This Day is Publiſhed
By ARCHIBALD CONSTABLE & CO. *Edinburgh*,
And sold by JOHN MURRAY, 32. *Fleet-Street*, *London*.

Handſomely printed in Seven Volumes 8vo, price 3l. 4s. 6d. in boards; or, in Numbers, price 3l. 1s.

THE

FARMER'S MAGAZINE:

