momentum of coheſion would be the ſame as if it had all acted at the centre of gravity of the ſection at 2 inches from the axis of fracture, and is therefore 512,000. The 4-inch beam, 7 feet long, was broken by 5312 pounds hung on its middle. The half of this, or 2656 pounds, would have broken it, if ſuſpended at its extremity, projecting $3\frac{1}{2}$ feet, or 42 inches from a wall. The momentum of this ſtrain is therefore $2656 \times 42, = 111552$. Now this is in equilibrio with the actual momentum of coheſion, which is therefore 111552, inſtead of 512000. The ſtrength is therefore diminiſhed in the proportion of 512000 to 111552, or very nearly of 4,59 to 1.

As we are quite uncertain as to the place of the centre of effort, it is needleſs to conſider the full coheſion as acting at the centre of gravity, and producing the momentum 512,000; and we may convert the whole into a ſimple multiplier m of the length, and ſay, *as* m *times the length is to the depth, ſo is the abſolute coheſion of the ſection to the relative ſtrength.* Therefore let the abſolute coheſion of a ſquare inch be called f, the breadth b, the depth d, and the length l (all in inches), the relative ſtrength, or the external force p, which balances it, is $\frac{f b d^2}{9,18 l}$, or in round numbers $\frac{f b d^2}{9 l}$; for $m = 2 \times 4,59$.

This great diminution of ſtrength cannot be wholly accounted for by the inequality of the coheſive forces exerted in the inſtant of fracture; for in this caſe we know that the centre of effort is at $\frac{1}{3}$d of the height in a rectangular ſection (becauſe the forces really exerted are as the extenſions of the fibres). The relative ſtrength would be $\frac{f b d^2}{3 l}$, and p would have been 8127 inſtead of 2656.

We muſt aſcribe this diminution (which is three times greater than that produced by the inequality of the coheſive forces) to the compreſſion of the under part of the beam; and we muſt endeavour to explain in what manner this compreſſion produces an effect which ſeems ſo little explicable by ſuch means.

As we have repeatedly obſerved, it is a matter of nearly univerſal experience that the forces *actually* exerted by the particles of bodies, when ſtretched or compreſſed, are very nearly in the proportion of the diſtances to which the particles are drawn from their natural poſitions. Now, although we are certain that, in enormous compreſſions, the forces increaſe faſter than in this proportion, this makes no ſenſible change in the preſent queſtion, becauſe the body is broken before the compreſſions have gone ſo far; nay, we imagine that the compreſſed parts are crippled in moſt caſes even before the extended parts are torn aſunder. Muſchenbroek aſſerts this with great confidence with reſpect to oak, on the authority of his own experiments. He ſays, that although oak will ſuſpend half as much again as fir, it will not ſupport, as a pillar, two-thirds of the load which fir will ſupport in that form.

We imagine therefore that the mechaniſm in the *preſent* caſe is nearly as follows:

Fig. 27.

Let the beam DCK Δ (fig. 27.) be loaded at its extremity with the weight P, acting in the direction KP perpendicular to DC. Let D Δ be the ſection of fracture. Let DA be about one-third of D Δ. A will be the particle or fibre which is neither extended nor compreſſed. Make $\Delta \delta : D d = DA : A \Delta$. The triangles DA d, Δ A δ, will repreſent the accumulated attracting and repelling forces. Make AI and A $i = \frac{1}{3}$ DA and $\frac{1}{3}$ Δ A. The point I will be that to which the full coheſion D d or f of the particles in AD muſt be applied, ſo as to produce the ſame momentum which the variable forces at I, D, &c. really produce at their ſeveral points of application. In like manner, i is the centre of ſimilar effort of the repulſive forces excited by the compreſſion between A and Δ, and it is the real fulcrum of a bended lever I i K, by which the whole effect is produced. The effect is the ſame as if the full coheſion of the ſtretched fibres in AD were accumulated in I, and the full repulſion of all the compreſſed fibres in A Δ were accumulated in i. The forces which are balanced in the operation are the weight P, acting by the arm $k\,i$, and the full coheſion of AD acting by the arm I i. The forces exerted by the compreſſed fibres between A and Δ only ſerve to give ſupport to the lever, that it may exert its ſtrain.

We imagine that this does not differ much from the real procedure of nature. The poſition of the point A may be different from what we have deduced from Mr Buffon's experiments, compared with Muſchenbroek's value of the abſolute coheſion of a ſquare inch. If this laſt ſhould be only 12000, DA muſt be greater than we have here made it, in the proportion of 12000 to 16000. For I i muſt ſtill be made $=\frac{1}{3}$ A Δ, ſuppoſing the forces to be proportional to the extenſions and compreſſions. There can be no doubt that a part only of the coheſion of D Δ operates in reſiſting the fracture in all ſubſtances which have any compreſſibility; and it is confirmed by the experiments of Mr Du Hamel on willow, and the inferences are by no means confined to that ſpecies of timber. We ſay therefore, that when the beam is broken, the coheſion of AD alone is exerted, and that each fibre exerts a force proportional to its extenſion; and the accumulated momentum is the ſame as if the full coheſion of AD were acting by the lever I i $=\frac{1}{3}$d of D Δ.

It may be ſaid, that if only one-third of the coheſion of oak be exerted, it may be cut two-thirds through without weakening it. But this cannot be, becauſe the coheſion of the whole is employed in preventing the lateral ſlide ſo often mentioned. We have no experiments to determine that it *may not* be cut through one-third without loſs of its ſtrength.

This muſt not be conſidered as a ſubject of mere ſpeculative curioſity. It is intimately connected with all the practical uſes which we can make of this knowledge; for it is almoſt the only way that we can learn the compreſſibility of timber. Experiments on the direct coheſion are indeed difficult, and exceedingly expenſive if we attempt them in large pieces. But experiments on compreſſion are almoſt impracticable. The moſt inſtructive experiments would be, firſt to eſtabliſh, by a great number of trials, the tranſverſe force of a moderate batten; and then to make a great number of trials of the diminution of its ſtrength, by cutting it through on the concave ſide. This would very nearly give us the proportion of the coheſion which really operates in reſiſting fractures. Thus if it be found that one-half of the beam may be cut on the under ſide without diminution of its ſtrength (taking care to drive in a ſlice of harder wood), we may conclude that the point A is at the middle, or ſomewhat above it.

Much lies before the curious mechanician, and we are as yet very far from a ſcientific knowledge of the ſtrength of timber.

In the mean time, we may derive from theſe experiments of Buffon a very uſeful practical rule, without relying on any value of the abſolute coheſion of oak. We ſee that the ſtrength is nearly as the breadth, as the ſquare of the depth, and as the inverſe of the length. It is moſt convenient to meaſure the breadth and depth of the beam in inches, and its length in feet. Since, then, a beam four inches ſquare and ſeven feet between the ſupports is broken by 5312 pounds, we muſt conclude that a batten one inch ſquare and one foot between the ſupports will be broken by 581 pounds. Then the ſtrength of any other beam of oak, or the weight which will juſt break it when hung on its middle, is $581\,\frac{b\,d^2}{l}$.

117
A uſeful practical rule may be deduced from Mr Buffon's experiments.

But we have ſeen that there is a very conſiderable deviation from the inverſe proportion of the lengths, and we muſt endeavour to accommodate our rule to this deviation. We found, that by adding 1245 to each of the ordinates or numbers in the column of the five-inch bars, we had a ſet of numbers very nearly reciprocal of the lengths; and if we make a ſimilar addition to the other columns in the proportion of the cubes of the ſixes, we have nearly the ſame reſult. The greateſt error (except in the caſe of experiments which are very irregular) does not exceed $\frac{1}{15}$th of the whole. Therefore, for a radical number, add to the 5312 the number 640, which is to 1245 very nearly as 4^3 to 5^3. This gives 5952. The 64th of this is 93, which correſponds to a bar of one inch ſquare and ſeven feet long. Therefore 93×7 will be the reciprocal correſponding to a bar of one foot. This is 651. Take from this the preſent empirical correction, which is $\frac{b\,40}{b\,4}$, or 10, and there remains 641 for the ſtrength of the bar. This gives us for a general rule $p=651\,\frac{b\,d^2}{l}-10\,b\,d^2$.

Example. Required the weight neceſſary to break an oak beam eight inches ſquare and 20 feet between the props, $p=651\times\frac{8\times 8^2}{20}-10\times 8\times 8^2$. This is 11545, whereas the experiment gives 11487. The error is very ſmall indeed. The rule is moſt deficient in compariſon with the five-inch bars, which we have already ſaid appear ſtronger than the reſt.

The following proceſs is eaſily remembered by ſuch as are not algebraiſts.

Multiply the breadth in inches twice by the depth, and call this product f. Multiply f by 651, and divide by the length in feet. From the quotient take 10 times f. The remainder is the number of pounds which will break the beam.

We are not ſufficiently ſenſible of our principles to be confident that the correction 10 f ſhould be in the proportion of the ſection, although we think it moſt probable. It is quite empirical, founded on Buffon's experiments. Therefore the ſafe way of uſing this rule is to ſuppoſe the beam ſquare, by increaſing or diminiſhing its breadth till equal to the depth. Then find the ſtrength by this rule, and diminiſh or increaſe it for the change which has been made in its breadth. Thus, there can be no doubt that the ſtrength of the beam given as an example is double of that of a beam of the ſame depth and half the breadth.

The reader cannot but obſerve that all this calculation relates to the very greateſt weight which a beam will bear for a very few minutes. Mr Buffon uniformly found

found that two-thirds of this weight ſenſibly impaired its ſtrength, and frequently broke at the end of two or three months. One-half of this weight brought the beam to a certain bend, which did not increaſe after the firſt minute or two, and may be borne by the beam for any length of time. But the beam contracted a bend, of which it did not recover any conſiderable portion. One-third ſeemed to have no permanent effect on the beam; but it recovered its rectilineal ſhape completely, even after having been loaded ſeveral months, provided that the timber was ſeaſoned when firſt loaded; that is to ſay, one third of the weight which would quickly break a ſeaſoned beam, or one-fourth of what would break one juſt felled, may lie on it forever without giving the beam a ſett.

We have no detail of experiments on the ſtrength of other kinds of timber: only Mr Buffon ſays, that fir has about $\frac{6}{10}$ths of the ſtrength of oak; Mr Parent makes it $\frac{10}{12}$ths; Emerſon, $\frac{2}{3}$ds, &c.

We have been thus minute in our examination of the mechaniſm of this tranſverſe ſtrain, becauſe it is the greateſt to which the parts of our machines are expoſed. We wiſh to impreſs on the minds of artiſts the neceſſity of avoiding this as much as poſſible. They are improving in this reſpect, as may be ſeen by comparing the centres on which ſtone arches of great ſpan are now turned with thoſe of former times. They were formerly a load of mere joiſts reſting on a multitude of poſts, which obſtructed the navigation, and were frequently loſing their ſhape by ſome of the poſts ſinking into the ground. Now they are more generally truſſes, where the beams abutt on each other, and are relieved from tranſverſe ſtrains. But many performances of eminent artiſts are ſtill very injudiciouſly expoſed to croſs ſtrains. We may inſtance one which is conſidered as a fine work, viz. the bridge at Walton on Thames. Here every beam of the great arch is a joiſt, and it hangs together by framing. The fineſt piece of carpentry that we have ſeen is the centre employed in turning the arches of the bridge at Orleans, deſcribed by Perronet. In the whole there is not one croſs ſtrain. The beam, too, of Hornblower's ſteam-engine, deſcribed in that article, is very ſcientifically conſtructed.

118 Strain produced by twiſting.

IV. The laſt ſpecies of ſtrain which we are to examine is that produced by twiſting. This takes place in all axles which connect the working parts of machines.

119 The reſiſtance muſt be proportional to the number of particles.

Fig. 28.

Although we cannot pretend to have a very diſtinct conception of that modification of the coheſion of a body by which it reſiſts this kind of ſtrain, we can have no doubt that, when all the particles act alike, the reſiſtance muſt be proportional to the number. Therefore if we ſuppoſe the two parts ABCD, ABFE (fig. 28.), of the body EFCD to be of inſuperable ſtrength, but cohering more weakly in the common ſurface AB, and that one part ABCD is puſhed laterally in the direction AB, there can be no doubt that it will yield only there, and that the reſiſtance will be proportional to the ſurface.

Fig. 29.

In like manner, we can conceive a thin cylindrical tube, of which KAH (fig. 29.) is the ſection, as cohering more weakly in that ſection than anywhere elſe. Suppoſe it to be graſped in both hands, and the two parts twiſted round the axis in oppoſite directions, as we would twiſt the two joints of a flute, it is plain that it will firſt fail in this ſection, which is the circumference of a circle, and the particles of the two parts which are contiguous to this circumference will be drawn from each other laterally. The total reſiſtance will be as the number of equally reſiſting particles, that is, as the circumference (for the tube being ſuppoſed very thin, there can be no ſenſible difference between the dilatation of the external and internal particles). We can now ſuppoſe another tube within this, and a third within the ſecond, and ſo on till we reach the centre. If the particles of each ring exerted the ſame force (by ſuffering the ſame dilatation in the direction of the circumference), the reſiſtance of each ring of the ſection would be as its circumference and its breadth (ſuppoſed indefinitely ſmall,) and the whole reſiſtance would be as the ſurface; and this would repreſent the reſiſtance of a ſolid cylinder. But when a cylinder is twiſted in this manner by an external force applied to its circumference, the external parts will ſuffer a greater circular extenſion than the internal; and it appears that this extenſion (like the extenſion of a beam ſtrained tranſverſely) will be proportional to the diſtance of the particles from the axis. We cannot ſay that this is demonſtrable, but we can aſſign no proportion that is more probable. This being the caſe, the forces ſimultaneouſly exerted by each particle will be as its diſtance from the axis. Therefore the whole force exerted by each ring will be as the ſquare of its radius, and the accumulated force actually exerted will be as the cube of the radius; that is, the accumulated force exerted by the whole cylinder, whoſe radius is CA, is to the accumulated force exerted *at the ſame time* by the part whoſe radius is CE, as CA^3 to CE^3.

The whole coheſion now exerted is juſt two-thirds of what it would be if all the particles were exerting the ſame attractive forces which are juſt now exerted by the particles in the external circumference. This is plain to any perſon in the leaſt familiar with the fluxionary calculus. But ſuch as are not may eaſily ſee it in this way.

Let the rectangle AC ca be ſet upright on the ſurface of the circle along the line CA, and revolve round the axis C c. It will generate a cylinder whoſe height is C c or A a, and having the circle KAH for its baſe. If the diagonal C a be ſuppoſed alſo to revolve, it is plain that the triangle c C a will generate a cone of the ſame height, and having for its baſe the circle deſcribed by the revolution of ca, and the point C for its apex. The cylindrical ſurface generated by A a will expreſs the whole coheſion exerted by the circumference AHK, and the cylindrical ſurface generated by E e will repreſent the coheſion exerted by the circumference ELM, and the ſolid generated by the triangle CA a will repreſent the coheſion exerted by the whole circle AHK, and the cylinder generated by the rectangle AC ca will repreſent the coheſion exerted by the ſame ſurface if each particle had ſuffered the extenſion A a.

Now it is plain, in the firſt place, that the ſolid generated by the triangle e EC is to that generated by a AC as EC^3 to AC^3. In the next place, the ſolid generated by a AC is two-thirds of the cylinder, becauſe the cone generated by c C a is one-third of it.

We may now ſuppoſe the cylinder twiſted till the particles in the external circumference loſe their coheſion. There can be no doubt that it will now be wrenched aſunder, all the inner circles yielding in ſucceſſion. Thus we obtain one uſeful information, viz. that a body of homogeneous texture reſiſts a *ſimple twiſt* with two-

120
With what force a body of a homogeneous texture reſiſts a ſimple twiſt.

thirds of the force with which it reſiſts an attempt to force one part laterally from the other, or with one-third part of the force which will cut it aſunder by a ſquare-edged tool. For to drive a ſquare-edged tool through a piece of lead, for inſtance, is the ſame as forcing a piece of the lead as thick as the tool laterally away from the two pieces on each ſide of the tool. Experiments of this kind do not ſeem difficult, and they would give us very uſeful information.

121
The forces exerted in breaking two cylinders are as the ſquares of the diameters.

When two cylinders AHK and BNO are wrenched aſunder, we muſt conclude that the external particles of each are juſt put beyond their limits of coheſion, are equally extended, and are exerting equal forces. Hence it follows, that in the inſtant of fracture the ſum total of the forces actually exerted are as the ſquares of the diameters.

For drawing the diagonal C *e*, it is plain that E *e*, = A *a*, expreſſes the diſtenſion of the circumference ELM, and that the ſolid generated by the triangle CE *e* expreſſes the coheſion exerted by the ſurface of the circle ELM, when the particles in the circumference ſuffer the extenſion E *e* equal to A *a*. Now the ſolids generated by CA *a* and CE *e* being reſpectively two-thirds of the correſponding cylinders, are as the ſquares of the diameters.

122
Relative ſtrength of the ſection to the external force employed to break it.

Having thus aſcertained the real ſtrength of the ſection, and its relation to its abſolute lateral ſtrength, let us examine its ſtrength relative to the external force employed to break it. This examination is very ſimple in the caſe under conſideration. The ſtraining force muſt act by ſome lever, and the coheſion muſt oppoſe it by acting on ſome other lever. The centre of the ſection may be the neutral point, whoſe poſition is not diſturbed.

Let F be the force exerted laterally by an exterior particle. Let a be the radius of the cylinder, and x the indeterminate diſtance of any circumference, and $\dot{x}$ the indefinitely ſmall interval between the concentric arches; that is, let $\dot{x}$ be the breadth of a ring and x its radius. The forces being as the extenſions, and the extenſions as the diſtances from the axis, the coheſion actually exerted at any part of any ring will be $f\frac{x\dot{x}}{a}$. The force exerted by the whole ring (being as the circumference or as the radius) will be $f\frac{x^2\dot{x}}{a}$. The momentum of coheſion of a ring, being as the force multiplied by its lever, will be $f\frac{x^3\dot{x}}{a}$. The accumulated momentum will be the ſum or fluent of $f\frac{x^3\dot{x}}{a}$; that is, when $x=a$, it will be $\frac{1}{4}f\frac{a^4}{a}, =\frac{1}{4}fa^3$.

123
The reſiſtance of the axle is as the cube of its diameter.

Hence we learn that the ſtrength of an axle, by which it reſiſts being wrenched aſunder by a force acting at a given diſtance from the axis, is as the cube of its diameter.

But farther, $\frac{1}{4}fa^3$ is $=fa^2\times\frac{1}{4}a$. Now fa^2 repreſents the full lateral coheſion of the ſection. The momentum therefore is the ſame as if the full lateral coheſion were accumulated at a point diſtant from the axis by one-fourth of the radius or one-eighth of the diameter of the cylinder.

Therefore let F be the number of pounds which meaſures the lateral coheſion of a circular inch, d the diameter of the cylinder in inches, and l the length of the lever by which the ſtraining force p is ſuppoſed to act, we ſhall have $F\times\frac{1}{8}d^3=pl$, and $F\frac{d^3}{8l}=p$.

We ſee in general that the ſtrength of an axle, by which it reſiſts being wrenched aſunder by twiſting, is as the cube of its diameter.

We ſee alſo that the internal parts are not acting ſo powerfully as the external. If a hole be bored out of the axle of half its diameter, the ſtrength is diminiſhed only one-eighth, while the quantity of matter is diminiſhed one-fourth. Therefore hollow axles are ſtronger than ſolid ones containing the ſame quantity of matter. Thus let the diameter be 5 and that of the hollow 4: then the diameter of another ſolid cylinder having the ſame quantity of matter with the tube is 3. The ſtrength of the ſolid cylinder of the diameter 5 may be expreſſed by 5^3 or 125. Of this the internal part (of the diameter 4) exerts 64; therefore the ſtrength of the tube is 125 —64, =61. But the ſtrength of the ſolid axle of the ſame quantity of matter and diameter 3 is 3^3, or 27, which is not half of that of the tube.

124
Hollow axles more proper than ſolid ones,

125
and now generally uſed.

Engineers, therefore, have of late introduced this improvement in their machines, and the axles of caſt iron are all made hollow when their ſize will admit it. They have the additional advantage of being much ſtiffer, and of affording much better fixture for the flanches, which are uſed for connecting them with the wheels or levers by which they are turned and ſtrained. The ſuperiority of ſtrength of hollow tubes over ſolid cylinders is much greater in this kind of ſtrain than in the former or tranſverſe. In this laſt caſe the ſtrength of this tube would be to that of the ſolid cylinder of equal weight as 61 to 32 and a half nearly.

The apparatus which we mentioned on a former occaſion for trying the lateral ſtrength of a ſquare inch of ſolid matter, enabled us to try this theory of twiſt with all deſirable accuracy. The bar which hung down from the pin in the former trials was now placed in a horizontal poſition, and loaded with a weight at the extremity. Thus it acted as a powerful lever, and enabled us to wrench aſunder ſpecimens of the ſtrongeſt materials. We found the reſults perfectly conformable to the theory, in as far as it determined the proportional ſtrength of different ſizes and forms: but we found the ratio of the reſiſtance to twiſting to the ſimple lateral reſiſtance conſiderably different; and it was ſome time before we diſcovered the cauſe.

126
The ratio of reſiſtance to twiſting to the ſimple lateral reſiſtance appears different.

We had here taken the ſimpleſt view that is poſſible of the action of coheſion in reſiſting a twiſt. It is frequently exerted in a very different way. When, for inſtance, an iron axle is joined to a wooden one by being driven into one end of it, the extenſions of the different circles of particles are in a very different proportion. A little conſideration will ſhow that the particles in immediate contact with the iron axle are in a ſtate of violent extenſion; ſo are the particles of the exterior ſurface of the wooden part, and the intermediate parts are leſs ſtrained. It is almoſt impoſſible to aſſign the exact proportion of the coheſive forces exerted in the different parts.

parts. Numberleſs caſes can be pointed out where parts of the axle are in a ſtate of compreſſion, and where it is ſtill more difficult to determine the ſtate of the other particles. We muſt content ourſelves with the deductions made from this ſimple caſe, which is fortunately the moſt common. In the experiments juſt now mentioned the centre of the circle is by no means the neutral point, and it is very difficult to aſcertain its place: but when this conſideration occurred to us, we eaſily freed the experiments from this uncertainty, by extending the lever to both ſides, and by means of a pulley applied equal force to each arm, acting in oppoſite directions. Thus the centre became the neutral point, and the reſiſtance to twiſt was found to be two-thirds of the ſimple lateral ſtrength.

127 But when the experiment was altered, it was exactly the ſame.

128 Experiments on chalk, clay, and wax, ſatisfactory; but thoſe on timber irregular.

We beg leave to mention here that our ſucceſs in theſe experiments encouraged us to extend them much farther. We hoped by theſe means to diſcover the abſolute coheſion of many ſubſtances, which would have required an enormous apparatus and a moſt unmanageable force to tear them aſunder directly. But we could reaſon with confidence from the reſiſtance to twiſt (which we could eaſily meaſure), provided that we could aſcertain the proportion of the direct and the lateral ſtrengths. Our experiments on chalk, finely prepared clay, and white bees-wax (of one melting and one temperature), were very conſiſtent and ſatisfactory. But we have hitherto found great irregularities in this proportion in bodies of a fibrous texture like timber. Theſe are the moſt important caſes, and we ſtill hope to be able to accompliſh our project, and to give the public ſome valuable information. This being our ſole object, it was our duty to mention the method which promiſes ſucceſs, and thus excite others to the taſk; and it will be no mortification to us to be deprived of the honour of being the firſt who thus adds to the ſtock of experimental knowledge.

When the matter of the axle is of the moſt ſimple texture, ſuch as that of metals, we do not conceive that the length of the axle has any influence on the fracture. It is otherwiſe if it be of a fibrous texture like timber: the fibres are bent before breaking, being twiſted into ſpirals like a cork-ſcrew. The length of the axle has ſomewhat of the influence of a lever in this caſe, and it is eaſier wrenched aſunder if long. Accordingly we have found it ſo; but we have not been able to reduce this influence to calculation.

129 Concluding remarks.

Our readers are requeſted to accept of theſe endeavours to communicate information on this important and difficult ſubject. We are duly ſenſible of their imperfection, but flatter ourſelves that we have in many inſtances pointed out the method which muſt be purſued for improving our knowledge on this ſubject; and we have given the Engliſh reader a more copious liſt of experiments on the ſtrength of materials than he will meet with in our language. Many uſeful deductions might be made from theſe premiſes reſpecting the manner of diſpoſing and combining the ſtrength of materials in our ſtructures. The beſt form of joints, mortiſes, tenons, ſcarphs; the rules for joggling, tabling, faying, fiſhing, &c. practiſed in the delicate art of maſt-making, are all founded on this doctrine: but the diſcuſſion of theſe would be equivalent to writing a complete treatiſe of carpentry. We hope that this will be executed by ſome intelligent mechanician, for there is nothing in our language on this ſubject but what is almoſt contemptible; yet there is no mechanic art that is more ſuſceptible of ſcientific treatment. Such a treatiſe, if well executed, could not fail of being well received by the public in this age of mechanical improvement.

STRENGTHENERS, or CORROBORANTS, ſuch medicines as are ſuppoſed to add to the firmneſs of the ſolids. See MATERIA MEDICA *Index*.

STRETCHING, in *Navigation*, is generally underſtood to imply the progreſſion of a ſhip under a great ſurface of ſail, when cloſe-hauled. The difference between this term and *ſtanding*, conſiſts apparently in the quantity of ſail; which in the latter may be very moderate; but ſtretching generally ſignifies exceſs; as, we ſaw the enemy at daybreak ſtretching to the ſouthward under a croud of ſail, &c. *Falconer*.

STRETTO, in Italian muſic, is ſometimes uſed to ſignify that the meaſure is to be ſhort and conciſe, and conſequently quick. In this ſenſe it ſtands oppoſed to LARGO.

STRIATED LEAF, among botaniſts, one that has a number of longitudinal furrows on its ſurface.

STRIKE, a meaſure of capacity, containing four buſhels. Alſo an inſtrument uſed in meaſuring corn.

STRIX, the OWL; a genus of birds belonging to the order of accipitres. See ORNITHOLOGY *Index*.

The *bubo*, or great-eared owl inhabits inacceſſible rocks and deſert places, and preys on hares and feathered game. Its appearance in cities was deemed an unlucky omen; Rome itſelf once underwent a luſtration becauſe one of them ſtrayed into the capitol. The ancients had them in the utmoſt abhorrence; and thought them, like the ſcreech-owls, the meſſengers of death. Pliny ſtyles it *bubo funebris*, and *noctis monſtrum*.

Solaque culminibus ferali *carmine* bubo
Sæpe queri et longas in fletum ducere voces. VIRGIL.

Perch'd on the roof, the bird of night complains,
In lengthen'd ſhrieks and dire funereal ſtrains.

STROBILUS, in *Botany*, a pericarp formed from an amentum by the hardening of the ſcales.

STROKING, or rubbing gently with the hand, a method which has been employed by ſome perſons for curing diſeaſes.

Mr Greatrakes or Greatrix, the famous Iriſh ſtroker, is ſaid to have performed many wonderful cures. He gives the following account of his diſcovery of this art, and of the ſucceſs with which he practiſed it. "About 1662 I had an impulſe (ſays he), or a ſtrange perſuaſion in my own mind (of which I am not able to give any rational account to another), which did very frequently ſuggeſt to me, that there was beſtowed on me the gift of curing the king's evil; which, for the extraordinarineſs of it, I thought fit to conceal for ſome time; but at length I communicated this to my wife, and told her, that I did verily believe that God had given me the bleſſing of curing the king's evil; for whether I were in private or public, ſleeping or waking, ſtill I had the ſame impulſe. But her reply to me was, that ſhe conceived this was a ſtrange imagination; yet, to prove the contrary, a few days after there was one William Maher of Salterbridge in the pariſh of Liſmore, who brought his ſon William to my houſe, deſiring my wife to cure him, who was a perſon ready to afford her charity to her neighbours, according to her ſmall ſkill in chirurgery.

See *Brief Account of Mr Valentine Greatrakes*, Lond. 1666, 4to.

STRENGTH of MATERIALS.

Fig. 1.

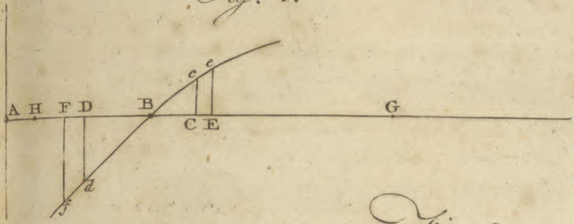

Fig. 3.

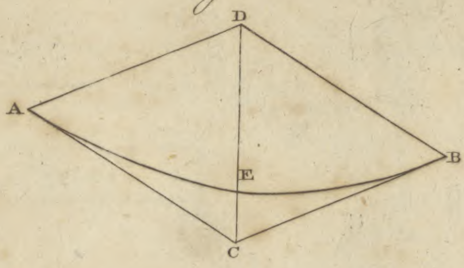

Fig. 2.

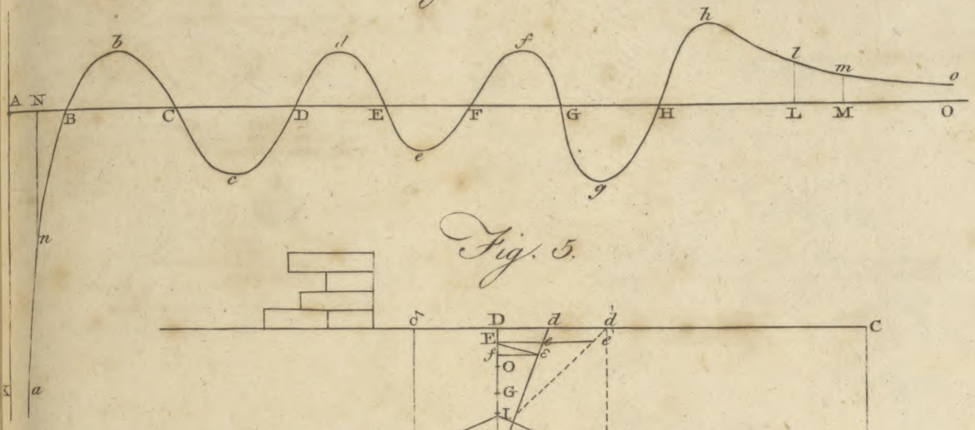

Fig. 4.

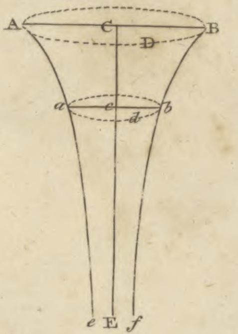

Fig. 5.

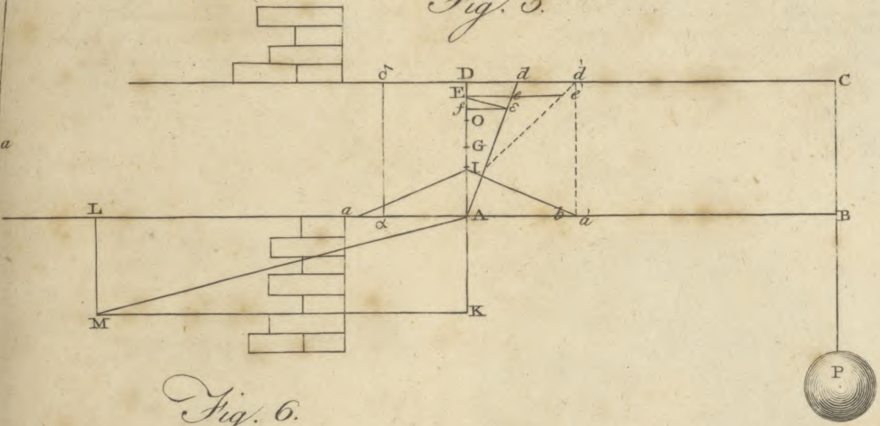

Fig. 6.

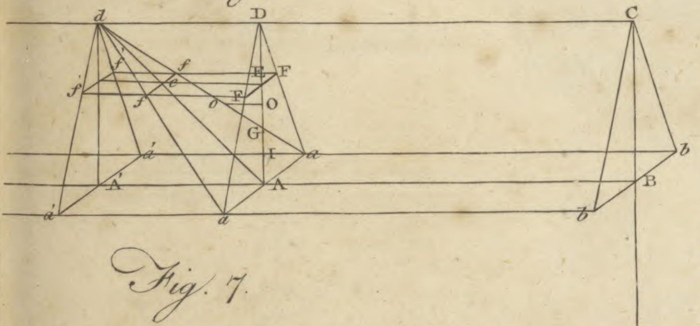

Fig. 8.

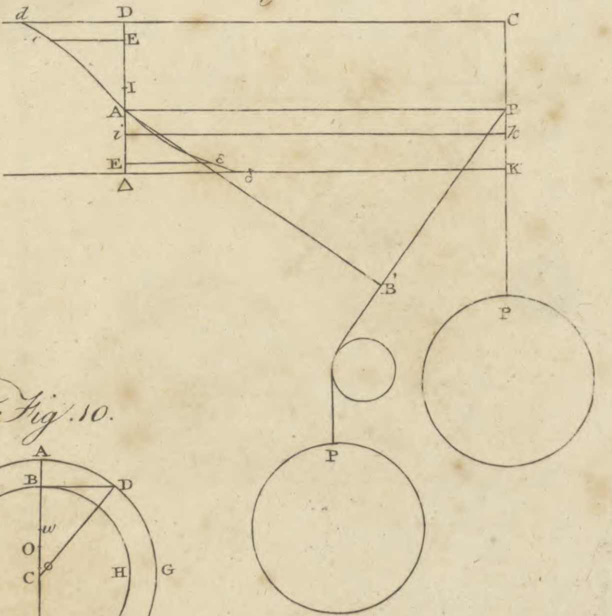

Fig. 7.

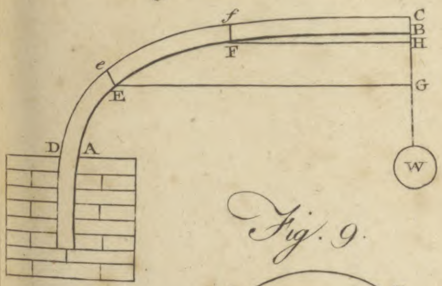

Fig. 9.

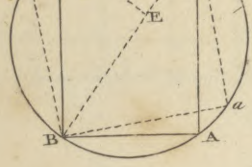

Fig. 10.

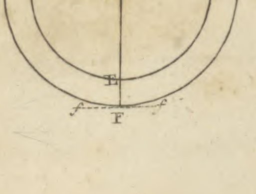

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Fig. 11.

Fig. 12.

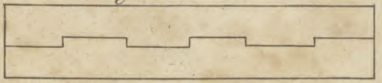


Fig. 13.

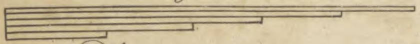


Fig. 14.

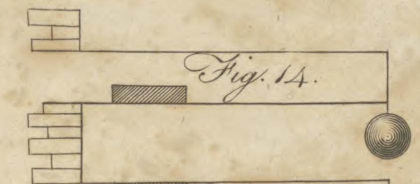
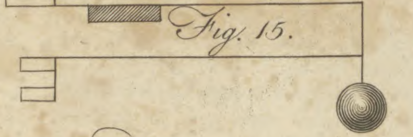


Fig. 15.



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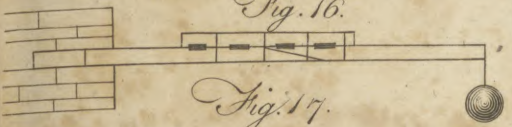
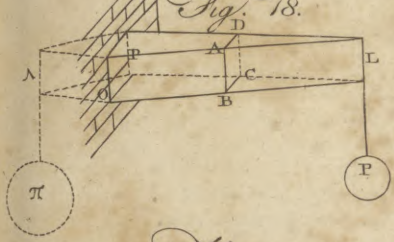


Fig. 17.

Fig. 18.



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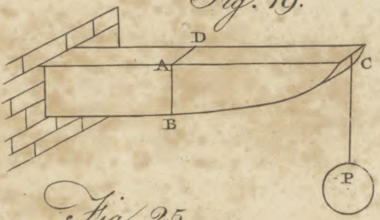

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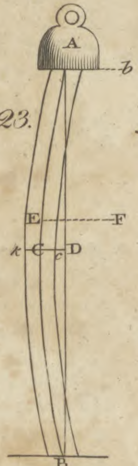


Fig. 24.

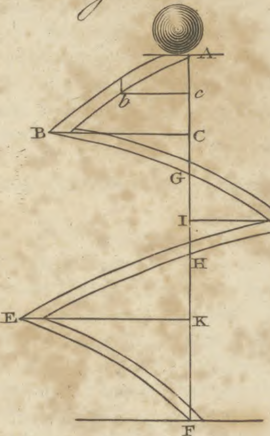


Fig. 20.

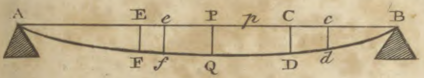


Fig. 25.

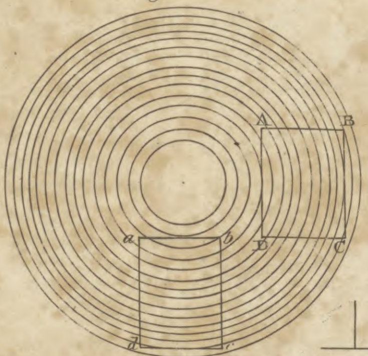
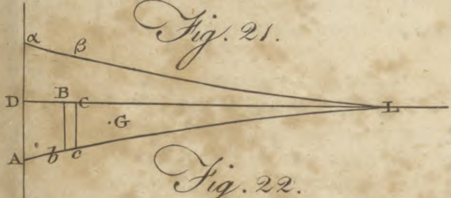


Fig. 21.



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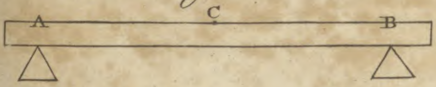

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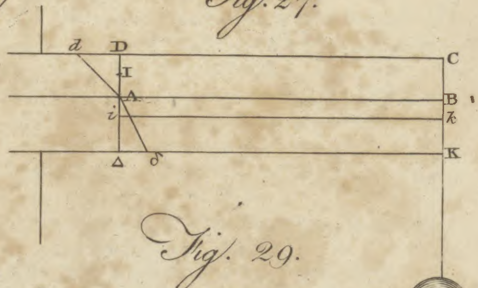


Fig. 26.

Fig. 29.

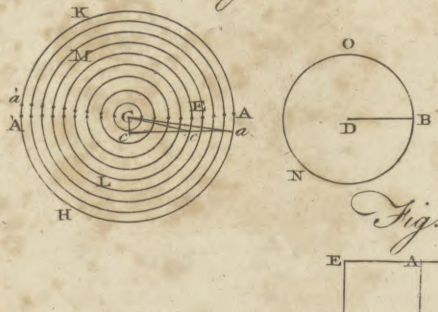
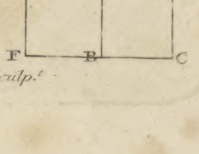


Fig. 28.



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chirurgery. On which my wife told me, there was one that had the king's evil very grievouſly in the eyes, cheek, and throat; whereupon I told her, that ſhe ſhould now ſee whether this was a bare fancy or imagination, as ſhe thought it, or the dictates of God's Spirit on my heart. Then I laid my hands on the places affected, and prayed to God for Jeſus ſake to heal him; and bid the parent two or three days afterwards to bring the child to me again, which accordingly he did; and I then ſaw the eye was almoſt quite whole; and the node, which was almoſt as big as a pullet's egg, was ſuppurated; and the throat ſtrangely amended; and, to be brief (to God's glory I ſpeak it) within a month diſcharged itſelf quite, and was perfectly healed, and ſo continues, God be praiſed."

Then there came to him one Margaret Mackſhane of Ballinecly, in the pariſh of Liſmore, who had been afflicted with the evil above ſeven years, in a much more violent degree; and ſoon after, his fame increaſing, he cured the ſame diſeaſe in many other perſons for three years. He did not meddle all this time with any other diſtemper; till about the end of theſe three years, the ague growing epidemical, he found, as formerly, that there was beſtowed on him the gift of curing that diſeaſe. He cured Colonel Phaire, of Cahirmony in the county of Corke, of an ague, and afterwards many other perſons of different diſtempers, by ſtroking; ſo that his name was wonderfully cried up, as if ſome divine perſon had been ſent from above. January 1665-6, he came over to England, at the requeſt of the earl of Orrery; in order to cure the lady of the lord-viſcount Conway, of Ragley in Warwickſhire, who had for many years laboured under a moſt violent headache. He ſtaid at Ragley three weeks or a month; and though he failed in his endeavours to relieve that lady, he cured vaſt numbers of people in thoſe parts and at Worceſter.

Though we are no friends to the marvellous, nor believe it poſſible that either the king's evil or ague can be cured by ſtroking or friction of any kind, whether gentle or ſevere, we have no heſitation to acknowledge that many cures might be performed by Mr Greatrakes. Every reflecting perſon who reads the foregoing account which he gives of himſelf will ſee that he was an enthuſiaſt, and believed himſelf guided by a particular revelation; and ſuch is the credulity of mankind, that his pretenſions were readily admitted, and men crowded with eagerneſs to be relieved of their diſeaſes. But it is well known to phyſicians, that in many caſes the imagination has accompliſhed cures as wonderful as the force of medicine. It is owing chiefly to the influence of imagination that we have ſo many accounts from people of veracity of the wonderful effects of quack medicines. We are perfectly aſſured that theſe medicines, by their natural operation, can never produce the effects aſcribed to them; for there is no kind of proportion between the medicine and the effect produced, and often no connection between the medicine and the diſeaſe.

STROMATEUS, a genus of fiſhes belonging to the order of apodes. See ICHTHYOLOGY *Index*.

STROMBOLI, the moſt northern of the Lipari iſlands. It is a volcano, which conſtantly diſcharges much fire and ſmoke. It riſes in a conical form above the ſurface of the ſea. On the eaſt ſide it has three or four little craters ranged near each other, not at the ſummit, but on the declivity, nearly at two-thirds of its height. But as the ſurface of the volcano is very rugged and interſected with hollow ways, it may be naturally concluded, that at the time of ſome great eruption, the ſummit and a part of this ſide fell in, as muſt have happened alſo to Veſuvius; conſequently, the common chimney is at this day on the declivity, although always in the centre of the whole baſe. It is inhabited notwithſtanding its fires; but care is taken to avoid the proximity of the crater, which is yet much to be feared. "I was aſſured (ſays M. de Luc) by an Engliſhman, who, like me, had the curioſity to viſit theſe iſles, that the fine weather having invited him and his company to land at Stromboli, they aſcended a volcano, whoſe craters at that time threw out nothing; but that while they were attentively viewing them, unapprehenſive of any danger, they were ſuddenly ſaluted by ſuch a furious diſcharge, as to be obliged to retreat with precipitation, and not without one of the company being wounded by a piece of ſcoria." Of all the volcanoes recorded in hiſtory, Stromboli ſeems to be the only one that burns without ceaſing. Etna and Veſuvius often remain quiet for many months, and even years, without the leaſt appearance of fire; but Sromboli is ever at work, and for ages paſt has been looked upon as the great lighthouſe of theſe ſeas. E. Long. 15. 45. N. Lat. 30. 0.

STROMBUS, a genus of ſhell-fiſh. See CONCHOLOGY *Index*.

STRONGOLI, a town of the kingdom of Naples, with a biſhop's ſee. It is ſituated on a rugged mountain, is about three miles from the ſea, and ſeven north from St Severino. It is ſuppoſed to be the ancient *Petelia*, which made a conſpicuous figure in the ſecond Punic war by its obſtinate reſiſtance againſt Hannibal. Near its walls Marcellus the rival of Hannibal was ſlain in a ſkirmiſh. E. Long. 17. 26. N. Lat. 39. 20.

STRONTITES, or STRONTIAN EARTH, ſo called from having been diſcovered at Strontian in Argyleſhire in Scotland. See CHEMISTRY *Index*.

STROPHE, in ancient poetry, a certain number of verſes, including a perfect ſenſe, and making the firſt part of an ode. See POETRY, N° 130.

STRUMÆ, ſcrophulous tumours ariſing on the neck and throat, conſtituting what is commonly called the *king's evil*. See MEDICINE *Index*.

STRUMPFIA, a genus of plants belonging to the claſs ſyngeneſia. See BOTANY *Index*.

STRUTHIO, a genus of birds belonging to the order of grallæ. See ORNITHOLOGY *Index*.

STRUTHIOLA, a genus of plants belonging to the claſs of tetrandria. See BOTANY *Index*.

STRYCHNOS, a genus of plants belonging to the claſs pentandria, and in the natural ſyſtem ranging under the 28th order, *Luridæ*. See BOTANY *Index*.

STRYMON, in *Ancient Geography*, formerly *Conozus*; a river conſtituting the ancient limits of Macedonia and Thrace; riſing in Mount Scombrus (Ariſtotle). Authors differ as to the modern name of this river.

STRYPE, JOHN, was deſcended from a German family, born at London, and educated at Cambridge. He was vicar of Low Layton in Eſſex, and diſtinguiſhed himſelf by his compilations of Lives and Memoirs; in which, as Dr Birch remarks, his fidelity and induſtry will always give a value to his writings, however deſtitute they may be of the graces of ſtyle. He died in 1737, after having enjoyed his vicarage near 68 years.

STUART, Dr Gilbert, was born at Edinburgh in the year 1742. His father Mr George Stuart was profeſſor of humanity in the univerſity, and a man of conſiderable eminence for his claſſical taſte and literature. For theſe accompliſhments he was probably indebted in no ſmall degree to his relation the celebrated Ruddiman, with whom both he and his ſon converſed familiarly, though they afterwards united to injure his fame.

Gilbert having finiſhed his claſſical and philoſophical ſtudies in the grammar-ſchool and univerſity, applied himſelf to juriſprudence, without following, or probably intending to follow, the profeſſion of the law. For that profeſſion he has been repreſented as unqualified by indolence; by a paſſion which at a very early period of life he diſplayed for general literature; or by boundleſs diſſipation:—and all theſe circumſtances may have contributed to make him relinquiſh purſuits in which he could hope to ſucceed only by patient perſeverance and ſtrict decorum of manners. That he did not waſte his youth in idleneſs, is, however, evident from an Hiſtorical Diſſertation concerning the Antiquity of the Britiſh Conſtitution, which he publiſhed before he had completed his twenty-ſecond year, and which had ſo much merit as to induce the univerſity of Edinburgh to confer upon the author, though ſo young a man, the degree of LL.D.

After a ſtudious interval of ſome years, he produced a valuable work, under the title of A View of Society in Europe, in its Progreſs from Rudeneſs to Refinement; or, Inquiries concerning the Hiſtory of Laws, Government, and Manners. He had read and meditated with patience on the moſt important monuments of the middle ages; and in this volume (which ſpeedily reached a ſecond edition) he aimed chiefly at the praiſe of originality and invention, and diſcovered an induſtry that is ſeldom connected with ability and diſcernment. About the time of the publication of the firſt edition of this performance, having turned his thoughts to an academical life, he aſked for the profeſſorſhip of public law in the univerſity of Edinburgh. According to his own account he had been promiſed that place by the miniſter, but had the mortification to ſee the profeſſorſhip beſtowed on another, and all his hopes blaſted by the influence of Dr Robertſon, whom he repreſented as under obligations to him.

To the writer of this article, who was a ſtranger to theſe rival candidates for hiſtorical fame, this part of the ſtory ſeems very incredible; as it is not eaſy to conceive how it ever could be in the power of Dr Stuart to render to the learned Principal any eſſential ſervice. It was believed indeed by many, who obſerved that the illiberal jealouſy not unfrequent in the world of letters, was probably the ſource of this oppoſition; which entirely broke the intimacy of two perſons who, before that time, were underſtood to be on the moſt friendly footing with each other. Ingratitude, however, is as likely to have been the vice of Dr Stuart as of Dr Robertſon; for we have been told by a writer *, who, at leaſt in one inſtance, has completely proved what he affirms, that "ſuch was Gilbert Stuart's laxity of principle as a man, that he conſidered ingratitude as one of the moſt venial ſins; ſuch was his conceit as a writer, that he regarded no one's merits but his own; ſuch were his diſappointments, both as a writer and a man, that he allowed his peeviſhneſs to ſour into malice, and indulged his malevolence till it ſettled in corruption."

Soon after this diſappointment, Dr Stuart went to London, where he became from 1768 to 1774 one of the writers of the Monthly Review. In 1772 Dr Adam, rector of the high-ſchool at Edinburgh, publiſhed a Latin Grammar, which he intended as an improvement of the famous Ruddiman's. Stuart attacked him in a pamphlet under the name of *Buſhby*, and treated him with much ſeverity. In doing this, he was probably actuated more by ſome perſonal diſlike of Dr Adam than by regard for the memory of his learned relation; for on other occaſions he ſhowed ſufficiently that he had no regard to Ruddiman's honour as a grammarian, editor, or critic.

In 1774 he returned to his native city, and began the Edinburgh Magazine and Review, in which he diſcuſſed the liberty and conſtitution of England, and diſtinguiſhed himſelf by an inquiry into the character of John Knox the reformer, whoſe principles he reprobated in the ſevereſt terms. About this time he reviſed and publiſhed Sullivan's Lectures on the Conſtitution of England. Soon after he turned his thoughts to the hiſtory of Scotland, and publiſhed Obſervations concerning its Public Law and Conſtitutional Hiſtory; in which he examined with a critical care the preliminary book to Dr Robertſon's Hiſtory. His next work was The Hiſtory of the Reformation; a book which deſerves praiſe for the eaſy dignity of the narrative, and for ſtrict impartiality. His laſt great work, The Hiſtory of Scotland from the Eſtabliſhment of the Reformation to the Death of Queen Mary, which appeared in 1782, has been very geneally read and admired. His purpoſe was to vindicate the character of the injured queen, and expoſe the weakneſs of the arguments by which Dr Robertſon had endeavoured to prove her guilty; but though the ſtyle of this work is his own, it contains very little matter which was not furniſhed by Goodall and Tytler; and it is with the arms which theſe two writers put into his hands that Dr Stuart attacked his great antagoniſt.

In 1782 he once more viſited London, and engaged in the Political Herald and Engliſh Review; but the jaundice and dropſy increaſing on him, he returned by ſea to his native country, where he died in the houſe of his father on the 13th of Auguſt 1786.

In his perſon Dr Stuart was about the middle ſize and juſtly proportioned. His countenance was modeſt and expreſſive, ſometimes glowing with ſentiments of friendſhip, of which he was truly ſuſceptible, and at others darting that ſatire and indignation at folly and vice which appear in ſome of his writings. He was a boon companion; and, with a conſtitution that might have ſtood the ſhock of ages, he fell a premature martyr to intemperance. His talents were certainly great, and his writings are uſeful; but he ſeems to have been influenced more by paſſion than prejudice, and in his character there was not much to be imitated.

STUCCO, in building, a compoſition of white marble pulveriſed, and mixed with plaſter of lime; and the whole being ſifted and wrought up with water, is to be uſed like common plaſter: this is called by Pliny *marmoratum opus*, and *albarium opus*.

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* *Chalmers in his life of Ruddiman.*

A patent was granted to Mr B. Higgins for inventing a new kind of ſtucco, or water cement, more firm and durable than any heretofore. Its compoſition, as extracted from the ſpecification ſigned by himſelf, is as follows : "Drift-ſand, or quarry (A) ſand, which conſiſts chiefly of hard quartzoſe flat-faced grains with ſharp angles ; which is the freeſt, or may be moſt eaſily freed by waſhing, from clay, ſalts, and calcareous, gypſeous, or other grains leſs hard and durable than quartz ; which contains the ſmalleſt quantity of pyrites or heavy metallic matter inſeparable by waſhing ; and which ſuffers the ſmalleſt diminution of its bulk in waſhing in the following manner—is to be preferred before any other. And where a coarſe and a fine ſand of this kind, and correſponding in the ſize of their grains with the coarſe and fine ſands hereafter deſcribed, cannot be eaſily procured, let ſuch ſand of the foregoing quality be choſen as may be ſorted and cleanſed in the following manner :

"Let the ſand be ſifted in ſtreaming clear water, through a ſieve which ſhall give paſſage to all ſuch grains as do not exceed one-ſixteenth of an inch in diameter ; and let the ſtream of water and the ſifting be regulated ſo that all the ſand, which is much finer than the Lynn-ſand commonly uſed in the London glaſs-houſes, together with clay and every other matter ſpecifically lighter than ſand, may be waſhed away with the ſtream, whilſt the purer and coarſer ſand, which paſſes through the ſieve, ſubſides in a convenient receptacle, and whilſt the coarſe rubbiſh and rubble remain on the ſieve to be rejected.

"Let the ſand which thus ſubſides in the receptacle be waſhed in clean ſtreaming water through a finer ſieve, ſo as to be further cleanſed and ſorted into two parcels ; a coarſer, which will remain in the ſieve which is to give paſſage to ſuch grains of ſand only as are leſs than one-thirtieth of an inch in diameter, and which is to be ſaved apart under the name of *coarſe ſand ;* and a finer, which will paſs through the ſieve and ſubſide in the water, and which is to be ſaved apart under the name of *fine ſand.*—Let the coarſe and the fine ſand be dried ſeparately, either in the ſun or on a clean iron-plate, ſet on a convenient ſurface, in the manner of a ſand-heat (B).

"Let lime be choſen (C) which is ſtone-lime, which heats the moſt in ſlaking, and ſlakes the quickeſt when duly watered ; which is the freſheſt made and cloſeſt kept ; which diſſolves in diſtilled vinegar with the leaſt effervefcence, and leaves the ſmalleſt reſidue inſoluble, and in this reſidue the ſmalleſt quantity of clay, gypſum, or martial matter.

"Let the lime choſen according to theſe important rules be put in a braſs-wired ſieve to the quantity of 14 pounds. Let the ſieve be finer than either of the foregoing ; the finer, the better it will be : let the lime be ſlaked (D) by plunging it in a butt filled with ſoft water, and raiſing it out quickly and ſuffering it to heat and fume, and by repeating this plunging and raiſing alternately, and agitating the lime, until it be made to paſs through the ſieve into the water ; and let the part of the lime which does not eaſily paſs through the ſieve be rejected : and let freſh portions of the lime be thus uſed, until as many (E) ounces of lime have paſſed through the ſieve as there are quarts of water in the butt. Let the water thus impregnated ſtand in the butt cloſely covered (F) until it becomes clear ; and through wooden (G) cocks placed at different heights in the butt, let the clear liquor be drawn off as faſt (H) and

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(A) "This is commonly called *pit-ſand.*

(B) "The ſand ought to be ſtirred up continually until it is dried, and is then to be taken off ; for otherwiſe the evaporation will be very ſlow, and the ſand which lies next the iron-plate, by being overheated, will be diſcoloured.

(C) "The preference given to ſtone-lime is founded on the preſent practice in the burning of lime, and on the cloſer texture of it, which prevents it from being ſo ſoon injured by expoſure to the air as the more ſpongy chalk-lime is ; not on the popular notion that ſtone-lime has ſomething in it whereby it excels the beſt chalk in the cementing properties. The gypſum contained in lime-ſtone remains unaltered, or very little altered, in the lime, after the burning ; but it is not to be expected that clay or martial matter ſhould be found in their native ſtate in well-burned lime ; for they concrete or vitrify with a part of the calcareous earth, and conſtitute the hard grains or lumps which remain undiſſolved in weak acids, or are ſeparable from the ſlaked lime by ſifting it immediately through a ſieve.

(D) "This method of impregnating the water with lime is not the only one which may be adopted. It is, however, preferred before others, becauſe the water clears the ſooner in conſequence of its being warmed by the ſlaking lime ; and the gypſeous part of the lime does not diffuſe itſelf in the water ſo freely in this way as it does when the lime is ſlaked to fine powder in the common method, and is then blended with the water ; for the gypſeous part of the lime ſlakes at firſt into grains rather than into fine powder, and will remain on the ſieve after the pure lime has paſſed through, long enough to admit of the intended ſeparation ; but when the lime is otherwiſe ſlaked, the gypſeous grains have time to ſlake to a finer powder, and paſſing through the ſieve, diſſolve in the water along with the lime. I have imagined that other advantages attended this method of preparing the lime-water, but I cannot yet ſpeak of them with preciſion.

(E) "If the water contains no more acidulous gas than is uſually found in river or rain water, a fourth part of this quantity of lime, or leſs, will be ſufficient.

(F) "The calcareous cruſt which forms on the ſurface of the water ought not to be broken, for it aſſiſts in excluding the air, and preventing the abſorption of acidulous gas whereby the lime-water is ſpoiled.

(G) "Braſs cocks are apt to colour a part of the liquor.

(H) "Lime-water cannot be kept many days unimpaired, in any veſſels that are not perfectly air-tight. If the liquor be drawn off before it clears, it will contain whiting, which is injurious ; and if it be not inſtantly as low as the lime ſubſides, for uſe. This clear liquor I call the *cementing liquor* (I). The freer the water is from ſaline matter, the better will be the cementing liquor made with it.

"Let 56 pounds of the aforeſaid choſen lime be ſlaked, by gradually ſprinkling on it, and eſpecially on the unſlaked pieces, the cementing liquor, in a cloſe (K) clean place. Let the ſlaked part be immediately (L) ſifted through the laſt-mentioned fine braſs-wired ſieve: Let the lime which paſſes be uſed inſtantly, or kept in air-tight veſſels, and let the part of the lime which does not paſs through the ſieve be rejected (M).—This finer richer part of the lime which paſſes through the ſieve I call *purified lime*.

"Let bone-aſh be prepared in the uſual manner, by grinding the whiteſt burnt bones, but let it be ſifted, to be much finer than the bone-aſh commonly ſold for making cupels.

"The moſt eligible materials for making my cement being thus prepared, take 56 pounds of the coarſe ſand and 42 pounds of the fine ſand; mix them on a large plank of hard wood placed horizontally; then ſpread the ſand ſo that it may ſtand to the height of ſix inches, with a flat ſurface on the plank; wet it with the cementing liquor; and let any ſuperfluous quantity of the liquor, which the ſand in the condition deſcribed cannot retain, flow away off the plank. To the welteſt ſand add 14 pounds of the putrefied lime in ſeveral ſucceſſive portions, mixing and beating them up together in the mean time with the inſtruments generally uſed in making fine mortar: then add 14 pounds of the bone-aſh in ſucceſſive portions, mixing and beating all together. The quicker and the more perfectly theſe materials are mixed and beaten together, and the ſooner the cement thus formed is uſed, the better (N) it will be. This I call the *water-cement coarſe-grained*, which is to be applied in building, pointing, plaſtering, ſtuccoing, or other work, as mortar and ſtucco now are; with this difference chiefly, that as this cement is ſhorter than mortar or common ſtucco, and dries ſooner, it ought to be worked expeditiouſly in all caſes; and in ſtuccoing, it ought to be laid on by ſliding the trowel upwards on it; that the materials uſed along with this cement in building, or the ground on which it is to be laid in ſtuccoing, ought to be well wetted with the cementing liquor in the inſtant of laying on the cement; and that the cementing liquor is to be uſed when it is neceſſary to moiſten the cement, or when a liquid is required to facilitate the floating of the cement.

"When ſuch cement is required to be of a finer texture, take 98 pounds of the fine ſand, wet it with the cementing liquor, and mix it with the purified lime and the bone-aſh in the quantities and in the manner above deſcribed; with this difference only, that 15 pounds of lime, or (O) thereabouts, are to be uſed inſtead of 14 pounds, if the greater part of the ſand be as fine as Lynn-ſand. This I call *water-cement fine-grained*. It is to be uſed in giving the laſt coating, or the finiſh to any work intended to imitate the finer-grained ſtones or ſtucco. But it may be applied to all the uſes of the water-cement coarſe-grained, and in the ſame manner.

"When for any of the foregoing purpoſes of pointing, building, &c. ſuch a cement is required much cheaper and coarſer grained, then much coarſer clean ſand than the foregoing coarſe ſand, or well-waſhed fine rubble, is to be provided. Of this coarſe ſand or rubble take 56 pounds, of the foregoing coarſe ſand 28 pounds, and of the fine ſand 14 pounds; and after mixing theſe, and wetting them with the cementing liquor in the foregoing manner, add 14 pounds, or ſomewhat leſs, of the (P) purified lime, and then 14 pounds or ſomewhat leſs

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uſed after it is drawn limpid from the butt into open veſſels, it will grow turbid again, and depoſit the lime changed to whiting by the gas abſorbed from the air. The calcareous matter which ſubſides in the butt reſembles whiting the more nearly as the lime has been more ſparingly employed; in the contrary circumſtances, it approaches to the nature of lime; and in the intermediate ſtate, it is fit for the common compoſition of the plaſterers for inſide ſtucco.

(I) "At the time of writing this ſpecification, I preferred this term before that of lime-water, on grounds which I had not ſufficiently examined.

(K) "The vapour which ariſes in the ſlaking of lime contributes greatly to the ſlaking of theſe pieces which lie in its way; and an unneceſſary waſte of the liquor is prevented, by applying it to the lime heaped in a pit or in a veſſel, which may reſtrain the iſſue of the vapour, and direct it through the maſs. If more of the liquor be uſed than is neceſſary to ſlake the lime, it will create error in weighing the ſlaked powder, and will prevent a part of it from paſſing freely through the ſieve. The liquid is therefore to be uſed ſparingly, and the lime which has eſcaped its action is to be ſprinkled apart with freſh liquor.

(L) "When the aggregation of the lumps of lime is thus broken, it is impaired much ſooner than it is in the former ſtate, becauſe the air more freely pervades it.

(M) "Becauſe it conſiſts of heterogeneous matter or of ill-burnt lime; which laſt will ſhake and paſs through the ſieve, if the lime be not immediately ſifted after the ſlaking, agreeable to the text.

(N) "Theſe proportions are intended for a cement made with ſharp ſand, for incruſtation in expoſed ſituations, where it is neceſſary to guard againſt the effects of hot weather and rain. In general, half this quantity of bone-aſhes will be found ſufficient; and although the incruſtation in this latter caſe will not harden deeply ſo ſoon, it will be ultimately ſtronger, provided the weather be favourable.

"The injuries which lime and mortar ſuſtain by expoſure to the air, before the cement is finally placed in a quieſcent ſtate, are great; and therefore our cement is the worſe for being long beaten, but the better as it is quickly beaten until the mixture is effected, and no longer.

(O) "The quantity of bone-aſhes is not to be increaſed with that of the lime; but it is to be leſſened as the expoſure and purpoſes of the work will admit.

(P) "Becauſe leſs lime is neceſſary, as the ſand is coarſer.

leſs of the bone-aſh, mixing them together in the manner already deſcribed. When my cement is required to be white, white ſand, white lime, and the whiteſt bone-aſh are to be choſen. Gray ſand, and gray bone-aſh formed of half-burnt bones, are to be choſen to make the cement gray; and any other colour of the cement is obtained, either by chooſing coloured ſand, or by the admixture of the neceſſary quantity of coloured talc in powder, or of coloured, vitreous, or metallic powders, or other durable colouring ingredients commonly uſed in paint.

" To the end that ſuch a water-cement as I have deſcribed may be made as uſeful as it is poſſible in all circumſtances; and that no perſon may imagine that my claim and right under theſe letters patent may be eluded by divers variations, which may be made in the foregoing proceſs without producing any notable defect in the cement; and to the end that the principles of this art, as well as the art itſelf, of making my cement, may be gathered from this ſpecification and perpetuated to the public; I ſhall add the following obſervations:

" This my water-cement, whether the coarſe or fine-grained, is applicable in forming artificial ſtone, by making alternate layers of the cement and of flint, hard ſtone, or brick, in moulds of the figure of the intended ſtone, and by expoſing the maſſes ſo formed to the open (Q) air to harden.

" When ſuch cement is required for water (R) fences, two-thirds of the preſcribed quantity of bone-aſhes are to be omitted; and in the place thereof an equal meaſure of powdered terras is to be uſed; and if the ſand employed be not of the coarſeſt ſort, more terras muſt be added, ſo that the terras ſhall be by weight one-ſixth part of the weight of the ſand.

" When ſuch a cement is required of the fineſt grain (S) or in a fluid form, ſo that it may be applied with a bruſh, flint powder, or the powder of any quartoſe or hard earthy ſubſtance, may be uſed in the place of ſand; but in a quantity ſmaller, as the flint or other powder is finer; ſo that the flint-powder, or other ſuch powder, ſhall not be more than ſix times the weight of the lime, nor leſs than four times its weight. The greater the quantity of lime within theſe limits, the more will the cement be liable to crack by quick drying, and *vice verſa*.

" Where ſuch ſand as I prefer cannot be conveniently procured, or where the ſand cannot be conveniently waſhed and ſorted, that ſand which moſt reſembles the mixture of coarſe and fine ſand above preſcribed, may be uſed as I have directed, provided due attention is paid to the quantity of the lime, which is to be greater (T) as the quantity is finer, and *vice verſa*.

" Where ſand cannot be eaſily procured, any durable ſtony body, or baked earth groſsly powdered (U), and ſorted nearly to the ſizes above preſcribed for ſand, may be uſed in the place of ſand, meaſure for meaſure, but not weight for weight, unleſs ſuch groſs powder be as heavy ſpecifically as ſand.

" Sand may be cleanſed from every ſofter, lighter, and leſs durable matter, and from that part of the ſand which is too fine, by various methods preferable (X), in certain circumſtances, to that which I have deſcribed.

" Water may be found naturally free from fixable gas, ſelenite, or clay; ſuch water may, without any notable inconvenience, be uſed in the place of the cementing liquor; and water approaching this ſtate will not require ſo much lime as I have ordered to make the cementing liquor; and a cementing liquor ſufficiently uſeful may be made by various methods of mixing lime and water in the deſcribed proportions, or nearly ſo.

" When ſtone-lime cannot be procured, chalk-lime, or ſhell-lime, which beſt reſembles ſtone-lime, in the characters above written of lime, may be uſed in the manner

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(Q) " But they muſt not be expoſed to the rain until they are almoſt as ſtrong as freſh Portland ſtone; and even then they ought to be ſheltered from it as much as the circumſtances will admit. Theſe ſtones may be made very hard and beautiful, with a ſmall expence of bone-aſh, by ſoaking them, after they have dried thoroughly and hardened, in the lime liquor, and repeating this proceſs twice or thrice, at diſtant intervals of time. The like effect was experienced in incruſtations.

(R) " In my experiments, mortar made with terras-powder, in the uſual method, does not appear to form ſo ſtrong a cement for water-fences as that made, according to the ſpecification, with coarſe ſand; and I ſee no more reaſon for avoiding the uſe of ſand in terras-mortar, than there would be for rejecting ſtone from the embankment. The bone-aſhes meant in this place are the dark gray or black ſort. I am not yet fully ſatisfied about the operation of them in this inſtance.

(S) " The qualities and uſes of ſuch fine calcareous cement are recommended chiefly for the purpoſe of ſmoothing and finiſhing the ſtronger cruſtaceous works, or for waſhing walls to a lively and uniform colour. For this laſt intention, the mixture muſt be as thin as new cream, and laid on briſkly with a bruſh, in dry weather; and a thick and durable coat is to be made by repeated waſhing; but is not to be attempted by uſing a thicker liquor; for the coat made with this laſt is apt to ſcale, whilſt the former endures the weather much longer than any other thin calcareous covering that has been applied in this way. Fine yellow-ochre is the cheapeſt colouring ingredient for ſuch waſh, when it is required to imitate Bath-ſtone, or the warm-white ſtones.

(T) " If ſea-ſand be well waſhed in freſh water, it is as good as any other round ſand.

(U) " The cement made with theſe and the proper quantities of purified lime and lime-water, are inferior to the beſt, as the grains of theſe powders are more periſhable and brittle than thoſe of ſand. They will not therefore be employed, unleſs for the ſake of evaſion, or for want of ſand: in this latter caſe, the finer powder ought to be waſhed away.

(X) " This and the next paragraph is inſerted with a view to evaſions, as well as to ſuggeſt the eaſier and cheaper methods which may be adopted in certain circumſtances, by artiſts who underſtand the principles which I endeavoured to teach.

manner deſcribed, except that fourteen pounds and a half of chalk-lime will be required in the place of fourteen pounds of ſtone-lime. The proportion of lime which I have preſcribed above may be increaſed without inconvenience, when the cement or ſtucco is to be applied where it is not liable to dry quickly; and in the contrary circumſtance, this proportion may be diminiſhed; and the defect of lime in quantity or quality may be very advantageouſly ſupplied (y), by cauſing a conſiderable quantity of the cementing liquor to ſoak into the work, in ſucceſſive portions, and at diſtant intervals of time, ſo that the calcareous matter of the cementing liquor, and the matter attracted from the open air, may fill and ſtrengthen the work.

"The powder of almoſt every well-dried or burnt animal ſubſtance may be uſed inſtead of bone-aſh; and ſeveral earthy powders, eſpecially the micaceous and the metallic; and the elixated aſhes of divers vegetables whoſe earth will not burn to lime; and the aſhes of mineral fuel, which are of the calcareous kind, but will not burn to lime, will anſwer the ends of bone-aſh in ſome degree.

"The quantity of bone-aſh deſcribed may be leſſened without injuring the cement, in thoſe circumſtances eſpecially which admit the quantity of lime to be leſſened, and in thoſe wherein the cement is not liable to dry quickly. And the art of remedying the defects of lime may be advantageouſly practiſed to ſupply the deficiency of bone aſh, eſpecially in building, and in making artificial ſtone with this cement."

STUD, in the manege, a collection of breeding horſes and mares.

STUDDING-SAILS, certain light ſails extended, in moderate and ſteady breezes, beyond the ſkirts of the principal ſails, where they appear as wings upon the yard-arms.

STUFF, in commerce, a general name for all kinds of fabrics of gold, ſilver, ſilk, wool, hair, cotton, or thread, manufactured on the loom; of which number are velvets, brocades, mohairs, ſatins, taffetas, cloths, ſerges, &c.

STUKELY, Dr William, a celebrated antiquarian, deſcended from an ancient family in Lincolnſhire, was born at Holbech in 1687, and educated in Bennet college, Cambridge. While an under graduate, he often indulged a ſtrong propenſity to drawing and deſigning; but made phyſic his principal ſtudy, and firſt began to practiſe at Boſton in his native country. In 1717 he removed to London, where, on the recommendation of Dr Mead, he was ſoon after elected a fellow of the Royal Society; he was one of the firſt who revived that of the antiquarians in 1718, and was their ſecretary for many years during his reſidence in town. In 1729 he took holy orders by the encouragement of Archbiſhop Wake; and was ſoon after preſented by Lord-chancellor King with the living of All-Saints in Stamford. In 1741 he became one of the founders of the Egyptian ſociety, which brought him acquainted with the benevolent duke of Montague, one of the members; who prevailed on him to leave Stamford, and preſented him to the living of St George the Martyr, Queen Square. He died of a ſtroke of the palſy in 1765. In his medical capacity, his Diſſertation on the Spleen was well received; and his *Itinerarium Curioſum*, the firſt fruit of his juvenile excurſions, was a good ſpecimen of what was to be expected from his riper age. His great learning, and profound reſearches into the dark remains of antiquity, enabled him to publiſh many elaborate and curious works: his friends uſed to call him the *arch-druid* of his age. His diſcourſes, intitled *Palæographia Sacra*, on the vegetable creation, beſpeak him a botaniſt, philoſopher, and divine.

STUM, in the wine-trade, denotes the unfermented juice of the grape after it has been ſeveral times racked off and ſeparated from its ſediment. The caſks are for this purpoſe well matched or fumigated with brimſtone every time, to prevent the liquor from fermenting, as it would otherwiſe readily do, and become wine. See Must.

STUPIDITY. The Greek word μωροτης correſponds moſt with our Engliſh word *ſtupidity* or *fooliſhneſs*, when uſed to expreſs that ſtate of mind in which the intellects are defective. The immediate cauſes are ſaid to be, a deficiency of vital heat, or a defect in the brain. Stupid children ſometimes become ſprightly youths; but if ſtupidity continues to the age of puberty, it is hardly ever removed. If ſtupidity follows upon a violent paſſion, an injury done to the head, or other evident cauſe, and if it continues long, it becomes incurable. But the ſtupidity which conſiſts in a loſs of memory, and ſucceeds a lethargy, ſpontaneouſly ceaſes when the lethargy is cured.

STUPOR, a numbneſs in any part of the body, whether occaſioned by ligatures obſtructing the blood's motion, by the palſy, or the like.

STUPPA, or Stupe, in *Medicine*, is a piece of cloth dipped in ſome proper liquor, and applied to an affected part.

STURDY, a diſtemper to which cattle are ſubject, called alſo the *turning evil*. See Farriery *Index*.

STURGEON. See Accipenser, Ichthyology *Index*.

STURMIUS, John, a learned philologer and rhetorician, was born at Sleida in Eiſel near Cologne in 1507. He ſtudied at firſt in his native country with the ſons of Count de Manderſcheid, whoſe receiver his father was. He afterwards purſued his ſtudy at Liege in the college of St Jerome, and then went to Louvain in 1524. Five years he ſpent there, three in learning and two in teaching. He ſet up a printing-preſs with Rudger Reſcius profeſſor of the Greek tongue, and printed ſeveral Greek authors. He went to Paris in 1529, where he was highly eſteemed, and read public lectures on the Greek and Latin writers, and on logic. He married there, and kept a great number of boarders: but as he liked what were called the *new opinions*, he was more than once in danger; and this undoubtedly was the reaſon why he removed to Straſburg in 1537, in order to take poſſeſſion of the place offered him by the magiſtrates. The year following he opened a ſchool, which became

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(y) "This practice is noticed, as the remedy which may be uſed for the defects ariſing from evaſive meaſures, and as the method of giving ſpongy incruſtations containing bone-aſhes the greateſt degree of hardneſs."

became famous, and by his means obtained of Maximilian II. the title of an univerſity in 1566. He was very well ſkilled in polite literature, wrote Latin with great purity, and was a good teacher. His talents were not confined to the ſchool; for he was frequently intruſted with deputations in Germany and foreign countries, and diſcharged theſe employments with great honour and diligence. He ſhowed extreme charity to the refugees on account of religion: He not only laboured to aſſiſt them by his advice and recommendations; but he even impoveriſhed himſelf for them. He died in his 82d year, after he had been for ſome time blind. He publiſhed many books; the principal of which are, 1. *Partitiones Dialecticæ*. 2. *De Educatione Principum*. 3. *De Nobilitate Anglicana*. 4. *Linguæ Latinæ reſolvendæ Ratio*. 5. Excellent Notes on Ariſtotle's and Hermogenes's Rhetoric, &c.

He ought not to be confounded with *John Sturmius*, a native of Mechlin, and phyſician and profeſſor of mathematics at Louvain, who alſo wrote ſeveral works.

STURNUS, the STARLING; a genus of birds belonging to the order of paſſeres. See ORNITHOLOGY *Index*.

STYE, or STYTHE, in the eye. See CRITHE.

STYLE, a word of various ſignifications, originally deduced from *ſtylos*, a kind of bodkin wherewith the ancients wrote on plates of lead, or on wax, &c. and which is ſtill uſed to write on ivory-leaves and paper prepared for that purpoſe, &c.

STYLE, in dialling, denotes the gnomon or cock of a dial raiſed on the plane thereof to project a ſhadow.

STYLE, in *Botany*. See BOTANY.

STYLE, in language, is the peculiar manner in which a man expreſſes his conceptions. It is a picture of the ideas which riſe in his mind, and of the order in which they are there produced.

The qualities of a good ſtyle may be ranked under two heads; perſpicuity and ornament. It will readily be admitted, that perſpicuity ought to be eſſentially connected with every kind of writing; and to attain it, attention muſt be paid, firſt to ſingle words and phraſes, and then to the conſtruction of ſentences. When conſidered with reſpect to words and phraſes, it requires theſe three qualities; purity, propriety, and preciſion. When conſidered with regard to ſentences, it requires a clear arrangement of the words and unity in the ſenſe; to which, if ſtrength and harmony be added, the ſtyle will become ornamented.

One of the moſt important directions to be obſerved by him who wiſhes to form a good ſtyle, is to acquire clear and preciſe ideas on the ſubject concerning which he is to write or ſpeak. To this muſt be added frequency of compoſition, and an acquaintance with the ſtyle of the beſt authors. A ſervile imitation, however, of any author is carefully to be avoided; for he who copies, can hardly avoid copying faults as well as beauties. A ſtyle cannot be proper unleſs it be adapted to the ſubject, and likewiſe to the capacity of our hearers, if we are to ſpeak in public. A ſimple, clear, and unadorned ſtyle, ſuch as that of Swift, is fitteſt for intricate diſquiſition; a ſtyle elegant as Addiſon's, or impetuous like Johnſon's, is moſt proper for fixing the attention on truths, which, though known, are too much neglected. We muſt not be inattentive to the ornaments of ſtyle, if we wiſh that our labours ſhould be read and admired: but he is a contemptible writer, who looks not beyond the dreſs of language, who lays not the chief ſtreſs upon his matter, and who does not regard ornament as a ſecondary and inferior recommendation. For further obſervations on the different kinds of ſtyle, ſee ORATORY, N° 99, &c.

STYLE, in *Juriſprudence*, the particular form or manner of proceeding in each court of juriſdiction, agreeable to the rules and orders eſtabliſhed therein: thus we ſay, the ſtyle of the court of Rome, of chancery, of parliament, of the privy-council, &c.

STYLE, in *Muſic*, denotes a peculiar manner of ſinging, playing, or compoſing; being properly the manner that each perſon has of playing, ſinging, or teaching; which is very different both in reſpect of different geniuſes, of countries, nations, and of the different matters, places, times, ſubjects, paſſions, expreſſions, &c. Thus we ſay, the ſtyle of Paleſtrina, of Lully, of Corelli, of Handel, &c.; the ſtyle of the Italians, French, Spaniards, &c.

Old STYLE, the Julian method of computing time, as the

New STYLE is the Gregorian method of computation. See KALENDAR.

STYLEPHORUS CHORDATUS, a genus of fiſhes belonging to the order of apodes. See ICHTHYOLOGY *Index*, and Tranſactions of the Linnæan Society, vol. i.

STYLET, a ſmall dangerous kind of poniard which may be concealed in the hand, chiefly uſed in treacherous aſſaſſinations. The blade is uſually triangular, and ſo ſmall that the wound it makes is almoſt imperceptible.

STYLITES, PILLAR SAINTS, in eccleſiaſtical hiſtory, an appellation given to a kind of ſolitaries, who ſtood motionleſs upon the tops of pillars, raiſed for this exerciſe of their patience, and remained there for ſeveral years, amidſt the admiration and applauſe of the ſtupid populace. Of theſe we find ſeveral mentioned in ancient writers, and even as low as the twelfth century, when they were totally ſuppreſſed.

The founder of the order was St Simeon Stylites, a famous anchoret in the fifth century, who firſt took up his abode on a column ſix cubits high; then on a ſecond of twelve cubits, a third of twenty-two, a fourth of thirty-ſix, and on another of forty cubits, where he thus paſſed thirty-ſeven years of his life. The tops of theſe columns were only three feet in diameter, and were defended by a rail that reached almoſt to the girdle, ſomewhat reſembling a pulpit. There was no lying down in it. The faquirs, or devout people of the Eaſt, imitate this extraordinary kind of life to this day.

STYLOCERALOIDES,
STYLO-GLOSSUS,
STYLO-Hyoidæus,
STYLO-Pharyngæus,
STYLOIDES,
} The names of different muſcles in the human body. See *Table of the Muſcles* under ANATOMY.

STYLOSANTHES, a genus of plants belonging to the *diadelphia* claſs, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

STYPTIC, in *Pharmacy*, a medicine which by its aſtringency ſtops hæmorrhagies, &c. See MATERIA MEDICA *Index*.

STYRAX, the STORAX-TREE, a genus of plants belonging to the claſs *decandria*, and in the natural ſyſtem ranging under the 18th order, *Bicornes*. See BOTANY and MATERIA MEDICA *Index*.

STYX, in *Fabulous Hiſtory*, a celebrated river of hell, round which it flows nine times. The gods held the waters of the Styx in ſuch veneration, that to ſwear by them was reckoned an oath altogether inviolable. If any of the gods had perjured themſelves, Jupiter obliged them to drink the waters of the Styx, which lulled them for one whole year into a ſenſeleſs ſtupidity, for the nine following years they were deprived of the ambroſia and the nectar of the gods, and after the expiration of the years of their puniſhment, they were reſtored to the aſſembly of the deities, and to all their original privileges. It is ſaid that this veneration was ſhown to the Styx, becauſe it received its name from the nymph Styx, who with her three daughters aſſiſted Jupiter in his war againſt the Titans.

Tranſactions of the Royal Society of Edinburgh, vol. ii.

Styx was a river which it was neceſſary for departed ſhades to paſs before they could enter the infernal regions; and it was the office of Charon to ferry them over in a boat which was kept for that purpoſe. The ghoſts of thoſe who had not been honoured with the rites of ſepulture were obliged to wander an hundred years before Charon could admit them into his boat to convey them before the judges of Hades. What could have given riſe to this fable of Charon and his boat, it is not very material to inquire. Mythological writers have ſaid, that the Greeks learned it from the Egyptians, which is indeed probable enough; that the Egyptians framed both this, and ſome other fables relating to the dead, from certain cuſtoms peculiar to their country; that in particular there was, not far from Memphis, a famous burying-place, to which the dead bodies were conveyed in a boat acroſs the lake Acheruſia; and that Charon was a boatman who had long officiated in that ſervice. The learned Dr Blackwell ſays, in his life of Homer, that, in the old Egyptian language, *Charoni* ſignified "ferryman."

SUABIA, a circle of Germany, bounded on the north by the circle of Franconia and that of the Lower Rhine; on the weſt by the circle of the Lower Rhine and Alſace; on the ſouth by Switzerland; and on the eaſt by the circle of Bavaria. Of all the circles of the empire, Suabia is the moſt divided; it contains four eccleſiaſtic and thirteen lay principalities, nineteen independent prelacies and abbeys, twenty-ſix earldoms and lordſhips, and thirty-one free cities. The prime directors of the circle, as they are termed, were formerly the biſhop of Conſtance and the duke of Wirtemberg. But this circle has ſuffered ſimilar changes with neighbouring ſtates.

Baron Rieſbeck's Travels through Germany, vol. 1.

The mixture of the various forms of government and religious ſects; the oppreſſion exerciſed by the great on the poor; the game conſtantly played by the emperor, who poſſeſſes many pieces of detached country in Suabia, which depend not on the circle, and can, in conſequence of his privileges as archduke of Auſtria, extend his poſſeſſions in it by various ways; are circumſtances (ſays Baron Rieſbeck) which give the cultivation of the country, and the character of the inhabitants, a moſt extraordinary caſt. In ſeveral of the poſt towns where you ſtop, you ſee the higheſt degree of cultivation in the midſt of the moſt ſavage wildneſs; a great degree of knowledge and poliſh of manners, mixed with the groſſeſt ignorance and ſuperſtition; traces of liberty, under the deepeſt oppreſſion; national pride, together with the contempt and neglect of the native country; in ſhort, all the ſocial qualities in ſtriking contraſt and oppoſition to each other. Thoſe parts of Suabia which belong to the great potentates, ſuch as Wirtemberg, Auſtria, and Baden, are certainly the moſt improved. The whole of Suabia may comprehend about nine hundred German ſquare miles, and two millions of people. More than half of theſe are ſubjects of the three abovementioned princes, though they are not proprietors of near one half of the lands.

SUARES, FRANCIS, a Jeſuit, was born in Granada in Spain, in January 1548. He was a profeſſor of theology at Alcala, Salamanca, Rome, and Coimbra in Portugal. He died at Liſbon in 1617 with the greateſt reſignation; "I never thought (ſaid he) that it was ſo eaſy to die." His memory was aſtoniſhing, he could repeat the whole of his voluminous works by heart. His writings fill 23 folio volumes, and are moſtly on theological and moral ſubjects. His Treatiſe of Laws has been reprinted in this country. His Defence of the Catholic Faith againſt the Errors of England was written at the requeſt of Pope Paul V. This book was publicly burnt at London by order of James I. When Suares heard it, he is ſaid to have exclaimed, "O that I too could ſeal with my blood the truths which I have defended with my pen!"

SUBAH, the general name of the viceroyſhips, or greater governments, into which the Mogul empire was divided, conſiſting of ſeveral provinces. The juriſdiction of a ſubahdar, the ſame as ſubahſhip, ſubaedaree, or nizamut.

SUBAHDAR, the viceroy, lord-lieutenant, or governor, holding a ſubah; the ſame as nabob or nazim. Alſo the black commander of a company of ſeapoys.

SUBALTERN, a ſubordinate officer, or one who diſcharges his poſt under the command and ſubject to the direction of another; ſuch are lieutenants, ſub-lieutenants, cornets, and enſigns, who ſerve under the captain.

SUBCLAVIAN, in *Anatomy*, is applied to any thing under the armpit or ſhoulder, whether artery, nerve, vein, or muſcle.

SUBDEACON, an inferior miniſter, who anciently attended at the altar, prepared the ſacred veſſels, delivered them to the deacons in time of divine ſervice, attended the doors of the church during communion-ſervice, went on the biſhop's embaſſies with his letters or meſſages to foreign churches, and was inveſted with the firſt of the holy orders. They were ſo ſubordinate to the ſuperior rulers of the church, that, by a canon of the council of Laodicea, they were forbidden to ſit in the preſence of a deacon without his leave. According to the canons, a perſon muſt be twenty-two years of age to be promoted to the order of ſubdeacon. See DEACON.

SUBDOMINANT, in *Muſic*, a name given by M. Rameau to the fourth note of the tone, which of conſequence is the ſame interval from the tonic when deſcending as the dominant in riſing. This denomination ariſes from the affinity which this author finds by inverſion between the minor mode of the ſubdominant and the major mode of the tonic.

SUBDUPLE RATIO, is when any number or quantity is contained in another twice. Thus 3 is ſaid to be ſubduple of 6, as 6 is duple of 3. See RATIO.

SUBDUPLICATE RATIO of any two quantities, is the ratio of their ſquare roots.

SUBER, the ſpecific name of the CORK-TREE. See QUERCUS, BOTANY *Index*.

SUBJECT, a perſon under the rule and dominion of a ſovereign prince or ſtate.

SUBJECT is alſo uſed for the matter of an art or ſcience, or that which it conſiders, or whereon it is employed: thus the human body is the ſubject of medicine.

SUBINFEUDATION, was where the inferior lords, in imitation of their ſuperiors, began to carve out and grant to others minuter eſtates than their own, to be held of themſelves; and were ſo proceeding downwards *in infinitum*, till the ſuperior lords obſerved, that by this method of ſubinfeudation they loſt all their feodal profits, of wardſhips, marriages, and eſcheats, which fell into the hands of theſe meſne or middle lords, who were the immediate ſuperiors of the terre-tenant, or him who occupied the land. This occaſioned the ſtat. of Weſtm. 3. or *quia emptores*, 18 Edw. I. to be made; which directs, that, upon all ſales or feoffments of lands, the feoffee ſhall hold the ſame, not of his immediate feoffer, but of the chief lord of the fee of whom ſuch feoffer himſelf held it. And from hence it is held, that all manors exiſting at this day muſt have exiſted by immemorial preſcription; or at leaſt ever ſince the 18 Edw. I. when the ſtatute of *quia emptores* was made.

Blackſt Comment. vol. ii.

SUBITO, in the Italian muſic, is uſed to ſignify that a thing is to be performed quickly and haſtily: thus we meet with *volti ſubito*, turn over the leaf quickly.

SUBJUNCTIVE, in *Grammar*. See GRAMMAR.

SUBLIMATE, a chemical preparation, conſiſting of quickſilver united with muriatic acid. See MERCURY, CHEMISTRY *Index*.

SUBLIMATION, in *Chemiſtry*, the condenſing and collecting, in a ſolid form, by means of veſſels aptly conſtructed, the fumes of bodies raiſed from them by the application of a proper heat.

SUBLIME, or SUBLIMITY. See the article GRANDEUR and SUBLIMITY.

SUBLINGUAL ARTERY. See ANATOMY.

SUBLINGUAL Glands, in *Anatomy*, two glands under the tongue, placed one on each ſide thereof.

SUBMULTIPLE, in *Geometry*, &c. A ſubmultiple number, or quantity, is that which is contained a certain number of times in another, and which, therefore, repeated a certain number of times, becomes exactly equal thereto. Thus 3 is a ſubmultiple of 21. In which ſenſe a ſubmultiple coincides with an aliquot part.

SUBMULTIPLE Ratio, is that between the quantity contained and the quantity containing. Thus the ratio of 3 to 21 is ſubmultiple. In both caſes ſubmultiple is the reverſe of multiple: 21, *e. gr.* being a multiple of 3, and the ratio of 21 to 3 a multiple ratio.

SUBORDINARIES. See HERALDRY, Chap. III. Sect. II.

SUBORDINATION, a relative term, expreſſing an inferiority betwixt one perſon and another.

SUBORNATION, in *Law*, a ſecret, underhand, preparing, inſtructing, or bringing in a falſe witneſs; and from hence *ſubornation of perjury* is the preparing or corrupt alluring to perjury. The puniſhment for this crime was formerly death, then baniſhment or cutting out the tongue, afterwards forfeitures of goods; and it is now a fine and impriſonment, and never more to be received as evidence. The ſtatute 2 Geo. II. c. 25. ſuperadded a power for the court to order the offender to be ſent to the houſe of correction for a term not exceeding ſeven years, or be tranſported for the ſame period.

SUBPOENA, in *Law*, a writ whereby common perſons are called into chancery, in ſuch caſes where the common law hath provided an ordinary remedy; and the name of it proceeds from the words therein, which charge the party called to appear at the day and place affirmed, *ſub pœna centum librarum*, &c. The ſubpœna is the leading proceſs in the courts of equity; and by ſtatute, when a bill is filed againſt any perſon, proceſs of ſubpœna ſhall be taken out to oblige the defendant to appear and anſwer the bill, &c.

SUBPOENA ad teſtificandum, a writ or proceſs to bring in witneſſes to give their teſtimony. If a witneſs on being ſerved with this proceſs does not appear, the court will iſſue an attachment againſt him; or a party, plaintiff or defendant, injured by his non-attendance, may maintain an action againſt the witneſs. See *Blackſt. Com.* vol. viii. p. 369.

SUBPOENA, in *Equity*, a proceſs in equity, calling on a defendant to appear and anſwer to the complainant's bill. See ſtatute 5th Geo. II. c. 25. which enacts, that where the party cannot be found to be ſerved with a ſubpœna, and abſconds (as is believed) to avoid being ſerved, a day ſhall be appointed him to appear to the bill of the plaintiff; which is to be inſerted in the London Gazette, read in the pariſh church where the defendant laſt lived, and fixed up at the Royal Exchange: and if the defendant doth not appear upon that day, the bill ſhall be taken *pro confeſſo*.

SUBREPTITIOUS, a term applied to a letter, licence, patent, or other act, fraudulently obtained of a ſuperior, by concealing ſome truth which, had it been known, would have prevented the conceſſion or grant.

SUBROGATION, or SURROGATION, in the civil law, the act of ſubſtituting a perſon in the place, and intitling him to the rights, of another. In its general ſenſe, ſubrogation implies a ſucceſſion of any kind, whether of a perſon to a perſon, or of a perſon to a thing.

There are two kinds of ſubrogation: the one *conventional*, the other *legal*. *Conventional* ſubrogation is a contract whereby a creditor transfers his debt, with all appurtenances thereof, to the profit of a third perſon. *Legal* ſubrogation is that which the law makes in favour of a perſon who diſcharges an antecedent creditor; in which caſe there is a legal tranſlation of all rights of the ancient creditor to the perſon of the new one.

SUBSCRIPTION, in general, ſignifies the ſignature put at the bottom of a letter, writing, or inſtrument.

In commerce, it is uſed for the ſhare or intereſt which particular perſons take in a public ſtock or a trading company, by writing their names, and the ſhares they require, in the backs or regiſter thereof.

SUBSCRIPTION to articles of faith is required of the clergy of every eſtabliſhed church, and of ſome churches not eſtabliſhed. Whether ſuch ſubſcription ſerves any good purpoſe, in a religious or theological view, is a very doubtful queſtion. It may be neceſſary in an eſtabliſhment, as a teſt of loyalty to the prince, and of attachment to the conſtitution, civil and eccleſiaſtical, but it cannot produce uniformity of opinion. As all language is more or leſs ambiguous, it becomes difficult, if not impoſſible, to determine in what ſenſe the words of long eſtabliſhed creeds are to be interpreted; and we believe that the clergy of the churches of England and Scotland ſeldom conſider themſelves as fettered by the Thirty-nine Articles, or the Confeſſion of Faith, when compoſing inſtructions either for their reſpective pariſhes or for the public at large. See Independents.

Subscription, in the commerce of books, ſignifies an engagement to take a certain number of copies of a book, intended to be printed, and a reciprocal obligation of the bookſeller or publiſher, to deliver the ſaid copies, on certain terms. Theſe ſubſcriptions, which had their riſe in England about the middle of the 17th century, were lately very frequent in France and Holland, and are now very common among ourſelves.

SUBSEQUENT, ſomething that comes after another, particularly with regard to the order of time.

SUBSIDY, in *Law*, ſignifies an aid or tax granted to the king by parliament, for the neceſſary occaſions of the kingdom; and is to be levied on every ſubject of ability, according to the rate or value of his lands or goods: but this word, in ſome of our ſtatutes, is confounded with that of cuſtoms. See Tax.

SUBSTANCE, the ſubjects to which we ſuppoſe qualities belong. Thus gold is the ſubſtance which the qualities of ductility, yellowneſs, denſity, &c. belong. See Metaphysics, N° 145.

SUBSTANTIAL, in the ſchools, ſomething belonging to the nature of ſubſtance.

SUBSTANTIVE, in *Grammar*. See Grammar.

SUBSTITUTE, a perſon who officiates for another in his abſence.

SUBSTITUTION, in the *Civil Law*, a diſpoſition of a teſtament, whereby the teſtator ſubſtitutes one heir for another, who has only the uſufruct, and not the property of the thing, left him.

SUBSTRACTION, or Subtraction, in *Arithmetic*, the ſecond rule, or rather operation, in arithmetic, whereby we deduct a leſs number from a greater, to learn their preciſe difference. See Arithmetic and Algebra.

SUBTANGENT of a curve, the line that determines the interſection of a tangent with the axis; or that determines the point wherein the tangent cuts the axis prolonged.

SUBTENSE, formed from *ſub* "under," and *tendo* "I ſtretch," in *Geometry*, a right line which is oppoſite to an angle, and drawn between the two extremities of the arc which meaſures that angle.

SUBTERRANEOUS, whatever is under ground: thus naturaliſts ſpeak of ſubterraneous fires, ſubterraneous damps, &c.

Subterraneous Cavern. See Quarries.

SUBTILE, in *Phyſics*, an appellation given to whatever is extremely ſmall, fine, and delicate; ſuch as the animal ſpirits, the effluvia of odorous bodies, &c. are ſuppoſed to be.

SUBULARIA, Rough-leaved Alysson, or *Awlwort*, a genus of plants belonging to the claſs tetradynamia, and in the natural order ranging under the 39th order, *Siliquoſæ*. See Botany *Index*.

SUBULATED, ſomething ſhaped like an awl.

SUCCEDANEUM, in *Pharmacy*, denotes a drug ſubſtituted in the place of another.

SUCCESSION, in *Metaphyſics*, the idea which we get by reflecting on the ideas that follow one another in our mind; and from the ſucceſſion of ideas we get the idea of *time*. See Metaphysics, N° 93. and 209.

Succession, in *Law*. See Descent.

Succession to the Crown. See *Hereditary Right*.—From the days of Egbert, the firſt ſole monarch of England, even to the preſent, the four cardinal maxims mentioned in that article have ever been held conſtitutional canons of ſucceſſion. It is true, as Sir William Blackſtone obſerves, this ſucceſſion, through fraud or force, or ſometimes through neceſſity, when in hoſtile times the crown deſcended on a minor or the like, has been very frequently ſuſpended; but has generally at laſt returned back into the old hereditary channel, though ſometimes a very conſiderable period has intervened. And even in thoſe inſtances where this ſucceſſion has been violated, the crown has ever been looked upon as hereditary in the wearer of it. Of which the uſurpers themſelves were ſo ſenſible, that they for the moſt part endeavoured to vamp up ſome feeble ſhow of a title by deſcent, in order to amuſe the people, while they gained the poſſeſſion of the kingdom. And, when poſſeſſion was once gained, they conſidered it as the purchaſe or acquiſition of a new eſtate of inheritance, and tranſmitted, or endeavoured to tranſmit it, to their own poſterity by a kind of hereditary right of uſurpation. (See Blackſt. Com. vol. i. 197—217.). From the hiſtorical view there given, it appears that the title to the crown is at preſent hereditary, though not quite ſo abſolutely hereditary as formerly: and the common ſtock or anceſtor, from whom the deſcent muſt be derived, is alſo different. Formerly the common ſtock was King Egbert; then William the Conqueror; afterwards, in James I.'s time, the two common ſtocks united; and ſo continued till the vacancy of the throne in 1688: now it is the Princeſs Sophia, in whom the inheritance was veſted by the new king and parliament. Formerly, the deſcent was abſolute, and the crown went to the heir without any reſtriction: but now, upon the new ſettlement, the inheritance is conditional: being limited to ſuch heirs only, of the body of the Princeſs Sophia, as are Proteſtant members of the church of England, and are married to none but Proteſtants.

And in this due medium conſiſts the true conſtitutional notion of the right of ſucceſſion to the imperial crown of theſe kingdoms. The extremes between which it ſteers are each of them equally deſtructive of thoſe ends for which ſocieties were formed and kept on foot. Where the magiſtrate, upon every ſucceſſion, is elected by the people, and may by the expreſs proviſion of the laws be depoſed (if not puniſhed) by his ſubjects, this may ſound like the perfection of liberty, and look well enough when delineated on paper; but in practice will be ever productive of tumult, contention, and anarchy. And, on the other hand, divine indefeaſible hereditary right, when coupled with the doctrine of unlimited paſſive obedience, is ſurely of all conſtitutions the moſt thoroughly ſlaviſh and dreadful. But when ſuch an hereditary right as our laws have created and veſted in the royal ſtock, is cloſely interwoven with thoſe liberties which are equally the inheritance of the ſubject; this union will form a conſtitution, in theory the moſt beautiful of any, in practice the moſt approved, and, we truſt, in duration the moſt permanent.

In France the ſucceſſion to the monarchy was limited to heirs male (ſee Salic); but in Navarre the crown was inherited by the heir of line, whether male or female. The caſe ſtands thus: Philip the fourth, king of France, ſurnamed *the Fair*, in the year 1285 eſpouſed Jane queen of Navarre in her own right; and as king conſort of this latter kingdom added the title of Navarre to his former one of France. Louis X. ſon and heir of Philip and Jane (ſurnamed *Hutin* or the *Boiſterous*), ſucceeded to both crowns. By Margaret his firſt wife, who had been crowned queen of Navarre, he left one daughter, Joan or Jane. His ſecond wife Clementina was pregnant at the time of his deceaſe, and was delivered of a poſthumous ſon, whom moſt of the French annaliſts recognize as John I. of France, though he lived no longer than three weeks. On his death the kingdom of France paſſed to Philip V. (ſurnamed *the Long*), and that of Navarre (to which the Salic law could by no conſtruction extend) to Joanna the only child and heir of Louis and Margaret. From Joanna, in lineal ſucceſſion, the kingdom of Navarre paſſed to Jane d'Albret, mother of Henry IV. of France, and wife of Anthony of Vendoſme, who as king conſort wore the crown of Navarre. On the acceſſion of Henry to the kingdom of France, the two monarchies were united, and the four ſucceeding princes aſſumed the joint title.

SUCCINIC acid, an acid extracted from amber by ſublimation in a gentle heat, and which riſes in a concrete form into the neck of the ſubliming veſſel. See Chemistry *Index*.

SUCCINUM, Amber, in *Mineralogy*, a ſpecies of bitumen claſſed under the inflammable ſubſtances. See Mineralogy *Index*.

SUCCORY. See Cichorium, Botany *Index*.

SUCCOTH, in *Ancient Geography*, a town which lay between the brook Jabbok and the river Jordan, where Jacob fixed his tents. There was another Succoth, where the Iſraelites firſt encamped after their departure from Rameſes towards the Red ſea. Succoth ſignifies *tents*.

SUCCUBUS, a term uſed by ſome writers for a dæmon who aſſumes the ſhape of a woman, and as ſuch lies with a man; in which ſenſe it ſtands oppoſed to *incubus*, which was a dæmon in form of a man, that lies with a woman. But the truth is, the ſuccubus is only a ſpecies of the nightmare. See Medicine, N° 329.

SUCCULA, in *Mechanics*, an axis or cylinder, with ſtaves in it to move it round; but without any tympanum or peritrochium.

SUCCULENT plants, among botaniſts, ſuch whoſe leaves are thick and full of juice.

SUCKER. See Cyclopterus, Ichthyology *Index*.

SUCKERS, in *Gardening*, the ſame with Offsets.

SUCKING-fish. See Echeneis, Ichthyology *Index*.

SUCKLING, Sir John, an Engliſh poet and dramatic writer, was the ſon of Sir John Suckling, comptroller of the houſehold to King Charles I. and born at Witham in Eſſex in 1613. He diſcovered an uncommon propenſity to the acquiring of languages, inſomuch that he is reported to have ſpoken Latin at five years of age, and to have written it at nine. When he grew up, he travelled; but ſeems to have affected nothing more than the character of a courtier and fine gentleman; which he ſo far attained, that he was allowed to have the peculiar happineſs of making every thing he did become him. In his travels he made a campaign under the great Guſtavus Adolphus; and his loyalty, if not his valour, appeared in the beginning of our civil wars; for, after his return to England, he raiſed a troop of horſe for the king's ſervice entirely at his own charge; and mounted them ſo completely and richly, that they are ſaid to have coſt him 12,000l. This troop, with Sir John at its head, behaved ſo ill in the engagement with the Scots, upon the Engliſh borders, in 1639, as to occaſion the famous lampoon compoſed by Sir John Mennis; "Sir John he got him an ambling nag," &c. This ballad, which was ſet to a briſk tune, was much ſung by the parliamentarians, and continues to be ſung to this day. This diſaſtrous expedition, and the ridicule that attended it, was ſuppoſed to have haſtened his death; being ſeized by a fever, of which he died, at 28 years of age. He was a ſprightly wit, and an eaſy verſifier, but no great poet. His works, conſiſting of a few poems, letters, and plays, have nevertheleſs gone through ſeveral editions.

SUCTION, the act of ſucking or drawing up a fluid, as air, water, milk, or the like, by means of the mouth and lungs; or, in a ſimilar manner, by artificial means. See Pneumatics and Hydrodynamics.

SUDATORY, a name given by the ancient Romans to their hot or ſweating rooms; ſometimes alſo called *Laconica*.

SUDEROE. See *Ferro-Iſlands*.

SUDORIFIC, an appellation given to any medicine that cauſes or promotes ſweat.

SUESSIONES, a branch of the Remi, a people of Gallia Belgica, (Pliny); called ſometimes *Sueſſones*, in the lower age *Sueſſi*; ſituated between the Remi to the eaſt, the Nervii to the north, the Veromandui to the weſt, and the Meldæ to the ſouth, in the tract now called *le Soiſſonois*.—*Sueſſiones*, *Sueſſones*, and *Sueſſonæ*, the name of their city in the lower age; thought to have been formerly called *Noviodunum* (Cæſar), is now called *Soiſſons*.

SUET, Sevum, or *Sebum*, in *Anatomy*, the ſolid fat found in ſeveral animals, as ſheep, oxen, &c. but not in the human ſpecies. See the article Fat.—It is of the ſevum that tallow is made.

SUETONIUS Tranquillus, Caius, a famous Latin hiſtorian, was born at Rome, and became ſecretary to the emperor Adrian, about the 118th year of the Chriſtian era; but that poſt was taken from him three years after, when ſeveral perſons fell under that prince's diſpleaſure for not ſhowing the empreſs Sabina all the reſpect ſhe deſerved. During his diſgrace he compoſed many works, which are loſt. Thoſe now extant are his Hiſtory of the XII firſt Emperors, and a part of his treatiſe of the Illuſtrious Grammarians and Rhetoricians. Pliny the Younger was his intimate friend, and perſuaded him to publiſh his books. His Hiſtory of the XII Roman Emperors has been much commended by moſt of our polite ſcholars. He repreſents, in a continued ſeries of curious and intereſting particulars, without any digreſſions or reflections, the actions of the emperors, without omitting their vices, which he expoſes with all their deformity, and with the ſame freedom mentions the good qualities of the very ſame perſons; but the horrid diſſoluteneſs and obſcene actions he relates of Tiberius, Caligula, Nero, &c. have made ſome ſay, that he wrote the lives of the emperors with the ſame licentiouſneſs with which they lived. The edition of this hiſtory procured by Grævius at Utrecht in 1672, with the excellent Commentaries of Torrentius and Caſaubon, and the notes of ſome other learned critics, is much eſteemed. Burman alſo publiſhed an edition in 2 vols. 4to, with notes.

SUEVI, the Catti or Chatti of Cæſar (Strabo), placed on the Rhine: the reaſon of Cæſar's calling them thus does not appear, though conſiderably diſtant from the proper Suevi or Alemanni.

SUEVI, (Tacitus), a common name of the people ſituated between the Elbe and the Viſtula, diſtinguiſhed otherwiſe by particular names; as in Ptolemy, *Suevi Angeli, Suevi Sennones.*

SUEVUS, in *Ancient Geography*, a river of Germany, thought to be the ſame with the Viadrus or Oder, emptying itſelf at three mouths into the Baltic, the middlemoſt of which is called *Swine* or *Swene;* which laſt comes nearer the name *Suevus.*

SUEZ, a ſmall ſea-port town, ſituated near the northern extremity of the Red ſea, and about 30 hours journey eaſt from Cairo. The country around it is a ſandy plain, without the ſmalleſt ſpot of verdure. The only water which can be drunk is brought from El-Naba, or the ſpring, at the diſtance of three hours journey; and it is ſo brackiſh, that without a mixture of rum it is inſupportable to Europeans. The town itſelf is a collection of miſerable ruins, the khans being the only ſolid buildings; yet from March till June, the ſeaſon when the Jidda and Yambo fleet arrives, the town becomes crowded; but after its departure nobody remains except the governor, who is a Mamlouk, 12 or 14 perſons who form his houſehold, and the garriſon. The fortreſs is a defenceleſs heap of ruins, which the Arabs conſider as a citadel, becauſe it contains ſix braſs four-pounders, and two Greek gunners, who turn their heads aſide when they fire. The harbour is a wretched quay, where the ſmalleſt boats are unable to reach the ſhore, except at the higheſt tides. There, however, the merchandiſe is embarked, to convey it over the banks of ſand to the veſſels which anchor in the road. This road, ſituated a league from the town, is ſeparated from it by a ſhore which is left dry at low water; it has no works for its defence, ſo that the veſſels which M. Volney tells us he has ſeen there, to the number of 28 at a time, might be attacked without oppoſition; for the ſhips themſelves are incapable of reſiſtance, none having any other artillery than four ruſty ſwivels.

Volney's Travels, vol. i.

Suez has always been, notwithſtanding its local diſadvantages, a place of great trade, on account of its geographical ſituation. It was by the gulf of Suez that the commodities of India were formerly conveyed to Europe, till the diſcovery of the paſſage by the Cape of Good Hope converted that trade into a new channel. As the iſthmus of Suez, which ſeparates the Red ſea from the Mediterranean, is not more than 57 miles, it has been frequently propoſed to join theſe two ſeas together by a canal. As there are no mountains nor remarkable inequalities of ſurface, this plan would at firſt view appear eaſy to be executed. But though the difference of levels would not prevent a junction, the great difficulty ariſes from the nature of the correſponding coaſts of the Mediterranean and the Red ſea, which are of a low and ſandy ſoil, where the waters form lakes, ſhoals, and moraſſes, ſo that veſſels cannot approach within a conſiderable diſtance. It will therefore be found ſcarcely poſſible to dig a permanent canal amid theſe ſhifting ſands: not to mention, that the ſhore is deſtitute of harbours, which muſt be entirely the work of art. The country beſides has not a drop of freſh water, and, to ſupply the inhabitants, it muſt be brought as far as from the Nile.

The beſt and only method therefore of effecting this junction, is that which has been already ſucceſsfully practiſed at different times; which is, by making the river itſelf the medium of communication, for which the ground is perfectly well calculated; for Mount Mokattum ſuddenly terminating in the latitude of Cairo, forms only a low and ſemicircular mound, round which is a continued plain from the banks of the Nile as far as the point of the Red ſea. The ancients, who early underſtood the advantage to be derived from this ſituation, adopted the idea of joining the two ſeas by a canal connected with the river. Strabo * obſerves, that this was firſt executed under Seſoſtris, who reigned about the time of the Trojan war; and this work was ſo conſiderable as to occaſion it to be remarked, "that it was 100 cubits (or 170 feet) wide, and deep enough for large veſſels." After the Greeks conquered the country, it was reſtored by the Ptolemies, and again renewed by Trajan. In ſhort, even the Arabs themſelves followed theſe examples. "In the time of Omar ebn-el-Kattab (ſays the hiſtorian El Makin), the cities of Mecca and Medina ſuffering from famine, the caliph ordered Amrou governor of Egypt to cut a canal from the Nile to Kolzoum, that the contributions of corn and barley appointed for Arabia might be conveyed that way."

* Lib. xvii.

This canal is the ſame which runs at preſent to Cairo, and loſes itſelf in the country to the north-eaſt of Berket-el-Hadj, or the Lake of the Pilgrims.

The place on the weſt coaſt of the gulf of Suez, where the children of Iſrael are ſuppoſed to have entered it, is called *Badea*, about ſix miles to the north of Cape Korondel, on the other ſide of the gulf, as we are informed in a letter from the ingenious Edward Wortley Montague, F. R. S. to Dr Watſon, containing an account of his journey from Cairo to the Written Mountains in the deſert of Sinai. Oppoſite to Badea is a ſtrong current which ſets to the oppoſite ſhore, about ſouth-eaſt, with a whirlpool called *Birque Pharaone*, the *well* or *pool of Pharaoh*, being the place where his hoſt is ſaid to have been deſtroyed. We are told by the ſame gentleman, that the Egyptian ſhore from Suez to Badea is ſo rocky and ſteep, that there was no entering upon the gulf but at one of theſe two places.

The Britiſh nation, we believe, never attempted to carry on commerce with any of the ports of the Red ſea beyond Jidda, till, on the ſuggeſtion of Mr Bruce, in 1776, ſome Britiſh merchants at Bengal equipped two or three veſſels for Suez, laden with piece-goods of Bengal and coaſt manufactures. The command of the veſſels was committed to Captain Greig, a meritorious ſeaman; and the management of the goods was entruſted to Mr Straw, a gentleman diſtinguiſhed for his mercantile knowledge. The ſale turned out to advantage; but ſuch great expences were incurred in making preſents to the bey of Cairo and Suez, as to conſume the whole profits gained by the ſale of the cargo. The great purpoſe of the expedition was, however, accompliſhed, as a firman was obtained from the government of Cairo to trade by the way of Suez. In conſequence of this, three ſhips went to Suez the following year, and as many in 1778. The opening of this trade alarmed the jealouſy of the Eaſt India Company; they applied to our government, and orders were given to relinquiſh this promiſing commerce. Theſe orders reached Egypt ſooner than Bengal, and the conſequence was fatal to the unfortunate adventurers who viſited Suez that year (1779). By a plan concerted between the beys, a large body of Bedouin Arabs attacked the caravan paſſing from Suez to Cairo with goods valued at 12 lacks of rupees. The goods were plundered, the Europeans were ſtripped and left naked in the deſert, expoſed to the burning rays of the ſun, without a drop of water to quench their thirſt, or food to ſupport life. Moſt of them died, and ſome of their bodies were afterwards found mangled and diſfigured by wolves. We have been favoured with a particular account of the ſufferings of our countrymen by a correſpondent, which, we are ſorry, we have not room to inſert. Thoſe who wiſh to obtain a more full account may conſult the Annual Regiſter for 1781 or 1782.

SUFFETULA, in *Ancient Geography*, a town of Africa, in the dominions of Carthage; probably ſo called from Suffetes, the title of the magiſtrates of that city. It is now called *Spaitla*, in the kingdom of Tunis, and has many elegant remains of antiquity. There are three temples in a great meaſure entire; one of them of the Compoſite order, the other two Corinthian. "A beautiful and perfect capital of the Compoſite order (ſays Mr Bruce), the only perfect one that now exiſts, is deſigned in all its parts in a very large ſize; and with the detail of the reſt of the ruin, is a precious monument of what that order was, now in the collection of the king." The town itſelf (he ſays) is ſituated in the moſt beautiful ſpot in Barbary, ſurrounded by great numbers of juniper-trees, and watered by a pleaſant ſtream, which ſinks under the earth at that place, without appearing any more.

SUFFOCATION, the privation of the function of reſpiration or breathing. See the articles DROWNING, HANGING, &c.

SUFFOLK, a county of England. Its name is contracted from *Southfolk*, ſo called from its ſituation in regard to Norfolk. It is bounded on the weſt by Cambridge-ſhire; on the ſouth by Eſſex, from which it is parted by the river Stour; on the eaſt by the German ocean; and on the north by Norfolk, ſeparated from it by the Leſſer Ouſe and the Waveney. From weſt to eaſt it is 52 miles in length, about 20 at a medium in breadth, and 196 in circumference. It contains 22 hundreds, 29 market-towns, 575 pariſhes, upwards of 34,000 houſes, and 210,431 inhabitants. The whole is divided into two parts, viz. the Liberty of St Edmund, and the Geldable; the former of which contains the weſt parts of the county, and the other the eaſt; and there is a grand jury for each at the aſſizes. The air is reckoned as wholeſome and pleaſant as any in the kingdom, nor is it otherwiſe upon the ſea coaſt, which is dry and ſandy, and free from ſalt marſhes. The ſoil, except to the weſt and upon the ſea-coaſt, is very rich, being a compound of clay and marle. Towards the ſea there are large heaths and tracts of land; but theſe produce hemp, rye, and peaſe, and feed great flocks of ſheep. About Newmarket the ſoil is much the ſame; but in high Suffolk or the woodlands, beſides wood, there are very rich paſtures, where abundance of cattle are fed. In other parts of the county, as about Bury, there is plenty of corn. As this county is noted for the richneſs of its paſtures, ſo is it for butter and cheeſe, eſpecially the former, which is ſaid to be remarkably good; ſo that being packed up in firkins, it is ſold for all uſes both by ſea and land, and conveyed to many parts of England, eſpecially to London. The inland parts of the county are well ſupplied with wood for fuel, and thoſe upon the ſea-coaſt with coals from Newcaſtle. The manufactures of the county are chiefly woollen and linen cloth. It lies in the dioceſe of Norwich, has two archdeacons, viz. of Sedbury and Suffolk; gives title of earl to a branch of the Howards; ſends two members to parliament for the county, and two for each of the following places, Ipſwich, Dunwich, Orford, Aldborough, Sudbury, Eye, and St Edmund's-Bury. The county is extremely well watered by the following rivers, which either traverſe its borders, or run acroſs into the German ocean, viz. the Leſſer Ouſe, the Waveney, the Blithe, the Deben, the Orwell or Gipping, and the Stour.

Gough's edition of Camden's Britannia.

SUFFRAGAN, an appellation given to ſimple biſhops with regard to archbiſhops, on whom they depend, and to whom appeals lie from the biſhops courts.

Suffragan is likewiſe the appellation given to a biſhop, who is occaſionally appointed to reſide in a town or village, and aſſiſt the dioceſan.

SUFFRAGE, denotes a vote given in an aſſembly, where ſomething is deliberated on, or where a perſon is elected to an office or benefice.

SUFFRUTEX, among botaniſts, denotes an under-ſhrub, or the loweſt kind of woody plants, as lavender.

SUGAR, a ſolid ſweet ſubſtance obtained from the juice of the ſugar-cane; or, according to chemiſts, an eſſential ſalt, capable of cryſtallization, of a ſweet and agreeable flavour, and contained in a greater or leſs quantity in almoſt every ſpecies of vegetables, but moſt abundant in the ſugar-cane.

1 Value of ſugar.

As the ſugar-cane is the principal production of the Weſt Indies, and the great ſource of their riches; as it is ſo important in a commercial view, from the employment which it gives to ſeamen, and the wealth which it opens for merchants; and beſides now is become a neceſſary of life—it may juſtly be eſteemed one of the moſt valuable plants in the world. The quantity conſumed in Europe is eſtimated at nine millions ſterling, and the demand would probably be greater if it could be ſold at a reduced price. Since ſugar then is reckoned ſo precious a commodity, it muſt be an object of deſire to all perſons of curioſity and reſearch, to obtain ſome general knowledge of the hiſtory and nature of the plant by which it is produced, as well as to underſtand the proceſs by which the juice is extracted and refined. We will therefore firſt inquire in what countries it originally flouriſhed, and when it was brought into general uſe, and became an article of commerce.

From the few remains of the Grecian and Roman authors which have ſurvived the ravages of time, we can find no proofs that the juice of the ſugar-cane was known at a very early period. There can be no doubt, however, that in thoſe countries where it was indigenous its value was not long concealed. 2 was probably known to the ancient Jews. It is not improbable that it was known to the ancient Jews; for there is ſome reaſon to ſuppoſe, that the Hebrew word קנה, which occurs frequently in the Old Teſtament, and is by our tranſlators rendered ſometimes *calamus*, and ſometimes *ſweet cane*, does in fact mean the ſugar-cane. The firſt paſſage in which we have obſerved it mentioned is Exod. xxx 23. where Moſes is commanded to make an ointment with myrrh, cinnamon, kené, and caſſia. Now the kené does not appear to have been a native of Egypt, nor of Judea; for in Jeremiah vi. 20. it is mentioned as coming from a far country. "To what purpoſe cometh there to me incenſe from Sheba, and the ſweet cane from a far country?" This is not true of the calamus aromaticus, which grows ſpontaneouſly in the Levant, as well as in many parts of Europe. 3 Account of it by Greek and Roman authors. If the cinnamon mentioned in the paſſage of Exodus quoted above was true cinnamon, it muſt have come from the Eaſt Indies, the only country in the world from which cinnamon is obtained. There is no difficulty therefore in ſuppoſing that the ſugar-cane was exported from the ſame country. If any credit be due to etymology, it confirms the opinion that kené denotes the ſugar-cane; for the Latin word *canna* and the Engliſh word *cane* are evidently derived from it. It is alſo a curious fact, that *ſachar* or *ſheker**, in Hebrew ſignifies *inebriation*, from which the Greek word σακχαρ, "ſugar," is undoubtedly to be traced.

The ſugar-cane was firſt made known to the weſtern parts of the world by the conqueſts of Alexander the Great. Strabo † relates that Nearchus his admiral found it in the Eaſt Indies in the year before Chriſt 325. It is evidently alluded to in a fragment of Theophraſtus, preſerved in Photius. Varro, who lived A. C. 68, deſcribes it in a fragment quoted by Iſidorus ‡ as a fluid preſſed from reeds of a large ſize, which was ſweeter than honey §. Dioſcorides, about the year 35 before Chriſt, ſays, "that there is a kind of honey called *ſaccharon*, which is found in India and Arabia Felix. It has the appearance of ſalt, and is brittle when chewed. If diſſolved in water, it is beneficial to the bowels and ſtomach, is uſeful in diſeaſes of the bladder and kidneys, and, when ſprinkled on the eye, removes thoſe ſubſtances that obſcure the ſight." This is the firſt account we have of its medical qualities. Galen often preſcribed it as a medicine. Lucan relates, that an oriental nation in alliance with Pompey uſed the juice of the cane as a common drink.

> *Quique bibunt tenera dulces ab arundine ſuccos.*
> Lib. iii. 237.

Pliny ſays it was produced in Arabia and India, but that the beſt came from the latter country. It is alſo mentioned by Arrian, in his Periplus of the Red ſea, by the name of σαχαρ (*ſachar*) as an article of commerce from India to the Red ſea. Ælian*, Tertullian†, and Alexander Aphrodiſæus‡, mention it as a ſpecies of honey procured from canes (A).

* שנך.

† Lib. xv.

‡ Lib. xvii. cap. 3.

§ *Matthioli Dios.* cap. lxxv.

* *Nat. Hiſt.*

† *De Judicio Dei.*

‡ Lib. ii. Prob. 79.

4 Is a native of the Eaſt Indies. That the ſugar-cane is an indigenous plant in ſome parts of the Eaſt Indies, we have the ſtrongeſt reaſon to believe; for Thunberg found it in Japan, and has accordingly mentioned it as a native of that country in his *Flora Japonica*, publiſhed in 1784. Oſbeck alſo found it in China in 1751. It may indeed have been tranſplanted from ſome other country; but as it does not appear from hiſtory that the inhabitants of Japan or China ever carried on any commerce with remote nations, it could only be conveyed from ſome neighbouring country. Marco Polo, a noble Venetian, who travelled into the eaſt about the year 1250, found ſugar in abundance in Bengal. Vaſco de Gama, who doubled the Cape of Good Hope in 1497, relates, that a conſiderable trade in ſugar was then carried on in the kingdom of Calicut. On the authority of Dioſcorides and Pliny, too, we ſhould be diſpoſed to admit, that it is a native of Arabia, did we not find, on conſulting Niebuhr's Travels, that that botaniſt has omitted it when enumerating the moſt valuable plants of that country. If it be a ſpontaneous production of Arabia, it muſt ſtill flouriſh in its native ſoil. Mr Bruce found it in Upper Egypt. If we may believe the relation of Giovan Lioni, a conſiderable trade was carried on in ſugar in Nubia in 1500: it abounded alſo at Thebes, on the Nile, and in the northern parts of Africa, about the ſame period.

5 Introduced into Europe probably during the cruſades. There is reaſon to believe that the ſugar-cane was introduced into Europe during the cruſades; expeditions which, however romantic in their plan, and unſucceſsful in their execution, were certainly productive of many advantages to the nations of Europe. Albertus Aquenſis, a monkiſh writer, obſerves, that the Chriſtian ſoldiers in the Holy Land frequently derived refreſhment and ſupport during a ſcarcity of proviſions by ſucking the canes. This plant flouriſhed alſo in the Morea, and in the iſlands of Rhodes and Malta; from which it was tranſported into Sicily. The date of this tranſaction it is not eaſy to aſcertain; but we are ſure that ſugar was cultivated in that iſland previous to the year 1166; for Lafitau the Jeſuit, who wrote a hiſtory of the Portugueſe diſcoveries, mentions a donation made that year to the monaſtery of St Bennet, by William the Second, king of Sicily, of a mill for grinding ſugar-canes, with all its rights, members, and appurtenances.

From Sicily, where the ſugar-cane ſtill flouriſhes on the ſides of Mount Hybla, it was conveyed to Spain, Madeira, the Canary and Cape de Verd iſlands, ſoon after they were diſcovered in the 15th century.

D'Orville's Travels.

6 Suppoſed by ſome not a native of America or the Weſt Indies. An opinion has prevailed, that the ſugar-cane is not a native of the weſtern continent, or its adjacent iſlands the Weſt Indies, but was conveyed thither by the Spaniards or Portugueſe ſoon after the diſcovery of America by Columbus. From the teſtimony of Peter Martyr, in the third book of his firſt decade, compoſed during Columbus's ſecond voyage, which commenced in 1493 and ended in 1495, it appears, that the ſugar-cane was known at that time in Hiſpaniola. It may be ſaid, that it was brought thither by Columbus; but for this aſſertion we have found no direct evidence; and though we had

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(A) For a more minute account of the hiſtory of ſugar in the early and middle ages, a paper of the Mancheſter Tranſactions, in vol. iv. by Dr Falconer, may be conſulted.

had direct evidence, this would not prove that the ſugar-cane was not an indigenous plant of the Weſt Indies. There are authors of learning who, after inveſtigating this ſubject with attention, do not heſitate to maintain, that it is a native both of the iſlands and of the continent of America.

7
This opinion oppoſed by Labat.

P. Labat has ſupported this opinion with much appearance of truth *; and, in particular, he appeals to the teſtimony of Thomas Gage, an Engliſhman, who viſited New Spain in 1625. Gage enumerates ſugar-canes among the proviſions with which the Charaibes of Guadaloupe ſupplied his ſhip. "Now (ſays Labat) it is a fact that the Spaniards had never cultivated an inch of ground in the ſmaller Antilles. Their ſhips commonly touched at thoſe iſlands indeed for wood and water; and they left ſwine in the view of ſupplying with freſh proviſions ſuch of their countrymen as might call there in future; but it would be abſurd in the higheſt degree to ſuppoſe, that they would plant ſugar-canes, and at the ſame time put hogs aſhore to deſtroy them.

"Neither had the Spaniards any motive for beſtowing this plant on iſlands which they conſidered as of no kind of importance, except for the purpoſe that has been mentioned; and to ſuppoſe that the Charaibes might have cultivated, after their departure, a production of which they knew nothing, betrays a total ignorance of the Indian diſpoſition and character.

8
From teſtimony.

"But (continues Labat) we have ſurer teſtimony, and ſuch as proves, beyond all contradiction, that the ſugar-cane is the natural production of America. For, beſides the evidence of Francis Ximenes, who, in a Treatiſe on American Plants, printed at Mexico, aſſerts, that the ſugar-cane grows without cultivation, and to an extraordinary ſize, on the banks of the river Plate, we are aſſured by Jean de Lery, a Proteſtant miniſter, who was chaplain in 1556 to the Dutch garriſon in the fort of Coligny, on the river Janeiro, that he himſelf found ſugar-canes in great abundance in many places on the banks of that river, and in ſituations never viſited by the Portugueſe. Father Hennepen and other voyagers bear teſtimony in like manner to the growth of the cane near the mouth of the Miſſiſſippi; and Jean de Laet to its ſpontaneous production in the iſland of St Vincent. It is not for the plant itſelf, therefore, but for the ſecret of making ſugar from it, that the Weſt Indies are indebted to the Spaniards and Portugueſe; and theſe to the nations of the eaſt."

Such is the reaſoning of Labat, which the learned Lafitau has pronounced incontrovertible; and it is greatly ſtrengthened by recent diſcoveries, the ſugar-cane having been found in many of the iſlands of the Pacific ocean by our late illuſtrious navigator Captain Cook.

9
Deſcription of the ſugar cane.

The ſugar-cane, or ſaccharum officinarum of botaniſts, is a jointed reed, commonly meaſuring (the flag part not included) from three feet and a half to ſeven feet in height, but ſometimes riſing to 12 feet When ripe it is of a fine ſtraw colour inclining to yellow, producing leaves or blades, the edges of which are finely and ſharply ſerrated, and terminating in an arrow decorated with a panicle. The joints in one ſtalk are from 40 to 60 in number, and the ſtalks riſing from one root are ſometimes very numerous. The young ſhoot aſcends from the earth like the point of an arrow; the ſhaft of which ſoon breaks, and the two firſt leaves, which had been incloſed within a quadruple ſheath of ſeminal leaves, riſe to a conſiderable height (b).

10
Soil moſt favourable to its growth.

As the cane is a rank ſucculent plant, it muſt require a ſtrong deep ſoil to bring it to perfection, perhaps indeed no ſoil can be too rich for this purpoſe. The ſoil which experience has found to be moſt favourable to the cultivation of it in the Weſt Indies is the dark gray loam of St Chriſtopher's, which is ſo light and porous as to be penetrable by the ſlighteſt application of the hoe. The under ſtratum is gravel from 8 to 12 inches deep. Canes planted in particular ſpots in this iſland have been known to yield 8000 pounds of Muſcovado ſugar from a ſingle acre. The average produce of the iſland for a ſeries of years has been 16,000 hogſheads of 16 cwt. which is one-half only of the whole cane-land, or 8500 acres. When annually cut, it gives nearly two hogſheads of 16 cwt. per acre for the whole of the land in ripe canes.

Next to the aſhy loam of St Chriſtopher's is the ſoil which in Jamaica is called *brick-mould;* not as reſembling a brick in colour, but as containing ſuch a due mixture of clay and ſand as is ſuppoſed to render it well adapted for the uſe of the kiln. It is a deep, warm, and mellow, hazel earth, eaſily worked; and though its ſurface ſoon grows dry after rain, the under ſtratum retains a conſiderable degree of moiſture in the drieſt weather; with this advantage too, that even in the wetteſt ſeaſon it ſeldom requires trenching. Plant-canes, by which is meant canes of the firſt growth, have been known in very fine ſeaſons to yield two tons and a half of ſugar per acre. After this may be reckoned the black mould of ſeveral varieties. The beſt is the deep black earth of Barbadoes, Antigua, and ſome other of the windward iſlands; but there is a ſpecies of this mould in Jamaica that is but little, if any thing inferior to it, which abounds with limeſtone and flint on a ſubſtratum of ſoapy marle. Black mould on clay is more common; but

Edward's Hiſtory of the Weſt Indies, vol. ii.

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* Tom. iii. c. xv.

(b) "A field of canes, when ſtanding, in the month of November, when it is in arrow or full bloſſom (ſays Mr Beckford in his deſcriptive Account of the Iſland of Jamaica), is one of the moſt beautiful productions that the pen or pencil can poſſibly deſcribe. It in common riſes from three to eight feet or more in height; a difference of growth that very ſtrongly marks the difference of ſoil or the varieties of culture. It is when ripe of a bright and golden yellow; and where obvious to the ſun, is in many parts very beautifully ſtreaked with red: the top is of a darkiſh green; but the more dry it becomes, from either an exceſs of ripeneſs or a continuance of drought, of a ruſſet yellow, with long and narrow leaves depending; from the centre of which ſhoots up an arrow like a ſilver wand from two to ſix feet in height; and from the ſummit of which grows out a plume of white feathers, which are delicately fringed with a lilac dye; and indeed is, in its appearance, not much unlike the tuft that adorns this particular and elegant tree."

but as the mould is generally ſhallow, and the clay ſtiff and retentive of water, this laſt ſort of land requires great labour, both in ploughing and trenching, to render it profitable. When manured and properly pulverized, it becomes very productive. It is unneceſſary to attempt a minute deſcription of all the other ſoils which are found in theſe iſlands. There is, however, a peculiar ſort of land on the north ſide of Jamaica, chiefly in the pariſh of Trelawney, that cannot be paſſed over unnoticed, not only on account of its ſcarcity but its value; few ſoils producing finer ſugars, or ſuch *as anſwer ſo well in the pan*; an expreſſion ſignifying a greater return of refined ſugar than common. The land alluded to is generally of a red colour; the ſhades of which, however, vary conſiderably from a deep chocolate to a rich ſcarlet; in ſome places it approaches to a bright yellow, but it is everywhere remarkable, when firſt turned up, for a gloſſy or ſhining ſurface, and if wetted ſtains the fingers like paint.

11 Proper ſeaſon for planting it. As in every climate there is a ſeaſon more favourable for vegetation than others, it is of great importance that plants for ſeed be committed to the ground at the commencement of this ſeaſon. As the cane requires a great deal of moiſture to bring it to maturity, the propereſt ſeaſon for planting it is in the months of September and October, when the autumnal rains commence, that it may be ſufficiently luxuriant to ſhade the ground before the dry weather ſets in. Thus the root is kept moiſt, and the crop is ripe for the mill in the beginning of the enſuing year. Canes planted in the month of November, or later in the ſeaſon, loſe the advantage of the autumnal rains; and it often happens that dry weather in the beginning of the enſuing year retards their vegetation until the vernal or May rains ſet in, when they ſprout both at the roots and the joints; ſo that by the time they are cut the field is loaded with unripe ſuckers inſtead of ſugar-canes. A January plant, however, commonly turns out well; but canes planted very late in the ſpring, though they have the benefit of the May rains, ſeldom anſwer expectation; for they generally come in unſeaſonably, and throw the enſuing crops out of regular rotation. They are therefore frequently cut before they are ripe; or if the autumnal ſeaſon ſets in early, are cut in wet weather, which has probably occaſioned them to ſpring afreſh; in either caſe the effect is the ſame: The juice is unconcocted, and all the ſap being in motion, the root is deprived of its natural nouriſhment, to the great injury of the ratoon. The chief objection to a fall plant is this, that the canes become rank and top-heavy, at a period when violent rains and high winds are expected, and are therefore frequently lodged before they are fit to be cut.

12 Method of planting. The ſugar cane is propagated by the top-ſhoots, which are cut from the tops of the old canes. The uſual method of planting in the Weſt Indies is this: The quantity of land intended to be planted, being cleared of weeds and other incumbrances, is firſt divided into ſeveral plats of certain dimenſions, commonly from 15 to 20 acres each; the ſpaces between each plat or diviſion are left wide enough for roads, for the conveniency of carting, and are called *intervals*. Each plat is then ſubdivided, by means of a line and wooden pegs, into ſmall ſquares of about three feet and a half. Sometimes indeed the ſquares are a foot larger; but this circumſtance makes but little difference. The negroes are then placed in a row in the firſt line, one to a ſquare, and directed to dig out with their hoes the ſeveral ſquares, commonly to the depth of five or ſix inches. The mould which is dug up being formed into a bank at the lower ſide, the excavation or cane-hole ſeldom exceeds 15 inches in width at the bottom, and two feet and a half at the top. The negroes then fall back to the next line, and proceed as before. Thus the ſeveral ſquares between each line are formed into a trench of much the ſame dimenſions with that which is made by the plough. An able negro will dig from 100 to 120 of theſe holes for his day's work of ten hours; but if the land has been previouſly ploughed and lain fallow, the ſame negro will dig nearly double the number in the ſame time (c).

13 and clearing it. The cane-holes or trench being now completed, whether by the plough or by the hoe, and the cuttings ſelected for planting, which are commonly the tops of the canes that have been ground for ſugar (each cutting containing five or ſix gems), two of them are ſufficient for a cane hole of the dimenſions deſcribed. Theſe, being placed longitudinally in the bottom of the hole, are covered with mould about two inches deep; the reſt of the bank being intended for future uſe. In 12 or 14 days the young ſprouts begin to appear; and as ſoon as they riſe a few inches above the ground, they are, or ought to be, carefully cleared of weeds, and furniſhed with an addition of mould from the banks. This is uſually performed by the hand. At the end of four or five months the banks are wholly levelled, and the ſpaces between the rows carefully hoe ploughed. Frequent cleanings, while the canes are young, are indeed ſo eſſentially neceſſary, that no other merit in an overſeer can compenſate for the want of attention in this particular. A careful manager will remove at the ſame time all the lateral ſhoots or ſuckers that ſpring up after the canes begin to joint, as they ſeldom come to maturity, and draw nouriſhment from the original plants.

14 The plough might be uſed with advantage. "In the cultivation of other lands, in Jamaica eſpecially (ſays Mr Edwards, the elegant hiſtorian of the Weſt Indies, whoſe ſuperior excellence has induced us frequently to refer to him in the courſe of this article), the plough has been introduced of late years, and in ſome few caſes to great advantage; but it is not every ſoil or ſituation that will admit the uſe of the plough; ſome lands being much too ſtony, and others too ſteep; and I am ſorry I have occaſion to remark, that a prac-

tice

(c) As the negroes work at this buſineſs very unequally, according to their different degrees of bodily ſtrength, it is ſometimes the practice to put two negroes to a ſingle ſquare; but if the land has not had the previous aſſiſtance of the plough, it commonly requires the labour of 50 able negroes for 13 days to hole 20 acres. In Jamaica, ſome gentlemen, to eaſe their own ſlaves, have this laborious part of the planting buſineſs performed by job-work. The uſual price for holing and planting is 6l. currency per acre (equal to 4l. 7s. ſterling). The coſt of falling and clearing heavy wood-land is commonly as much more.

tice commonly prevails in Jamaica, on properties where this auxiliary is uſed, which would exhauſt the fineſt lands in the world. It is that of ploughing, then croſs-ploughing, round-ridging, and harrowing the ſame lands from year to year, or at leaſt every other year, without affording manure: accordingly it is found that this method is utterly deſtructive of the ratoon or ſecond growth, and altogether ruinous. It is indeed aſtoniſhing that any planter of common reading or obſervation ſhould be paſſive under ſo pernicious a ſyſtem. Some gentlemen, however, of late manage better: their practice is to break up ſtiff and clayey land, by one or two ploughings, early in the ſpring, and give it a ſummer's fallow. In the autumn following, being then mellow and more eaſily worked, it is holed and planted by manual labour after the old method, which has been already deſcribed. But in truth, the only advantageous ſyſtem of ploughing in the Weſt Indies is to confine it to the ſimple operation of holing, which may certainly be performed with much greater facility and diſpatch by the plough than by the hoe; and the relief which, in the caſe of ſtiff and dry ſoils, is thus given to the negroes, exceeds all eſtimation, in the mind of a humane and provident owner. On this ſubject I ſpeak from practical knowledge. At a plantation of my own, the greateſt part of the land which is annually planted is neatly and ſufficiently laid into cane-holes, by the labour of one able man, three boys, and eight oxen, with the common ſingle-wheeled plough. The ploughſhare indeed is ſomewhat wider than uſual; but this is the only difference, and the method of ploughing is the ſimpleſt poſſible. By returning the plough back along the furrow, the turf is alternately thrown to the right and to the left, forming a trench ſeven inches deep, about two feet and a half wide at the top, and one foot wide at the bottom. A ſpace of 18 or 20 inches is left between each trench, on which the mould being thrown by the ſhare, the banks are properly formed, and the holing is complete. Thus the land is not exhauſted by being too much expoſed to the ſun; and in this manner a field of 20 acres is holed with one plough, and with great eaſe, in 13 days. The plants are afterwards placed in the trench as in the common method, where manual labour alone is employed.

Edwards's Hiſtory of the Weſt Indies, vol. ii.

15
Canes named according to the age of their roots.

In moſt parts of the Weſt Indies it is uſual to hole and plant a certain proportion of the cane-land, commonly one-third, in annual rotation. Canes of the firſt year's growth are called *plant canes*, as has been already obſerved. The ſprouts that ſpring from the roots of the canes that have been previouſly cut for ſugar are called *ratoons*; the firſt yearly returns from their roots are called *firſt ratoons*; the ſecond year's growth *ſecond ratoons*.

16
Manures employed.

Mr Edwards informs us, that the manure generally uſed is a compoſt formed, 1ſt, Of the vegetable aſhes drawn from the fires of the boiling and ſtill houſes. 2dly, Feculencies diſcharged from the ſtill houſe, mixed up with rubbiſh of buildings, white-lime, &c. 3dly, Refuſe, or field-traſh (i. e.), the decayed leaves and ſtems of the canes; ſo called in contradiſtinction to cane-traſh, reſerved for fuel. 4thly, Dung, obtained from the horſe and mule ſtables, and from moveable pens, or ſmall incloſures made by poſts and rails, occaſionally ſhifted upon the lands intended to be planted, and into which the cattle are turned at night. 5thly, Good mould, collected from gullies and other waſte places, and thrown into the cattle-pens.

17
The ſugar-cane deſtroyed by monkeys,

The ſugar-cane is liable to be deſtroyed by monkeys, rats, and inſects. The upland plantations ſuffer greatly from monkeys; theſe creatures, which now abound in the mountainous parts of St Chriſtopher's, were firſt brought thither by the French, when they poſſeſſed half that iſland; they come down from the rocks in ſilent parties by night, and having poſted centinels to give the alarm if any thing approaches, they deſtroy incredible quantities of the cane, by their gambols as well as their greedineſs. It is in vain to ſet traps for theſe creatures, however baited; and the only way to protect the plantation, and deſtroy them, is to ſet a numerous watch, well armed with fowling-pieces, and furniſhed with dogs. The negroes will perform this ſervice cheerfully, for they are very fond of monkeys as food. The celebrated Father Labat ſays, they are very delicious, but the white inhabitants of St Kitt's never eat them.

Grainger's Hiſtory of the Sugar-cane.

18
rats,

The low-land plantations ſuffer as much by rats as thoſe on the mountains do from monkeys; but the rats, no more than the monkeys, are natives of the place; they came with the ſhipping from Europe, and breed in the ground under looſe rocks and buſhes: the field negroes eat them greedily, and they are ſaid to be publicly ſold in the markets at Jamaica. To free the plantations from theſe vermin, the breed of wild cats ſhould be encouraged, and ſnakes ſuffered to multiply unmoleſted; they may alſo be poiſoned with arſenic, and the raſped root of the caſſava made into pellets, and plentifully ſcattered over the grounds. This practice, however, is dangerous; for as the rats when thus poiſoned become exceeding thirſty, they run in droves to the neighbouring ſtreams, which they poiſon as they drink, and the cattle grazing on the banks of theſe polluted waters have frequently periſhed by drinking after them: It is ſafer therefore to make the pellets of flour, kneaded with the juice of the nightſhade, the ſcent of which will drive them away though they will not eat it. There is an Eaſt Indian animal called *mungoes*, which bears a natural antipathy to rats; if this animal was introduced into our ſugar iſlands, it would probably extirpate the whole race of theſe noxious vermin. The *formica omnivora* of Linnæus, the carnivorous ant, which is called in Jamaica the *raffle's ant*, would ſoon clear a ſugar plantation of rats.

19
and inſects.

The ſugar-cane is alſo ſubject to a diſeaſe which no foreſight can obviate, and for which human wiſdom has hitherto in vain attempted to find a remedy. This diſeaſe is called the *blaſt*, and is occaſioned by a ſpecies of *aphis*. When this happens, the fine, broad, green blades become ſickly, dry, and withered; ſoon after they appear ſtained in ſpots; and if theſe ſpots are carefully examined, they will be found to contain innumerable eggs of an inſect like a bug, which are ſoon quickened, and cover the plants with the vermin: the juice of the canes thus affected becomes ſour, and no future ſhoot iſſues from the joints. Ants alſo concur with the bugs to ſpoil the plantation, and againſt theſe evils it is hard to find a remedy.

20
Time at which the crop ripens:

The crops of ſugar-canes do not ripen preciſely at the ſame period in all the colonies. In the Daniſh, Spaniſh, and Dutch ſettlements, they begin in January, and continue till October. This method does not imply any fixed ſeaſon for the maturity of the ſugar-cane. The

Raynal's Hiſtory of the Eaſt and Weſt Indies, vol. iv.

plant, however, like others, muſt have its progreſs; and it hath been juſtly obſerved to be in flower in the months of November and December. It muſt neceſſarily follow, from the cuſtom theſe nations have adopted of continuing to gather their crops for 10 months without intermiſſion, that they cut ſome canes which are not ripe enough, and others that are too ripe, and then the fruit hath not the requiſite qualities. The time of gathering them ſhould be at a fixed ſeaſon, and probably the months of March and April are the fitteſt for it; becauſe all the ſweet fruits are ripe at that time, while the ſour ones do not arrive at a ſtate of maturity till the months of July and Auguſt.

The Engliſh cut their canes in March and April; but they are not induced to do this on account of their ripeneſs. The drought that prevails in their iſlands renders the rains which fall in September neceſſary to their planting; and as the canes are 18 months in growing, this period always brings them to the preciſe point of maturity (D).

21 a ſeaſon of feſtivity. *Edwards*, vol. iv. p. 226.

"The time of crop in the ſugar iſlands (ſays Mr Edwards) is the ſeaſon of gladneſs and feſtivity to man and beaſt. So palatable, ſalutary, and nouriſhing, is the juice of the cane, that every individual of the animal creation, drinking freely of it, derives health and vigour from its uſe. The meagre and ſickly among the negroes exhibit a ſurpriſing alteration in a few weeks after the mill is ſet in action. The labouring horſes, oxen, and mules, though almoſt conſtantly at work during this ſeaſon, yet, being indulged with plenty of the green tops of this noble plant, and ſome of the ſcummings from the boiling-houſe, improve more than at any other period of the year. Even the pigs and poultry fatten on the refuſe. In ſhort, on a well-regulated plantation, under a humane and benevolent director, there is ſuch an appearance during crop-time of plenty and buſy cheerfulneſs, as to ſoften, in a great meaſure, the hardſhips of ſlavery, and induce a ſpectator to hope, when the miſeries of life are repreſented as inſupportable, that they are ſometimes exaggerated through the medium of fancy."

22 The canes when cut are ſent to the mill.

The plants being cut, the branches at the top are given to the cattle for food; the top-ſhoot, which is full of eyes, is preſerved for planting. The canes are cut into pieces about a yard long, tied up in bundles, and carried in carts to the mill, where they are bruiſed, and the juice is extracted from them. The mill conſiſts principally of three upright iron-plated rollers or cylinders, from 30 to 40 inches in length, and from 20 to 25 inches in diameter; and the middle one, to which the moving power is applied, turns the other two by means of cogs. Between theſe rollers, the canes (being previouſly cut ſhort, and tied into bundles) are twice compreſſed; for having paſſed through the firſt and ſecond rollers, they are turned round the middle one by a circular piece of frame-work or ſcreen, called in Jamaica the *Dumb-returner*, and forced back through the ſecond and third; an operation which ſqueezes them completely dry, and ſometimes even reduces them to powder. The cane juice is received in a leaden bed, and thence conveyed into a veſſel called the *receiver*. The refuſe, or macerated rind of the cane (which is called *cane-traſh*, in contradiſtinction to *field-traſh*), ſerves for fuel to boil the liquor.

23 The juice extracted from them,

The juice as it flows from the mill, taken at a medium, contains eight parts of pure water, one part of ſugar, and one part conſiſting of coarſe oil and mucilaginous gum, with a portion of eſſential oil.

24 Veſſels uſed for purifying it are,

As this juice has a ſtrong diſpoſition to fermentation, it muſt be boiled as ſoon as poſſible. There are ſome water-mills that will grind with great eaſe canes ſufficient for 30 hogſheads of ſugar in a week. It is neceſſary to have boiling veſſels, or clarifiers, that will correſpond in dimenſions to the quantity of juice flowing from the receiver. Theſe clarifiers are commonly three in number, and are ſometimes capable of containing 1000 gallons each; but it is more uſeful to ſee them of 300 or 400 gallons each. Beſides the clarifiers which are uſed for the firſt boiling, there are generally four coppers or boilers. The clarifiers are placed in the middle or at one end of the boiling-houſe. If at one end, the boiler called the *teache* is placed at the other, and ſeveral boilers (generally three) are ranged between them. The teache is ordinarily from 70 to 100 gallons, and the boilers between the clarifiers and teache diminiſh in ſize from the firſt to the laſt. Where the clarifiers are in the middle, there is uſually a ſet of three boilers on each ſide, which conſtitute in effect a double boiling-houſe. On very large eſtates this arrangement is found uſeful and neceſſary. The objection to ſo great a number is the expence of fuel; to obviate which, in ſome degree, the three boilers on each ſide of the clarifiers are commonly hung to one fire.

25 The clarifier,

The juice runs from the receiver along a wooden gutter lined with lead into the boiling-houſe, where it is received into one of the clarifiers. When the clarifier is filled, a fire is lighted, and a quantity of Briſtol quicklime in powder, which is called *temper*, is poured into the veſſel. The uſe of the lime is to unite with the ſuperabundant acid, which, for the ſucceſs of the proceſs, it is neceſſary to get rid of. The quantity ſufficient to ſeparate the acid muſt vary according to the ſtrength of the quicklime and the quality of the liquor. Some planters allow a pint of lime to every 100 gallons of liquor; but Mr Edwards thinks that little more than half the quantity is a better medium proportion, and even then, that it ought to be diſſolved in boiling water, that as little of it as poſſible may be precipitated. The heat is ſuffered gradually to increaſe till it approaches within a few degrees of the heat of boiling water, that the impurities

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(D) The account given in the text concerning the time when the ſugar-canes are collected, we have taken from the Abbé Raynal's Hiſtory of the Trade and Settlements of the Eaſt and Weſt Indies; but Mr Cazaud obſerves, that in February, March, and April, all the canes, whatever be their age, are as ripe as the nature of the ſoil ever allows them to be. He ſays farther, that the dryneſs of the weather, and not the age of the canes, which increaſes from January to April, is the cauſe that in January 400 gallons of juice commonly yield 48 gallons of ſugar and molaſſes, one with another; in February from 56 to 64; in March from 64 to 72; in April ſometimes 80; after which period the ſugar ferments, and even burns, when the refiner is not very expert at his buſineſs. *Philoſoph. Tranſact.* vol. lxix.

purities may be thoroughly ſeparated. But if the liquor were ſuffered to boil with violence, the impurities would again incorporate with it. It is known to be ſufficiently heated when the ſcum begins to riſe in bliſters, which break into white froth, and appear generally in about 40 minutes. The fire is then ſuddenly extinguiſhed by means of a damper, which excludes the external air, and the liquor is allowed to remain about an hour undiſturbed, during which period the impurities are collected in ſcum on the ſurface. The juice is then drained off either by a ſyphon or a cock; the ſcum being of a tenacious gummy nature, does not flow out with the liquor, but remains behind in the clarifier. The liquid juice is conveyed from the clarifier by a gutter into the evaporating boiler, commonly termed the *grand copper;* and if it has been obtained from good canes it generally appears tranſparent.

26 and four coppers.

In the evaporating boiler, which ſhould be large enough to receive the contents of the clarifier, the liquor is allowed to boil; and as the ſcum riſes it is taken off. The ſcumming and evaporation are continued till the liquor becomes finer and thicker, and ſo far diminiſhed in bulk that it may be eaſily contained in the ſecond copper. When put into the ſecond copper, it is nearly of the colour of Madeira wine; the boiling and ſcumming are continued, and if the impurities be conſiderable, a quantity of lime-water is added. This proceſs is carried on till the liquor be ſufficiently diminiſhed in quantity to be contained in the third copper. After being purified a third time, it is put into the fourth copper, which is called the *teache,* where it is boiled and evaporated till it is judged ſufficiently pure to be removed from the fire. In judging of the purity of the liquor, many of the negroes (ſays Mr Edwards) gueſs ſolely by the eye (which by long habit they do with great accuracy), judging by the appearance of the grain on the back of the ladle: but the practice moſt in uſe is to judge by what is called the *touch;* i. e. taking up with the thumb a ſmall portion of the hot liquor from the ladle; and, as the heat diminiſhes, drawing with the fore-finger the liquid into a thread. This thread will ſuddenly break, and ſhrink from the thumb to the ſuſpended finger, in different lengths, according as the liquor is more or leſs boiled. The proper boiling height for ſtrong muſcovado ſugar is generally determined by a thread of a quarter of an inch long. It is evident, that certainty in this experiment can be attained only by long habit, and that no verbal precepts will furniſh any degree of ſkill in a matter depending wholly on conſtant practice.

27 After being clarified it is cooled, granulated, and freed from its melaſſes.

The juice being thus purified by paſſing through the clarifier and four coppers, it is poured into coolers, which are uſually ſix in number. The removal from the teache to the cooler is called *ſtriking.* The cooler is a ſhallow wooden veſſel ſeven feet long, from five to ſix wide, about 11 inches deep, and capable of containing a hogſhead of ſugar. As the liquor cools, the ſugar grains, that is, collects into an irregular maſs of imperfect cryſtals, ſeparating itſelf from the melaſſes. It is then removed from the cooler, and conveyed to the curing-houſe, where the melaſſes drain from it. For receiving them there is a large ciſtern, the ſloping ſides of which are lined with boards. Directly above the ciſtern a frame of joiſt-work without boarding is placed, on which empty hogſheads without heads are ranged. The bottoms of theſe hogſheads are pierced with 8 or 10 holes, in each of which the ſtalk of a plantain leaf is fixed ſo as to project ſix or eight inches below the joiſts, and riſe a little above the top of the hogſhead. The hogſheads being filled with the contents of the cooler, conſiſting of ſugar and melaſſes, the melaſſes being liquid, drain through the ſpongy ſtalk, and drop into the ciſtern. After the melaſſes are drained off, the ſugar becomes pretty dry and fair, and is then called *muſcovado* or *raw ſugar.*

We have deſcribed the proceſs for extracting ſugar, which is generally adopted in the Britiſh Weſt India iſlands, according to the lateſt improvements; and have been anxious to preſent it to our readers in the ſimpleſt and moſt perſpicuous form, that it might be intelligible to every perſon; and have therefore avoided to mention the obſervations and propoſed amendments of thoſe who have written on this ſubject. Had we done ſo, we ſhould have ſwelled the preſent article to too great a ſize, without accompliſhing the purpoſe which we have in view; for our intention is not to inſtruct the planters, but to give a diſtinct account of the moſt approved methods which the planters have generally adopted. But though we judge it uſeleſs to trouble our readers with all the little varieties in the proceſs which different perſons employ, we flatter ourſelves it will not be diſagreeable to learn by what methods the French make their ſugar purer and whiter than ours.

28 Method of purifying uſed by the French.

A quantity of ſugar from the cooler is put into conical pans or earthen pots, called by the French *formes,* having a ſmall perforation at the apex, which is kept cloſed. Each cone, reverſed on its apex, is ſupported in another earthen veſſel. The ſyrup is ſtirred together, and then left to cryſtallize. At the end of 15 or 16 hours, the hole in the point of each cone is opened, that the impure ſyrup may run out. The baſe of the ſugar loaves is then taken out, and white pulverized ſugar ſubſtituted in its ſtead; which being well preſſed down, the whole is covered with clay moiſtened with water. This water filters through the maſs, carrying the ſyrup with it which was mixed with the ſugar, but which by this management flows into a pot ſubſtituted in the place of the firſt. This ſecond fluid is called *fine ſyrup.* Care is taken to moiſten and keep the clay to a proper degree of ſoftneſs as it becomes dry. The ſugar loaves are afterwards taken out, and dried in a ſtove for eight or ten days; after which they are pulverized, packed, and exported to Europe, where they are ſtill farther purified. The reaſon aſſigned why this proceſs is not univerſally adopted in the Britiſh ſugar iſlands is this, that the water which dilutes and carries away the melaſſes diſſolves and carries with it ſo much of the ſugar, that the difference in quality does not pay for the difference in quantity. The French planters probably think otherwiſe, upwards of 400 of the plantations of St Domingo having the neceſſary apparatus for claying and actually carrying on the ſyſtem.

Chaptal's Chemiſtry, vol. iii.

29 The art of refining ſugar introduced by a Venetian.

The art of refining ſugar was firſt made known to the Europeans by a Venetian, who is ſaid to have received 100,000 crowns for the invention. This diſcovery was made before the new world was explored; but whether it was an invention of the perſon who firſt communicated it, or whether it was conveyed from China, where it had been known for a conſiderable time before, cannot now perhaps be accurately aſcertained. We find no

Anderſon's Origin of Commerce.

mention made of the refining of ſugar in Britain till the year 1659, though it probably was practiſed ſeveral years before. For in the Portugueſe iſland of St Thomas in 1624 there were 74 ſugar ingenios, each having upwards of 200 ſlaves. The quantity of raw ſugar imported into England in 1778 amounted to 1,403,995 cwts.; the quantity imported into Scotland in the ſame year was 117,285 cwts.; the whole quantity imported into Great Britain in 1787 was 1,926,741 cwts.

30
In refining it is mixed with lime-water and bullock's blood, and expoſed to heat.

The ſugar which undergoes the operation of refining in Europe is either raw ſugar, ſometimes called *muſcovado* or *caſſonado*, which is raw ſugar in a purer ſtate. The raw ſugar generally contains a certain quantity of melaſſes as well as earthy and feculent ſubſtances. The caſſonado, by the operation of earthing, is freed from its melaſſes. As the intention of refining theſe ſugars is to give them a higher degree of whiteneſs and ſolidity, it is neceſſary for them to undergo other proceſſes. The firſt of theſe is called *clarification*. It conſiſts in diſſolving the ſugar in a certain proportion of lime-water, adding a proper quantity of bullock's blood, and expoſing it to heat in order to remove the impurities which ſtill remain. The heat is increaſed very gradually till it approach that of boiling water. By the aſſiſtance of the heat, the animal matter which was thrown in coagulates, at the ſame time that it attracts all the ſolid feculent and earthy matter, and raiſes it to the ſurface in the appearance of a thick foam of a browniſh colour. As the feculencies are never entirely removed by a firſt proceſs, a ſecond is neceſſary. The ſolution is therefore cooled to a certain degree by adding ſome water; then a freſh quantity of blood, but leſs conſiderable than at firſt, is poured in. The fire is renewed, and care is taken to increaſe the heat gently as before. The animal ſubſtance ſeizes on the impurities which remain, collects them on the ſurface, and they are then ſkimmed off. The ſame operation is repeated a third and even a fourth time, but no addition is made to the liquor except water. If the different proceſſes have been properly conducted, the ſolution will be freed from every impurity, and appear tranſparent. It is then conveyed by a gutter into an oblong baſket about 16 inches deep, lined with a woollen cloth; and after filtering through this cloth, it is received in a ciſtern or copper which is placed below.

31
Then freed from its remaining impurities by evaporation.

The ſolution being thus clarified, it undergoes a ſecond general operation called *evaporation*. Fire is applied to the copper into which the ſolution was received, and the liquid is boiled till it has acquired the proper degree of conſiſtency. A judgment is formed of this by taking up a ſmall portion of the liquid and drawing it into a thread. When, after this trial, it is found ſufficiently viſcous, the fire is extinguiſhed, and the liquid is poured into coolers. It is then ſtirred violently by an inſtrument called an *oar*, from the reſemblance it bears to the oar of a boat. This is done in order to diminiſh the viſcoſity, and promote what is called the *granulation*, that is, the forming of it into grains or imperfect cryſtals. When the liquid is properly mixed and cooled, it is then poured into moulds of the form of a ſugar loaf. Theſe moulds are ranged in rows. The ſmall ends, which are loweſt, are placed in pots; and they have each of them apertures ſtopped up with linen for filtering the ſyrup, which runs from the moulds into the pots. The liquor is then taken out ſlowly in ladlefuls from the coolers, and poured into the moulds. When the moulds are filled, and the contents ſtill in a fluid ſtate, it is neceſſary to ſtir them, that no part may adhere to the moulds, and that the ſmall cryſtals which are juſt formed may be equally diffuſed through the whole maſs. When the ſugar is completely cryſtallized, the linen is taken away from the apertures in the moulds, and the ſyrup, or that part which did not cryſtallize, deſcends into the pots in which the moulds are placed. After this purgation the moulds are removed and fixed in other pots, and a ſtratum of fine white clay diluted with water is laid on the upper part of the loaf. The water deſcending through the ſugar by its own weight, mixes with the ſyrup which ſtill remains in the body of the loaf, and waſhes it away. When the clay dries, it is taken off, and another covering of moiſt clay put in its place; and if it be not then ſufficiently waſhed, a third covering of clay is applied. After the loaves have ſtood ſome days in the moulds, and have acquired a conſiderable degree of firmneſs and ſolidity, they are taken out, and carried to a ſtove, where they are gradually heated to the 50° of Reaumur (64° of Fahrenheit), in order to diſſipate any moiſture which may be ſtill confined in them. After remaining in the ſtove eight days, they are taken out; and after cutting off all diſcolouring ſpecks, and the head if ſtill wet, they are wrapped in blue paper, and are ready for ſale. The ſeveral ſyrups collected during the different parts of the proceſs, treated in the ſame manner which we have juſt deſcribed, afford ſugars of inferior quality; and the laſt portion, which no longer affords any ſugar, is ſold by the name of *melaſſes*.

32
Afterwards poured into moulds, where the ſyrup is drained from it.

33
Laſtly expoſed to a certain degree of heat.

34
In what the beauty of ſugar conſiſts; how farther refined.

The beauty of refined ſugar, when formed into loaves, conſiſts in whiteneſs, joined to a ſmallneſs of grain; in being dry, hard, and ſomewhat tranſparent. The proceſs which we have deſcribed above refers to ſugar once refined; but ſome more labour is neceſſary to produce double refined ſugar. The principal difference in the operation is this, the latter is clarified by white of eggs inſtead of blood, and freſh water in place of lime-water.

35
How ſugar-candy is made.

Sugar-candy is the true eſſence of the cane formed into large cryſtals by a ſlow proceſs. When the ſyrup is well clarified, it is boiled a little, but not ſo much as is done for the proof mentioned in the proceſs for making common ſugar. It is then placed in old moulds, having their lower ends ſtopped with linen, and croſſed at little diſtances with ſmall twigs to retain the ſugar as it cryſtallizes. The moulds are then laid in a cool place. In proportion as the ſyrup cools, cryſtals are formed. In about nine or ten days the moulds are carried to the ſtove, and placed in a pot; but the linen is not removed entirely, ſo that the ſyrup falls down ſlowly in drops. When the ſyrup has dropped away, and the cryſtals of the ſugar-candy are become dry, the moulds are taken from the ſtove and broken in pieces, to diſengage the ſugar, which adheres ſtrongly to the ſides of the mould. If the ſyrup has been coloured with cochineal, the cryſtals take a ſlight taint of red; if indigo has been mixed, they aſſume a bluiſh colour. If it be deſired to have the candy perfumed, the eſſence of flowers or amber may be dropped into the moulds along with the ſyrup.

Having now given ſome account of the method uſually employed for refining ſugar, it will not be improper

proper to ſay a few things concerning its nature and its uſes.

36
Chemical qualities of ſugar.

Sugar is ſoluble in water, and in a ſmall degree in alcohol. When united with a ſmall portion of water, it becomes fuſible; from which quality the art of preſerving is indebted for many of its preparations. It is phoſphoric and combuſtible; when expoſed to fire emitting a blue flame if the combuſtion be ſlow, and a white flame if the combuſtion be rapid. By diſtillation it produces a quantity of phlegm, acid, oil, gas, and charcoal. Bergman, in treating ſugar with the nitrous acid, obtained a new acid now known by the name of the *oxalic acid;* but he has omitted to mention the principles of which ſugar is compoſed. Lavoiſier, however, has ſupplied this omiſſion; and after many experiments has aſſigned three principles in ſugar, hydrogen, oxygen, and carbone. If the juice expreſſed from the ſugar cane be left to itſelf it paſſes into the acetous fermentation; and during the decompoſition of the ſugar, which is continued for three or four months, a great quantity of glutinous matter is ſeparated. This matter when diſtilled gives a portion of ammoniac. If the juice be expoſed to the ſpirituous fermentation, a wine is obtained analogous to cyder. If this wine, after being kept in bottles a-year, be diſtilled, we obtain a portion of *eau de vie.*

37
Its uſes in medicine, &c.

The uſes to which ſugar are applied are indeed numerous and important: It can be made ſo ſolid as in the art of preſerving to receive the moſt agreeable colours and the greateſt variety of forms. It can be made ſo fluid as to mix with any ſoluble ſubſtance.—It preſerves the juice and ſubſtance of fruits in all countries and in all ſeaſons. It affords a delicious ſeaſoning to many kinds of food. It is uſeful in pharmacy, for it unites with medicines, and removes their diſagreeable flavour: it is the baſis of all ſyrups. M. Macquer has ſhown in a very ſatisfactory manner how uſeful ſugar would be if employed in fermenting wines. Sugar has alſo been found a remedy for the ſcurvy, and a valuable article of food in caſes of neceſſity. M. Imbert de Lennes, firſt ſurgeon to the late duke of Orleans, publiſhed the following ſtory in the *Gazette de Santé*, which confirms this aſſertion. A veſſel laden with ſugar bound from the Weſt Indies was becalmed in its paſſage for ſeveral days, during which the ſtock of proviſions was exhauſted. Some of the crew were dying of the ſcurvy, and the reſt were threatened with a ſtill more terrible death. In this emergency recourſe was had to the ſugar. The conſequence was, the ſymptoms of the ſcurvy went off, the crew found it a wholeſome and ſubſtantial aliment, and returned in good health to France.

38
Affords the greateſt quantity of nouriſhment of any kind of food.

“Sugar (ſays Dr Ruſh) affords the greateſt quantity of nouriſhment in a given quantity of matter of any ſubſtance in nature; of courſe it may be preſerved in leſs room in our houſes, and may be conſumed in leſs time, than more bulky and leſs nouriſhing aliment. It has this peculiar advantage over moſt kinds of aliment, that it is not liable to have its nutritious qualities affected by time or the weather; hence it is preferred by the Indians in their excurſions from home. They mix a certain quantity of maple ſugar, with an equal quantity of Indian corn, dried and powdered, in its milky ſtate. This mixture is packed in little baſkets, which are frequently wetted in travelling, without injuring the ſugar, A few ſpoonfuls of it mixed with half a pint of ſpring water afford them a pleaſant and ſtrengthening meal. From the degrees of ſtrength and nouriſhment which are conveyed into animal bodies by a ſmall bulk of ſugar, it might probably be given to horſes with great advantage, when they are uſed in places or under circumſtances which make it difficult or expenſive to ſupport them with more bulky or weighty aliment. A pound of ſugar with graſs or hay has ſupported the ſtrength and ſpirits of a horſe during a whole day's labour in one of the Weſt India iſlands. A larger quantity given alone has fattened horſes and cattle, during the war before laſt in Hiſpaniola, for a period of ſeveral months, in which the exportation of ſugar, and the importation of grain, were prevented by the want of ſhips.

Tranſactions of the American Philoſophical Society, vol. iii.

39
An excellent antidote againſt worms,

“The plentiful uſe of ſugar in diet is one of the beſt preventives that has ever been diſcovered of the diſeaſes which are produced by worms. Nature ſeems to have implanted a love for this aliment in all children, as if it were on purpoſe to defend them from thoſe diſeaſes. Dr Ruſh knew a gentleman in Philadelphia, who early adopted this opinion, and who, by indulging a large family of children in the uſe of ſugar, has preſerved them all from the diſeaſes uſually occaſioned by worms.

40
and probably againſt the plague and other malignant fevers.

“Sir John Pringle has remarked, that the plague has never been known in any country where ſugar compoſes a material part of the diet of the inhabitants. Dr Ruſh thinks it probable that the frequency of malignant fevers of all kinds has been leſſened by this diet, and that its more general uſe would defend that claſs of people who are moſt ſubject to malignant fevers from being ſo often affected by them.

“In the numerous and frequent diſorders of the breaſt, which occur in all countries where the body is expoſed to a variable temperature of weather, ſugar affords the baſis of many agreeable remedies. It is uſeful in weakneſſes, and acrid defluxions upon other parts of the body. Many facts may be adduced in favour of this aſſertion. Dr Ruſh mentions only one, which, from the venerable name of the perſon whoſe caſe furniſhed it, cannot fail of commanding attention and credit. Upon my inquiring of Dr Franklin, at the requeſt of a friend (ſays our reſpectable author), about a year before he died, whether he had found any relief from the pain of the ſtone from the blackberry jam, of which he took large quantities, he told me that he had, but that he believed the medicinal part of the jam reſided wholly in the ſugar; and as a reaſon for thinking ſo, he added, that he often found the ſame relief by taking about half a pint of a ſyrup, prepared by boiling a little brown ſugar in water, juſt before he went to bed, that he did from a doſe of opium. It has been ſuppoſed by ſome of the early phyſicians of our country, that the ſugar obtained from the maple-tree is more medicinal than that obtained from the Weſt India ſugar-cane; but this opinion I believe is without foundation. It is preferable in its qualities to the Weſt India ſugar only from its ſuperior cleanlineſs.

41
Has given relief from the pain of the ſtone.

“Caſes may occur in which ſugar may be required in medicine, or in diet, by perſons who refuſe to be benefited, even indirectly by the labour of ſlaves. In ſuch caſes the innocent maple ſugar will always be preferred. It has been ſaid, that ſugar injures the teeth; but this opinion now has ſo few advocates, that it does not deſerve a ſerious refutation.”

42
Not hurtful to the teeth.

43
Sugar manufactured in the Eaſt Indies by free men,

In the account which we have given above of the method of cultivating and manufacturing ſugar, we have had in our eye the plantations in the Weſt Indies, where ſlaves alone are employed; but we feel a peculiar pleaſure in having it in our power to add a ſhort deſcription of the method uſed in the Eaſt Indies, becauſe there ſugar is manufactured by free men, on a plan which is much more economical than what is followed in the Weſt Indies. The account which we mean to give is an extract from the report of the committee of Privy-council for trade on the ſubject of the African ſlave-trade, drawn up by Mr Botham. We ſhall give it in the author's own words.

44
of a ſuperior quality and at a lower price.

45
How ſugar eſtates are managed at Batavia.

"Having been for two years in the Engliſh and French Weſt India iſlands, and ſince conducted ſugar eſtates in the Eaſt Indies; before the abolition of the ſlave-trade was agitated in parliament, it may be deſirable to know that ſugar of a ſuperior quality and inferior price to that in our iſlands is produced in the Eaſt Indies; that the culture of the cane, the manufacture of the ſugar and arrack, is, with theſe material advantages, carried on by free people. China, Bengal, the coaſt of Malabar, all produce quantities of ſugar and ſpirits; but as the moſt conſiderable growth of the cane is carried on near Batavia, I ſhall explain the improved manner in which ſugar eſtates are there conducted. The proprietor of the eſtate is generally a wealthy Dutchman, who has erected on it ſubſtantial mills, boiling and curing houſes. He rents this eſtate to a Chineſe, who reſides on it as a ſuperintendant; and this renter (ſuppoſing the eſtate to conſiſt of 300 or more acres) relets it to free men in parcels of 50 or 60 on theſe conditions: 'That they ſhall plant it in canes, and receive ſo much per pecul of 133½ pounds for every pecul of ſugar that the canes ſhall produce."

When crop time comes on, the ſuperintendant collects a ſufficient number of perſons from the adjacent towns or villages, and takes off his crop as follows. To any ſet of tradeſmen who bring their carts and buffaloes he agrees to give ſuch a price per pecul to cut all his crop of canes, carry them to the mill and grind them. A ſecond to boil them per pecul. A third to clay them and baſket them for market per pecul. So that by this method of conducting a ſugar eſtate the renter knows to a certainty what the produce of it will coſt him per pecul. He has not any permanent or unneceſſary expence; for when the crop is taken off, the taſkmen return to their ſeveral purſuits in the towns and villages they came from; and there only remain the cane planters who are preparing the next year's crop. This, like all other complex arts, by being divided into ſeveral branches, renders the labour cheaper and the work more perfectly done.

Only clayed ſugars are made at Batavia; theſe are in quality equal to the beſt ſort from the Weſt Indies, and are ſold ſo low from the ſugar eſtates as eighteen ſhillings ſterling per pecul of 133½lbs. This is not the ſelling price to the trader at Batavia, as the government there is arbitrary, and ſugar ſubject to duties impoſed at will. The Shabander exacts a dollar per pecul on all ſugar exported. The price of common labour is from 9d. to 10d. per day. By the method of carrying on the ſugar eſtates, the taſkmen gain conſiderably more than this, not only from working extraordinary hours, but from being conſidered artiſts in their ſeveral branches. They do not make ſpirits on the ſugar eſtates. The melaſſes is ſent for ſale to Batavia, where one diſtillery may purchaſe the produce of an hundred eſtates. Here is a vaſt ſaving and reduction of the price of ſpirits; not as in the Weſt Indies, a diſtillery for each eſtate; many centre in one, and arrack is ſold at Batavia from 21 to 25 rixdollars per leaguer of 160 gallons; ſay 8d. per gallon."

46
Deſcription of the ſugar maple.

The SUGAR MAPLE, (the *acer ſaccharinum* of Linnæus), as well as the ſugar-cane, produces a great quantity of ſugar. This tree grows in great numbers in the weſtern counties of all the middle ſtates of the American union. Thoſe which grow in New York and Pennſylvania yield the ſugar in a greater quantity than thoſe which grow on the waters of the Ohio.—Theſe trees are generally found mixed with the beech, hemlock, white and water aſh, the cucumber tree, linden, aſpen, butter nut, and wild cherry trees. They ſometimes appear in groves covering five or ſix acres in a body, but they are more commonly interſperſed with ſome or all of the foreſt trees which have been mentioned. From 30 to 50 trees are generally found upon an acre of ground. They grow only in the richeſt ſoils, and frequently in ſtony ground. Springs of the pureſt water abound in their neighbourhood. They are, when fully grown, as tall as the white and black oaks, and from two to three feet in diameter. They put forth a beautiful white bloſſom in the ſpring before they ſhow a ſingle leaf. The colour of the bloſſom diſtinguiſhes them from the acer rubrum, or the common maple, which affords a bloſſom of a red colour. The wood of the ſugar maple-tree is extremely inflammable, and is preferred upon that account by hunters and ſurveyors for fire-wood. Its ſmall branches are ſo much impregnated with ſugar as to afford ſupport to the cattle, horſes, and ſheep of the firſt ſettlers, during the winter, before they are able to cultivate forage for that purpoſe. Its aſhes afford a great quantity of potaſh, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States. The tree is ſuppoſed to arrive at its full growth in the woods in twenty years.

Tranſactions of the American Philoſophical Society, vol. iii.

47
The oftener this tree is tapped the more ſyrup is obtained from it.

It is not injured by tapping; on the contrary, the oftener it is tapped, the more ſyrup is obtained from it. In this reſpect it follows a law of animal ſecretion. A ſingle tree had not only ſurvived, but flouriſhed after forty-two tappings in the ſame number of years. The effects of a yearly diſcharge of ſap from the tree, in improving and increaſing the ſap, are demonſtrated from the ſuperior excellence of thoſe trees which have been perforated in an hundred places, by a ſmall wood-pecker which feeds upon the ſap. The trees, after having been wounded in this way, diſtil the remains of their juice on the ground, and afterwards acquire a black colour. The ſap of theſe trees is much ſweeter to the taſte than that which is obtained from trees which have not been previouſly wounded, and it affords more ſugar.

48
What quantity of ſap will produce a certain quantity of ſugar.

From twenty-three gallons and one quart of ſap, procured in twenty-four hours from only two of theſe dark coloured trees, Arthur Noble, Eſq. of the ſtate of New-York, obtained four pounds and thirteen ounces of good grained ſugar.

A tree of an ordinary ſize yields in a good ſeaſon from twenty to thirty gallons of ſap, from which are made from five to ſix pounds of ſugar. To this there are ſometimes

times remarkable exceptions. Samuel Lowe, Eſq. a juſtice of peace in Montgomery county, in the ſtate of New York, informed Arthur Noble, Eſq. that he had made twenty pounds and one ounce of ſugar between the 14th and 23d of April, in the year 1789, from a ſingle tree that had been tapped for ſeveral ſucceſſive years before.

49 This quantity might be increaſed by culture.

From the influence which culture has upon foreſt and other trees, it has been ſuppoſed, that by tranſplanting the ſugar maple-tree into a garden, or by deſtroying ſuch other trees as ſhelter it from the rays of the ſun, the quantity of the ſap might be increaſed, and its quality much improved. A farmer in Northampton county, in the ſtate of Pennſylvania, planted a number of theſe trees above twenty years ago in his meadow, from three gallons of the ſap of which he obtains every year a pound of ſugar. It was obſerved formerly, that it required five or ſix gallons of the ſap of the trees which grow in the woods to produce the ſame quantity of ſugar.

50 The ſap diſtils from the wood in the ſpring months.

The ſap diſtils from the wood of the tree. Trees which have been cut down in the winter for the ſupport of the domeſtic animals of the new ſettlers, yield a conſiderable quantity of ſap as ſoon as their trunks and limbs feel the rays of the ſun in the ſpring of the year. It is in conſequence of the ſap of theſe trees being equally diffuſed through every part of them, that they live three years after they are girdled, that is, after a circular inciſion is made through the bark into the ſubſtance of the tree for the purpoſe of deſtroying it. It is remarkable that graſs thrives better under this tree in a meadow, than in ſituations expoſed to the conſtant action of the ſun. The ſeaſon for tapping the trees is in February, March, and April, according to the weather which occurs in theſe months.

51 Is increaſed by warm days and froſty nights.

Warm days and froſty nights are moſt favourable to a plentiful diſcharge of ſap. The quantity obtained in a day from a tree is from five gallons to a pint, according to the greater or leſs heat of the air. Mr Lowe informed Arthur Noble, Eſq. that he obtained near three and twenty gallons of ſap in one day (April 14. 1789) from the ſingle tree which was before mentioned. Such inſtances of a profuſion of ſap in ſingle trees are however not very common.

52 How the ſap is drained from the tree.

There is always a ſuſpenſion of the diſcharge of ſap in the night if a froſt ſucceed a warm day. The perforation in the tree is made with an axe or an auger. The latter is preferred from experience of its advantages. The auger is introduced about three quarters of an inch, and in an aſcending direction (that the ſap may not be frozen in a ſlow current in the mornings or evenings), and is afterwards deepened gradually to the extent of two inches. A ſpout is introduced about half an inch into the hole made by this auger, and projects from three to twelve inches from the tree. The ſpout is generally made of the ſumach or elder, which uſually grows in the neighbourhood of the ſugar trees. The tree is firſt tapped on the ſouth ſide; when the diſcharge of its ſap begins to leſſen, an opening is made on the north ſide, from which an increaſed diſcharge takes place. The ſap flows from four to ſix weeks, according to the temperature of the weather. Troughs large enough to contain three or four gallons, made of white pine, or white aſh, or of dried water aſh, aſpen, linden, poplar, or common maple, are placed under the ſpout to receive the ſap, which is carried every day to a large receiver, made of either of the trees before mentioned. From this receiver it is conveyed, after being ſtrained, to the boiler.

53 Is reduced to ſugar by three modes.

We underſtand that there are three modes of reducing the ſap to ſugar; by evaporation, by freezing, and by boiling; of which the latter is moſt general, as being the moſt expeditious. We are farther aſſured, that the profit of the maple tree is not confined to its ſugar. It affords moſt agreeable melaſſes, and an excellent vinegar. The ſap which is ſuitable for theſe purpoſes is obtained after the ſap which affords the ſugar has ceaſed to flow, ſo that the manufactories of theſe different products of the maple tree, by ſucceeding, do not interfere with each other. The melaſſes may be made to compoſe the baſis of a pleaſant ſummer beer. The ſap of the maple is moreover capable of affording a ſpirit; but we hope this precious juice will never be proſtituted to this ignoble purpoſe. Should the uſe of ſugar in diet become more general in this country (ſays Dr Ruſh) it may tend to leſſen the inclination or ſuppoſed neceſſity for ſpirits, for I have obſerved a reliſh for ſugar in diet to be ſeldom accompanied by a love for ſtrong drink.

54 Sugar procured from many other vegetables.

There are ſeveral other vegetables raiſed in our own country which afford ſugar; as beet-roots, ſkirrets, parſneps, potatoes, celeri, red cabbage ſtalks, the young ſhoots of Indian wheat. The ſugar is moſt readily obtained from theſe, by making a tincture of the ſubject in rectified ſpirit of wine; which, when ſaturated by heat, will depoſit the ſugar upon ſtanding in the cold.

SUGAR of Milk. See MILK, CHEMISTRY *Index*.

Acid of SUGAR. See CHEMISTRY *Index*.

SUGILLATION, in *Medicine*, an extravaſation of blood in the coats of the eye, which at firſt appears of a reddiſh colour, and afterwards livid or black. If the diſorder is great, bleeding and purging are proper, as are alſo diſcutients.

END OF THE NINETEENTH VOLUME.

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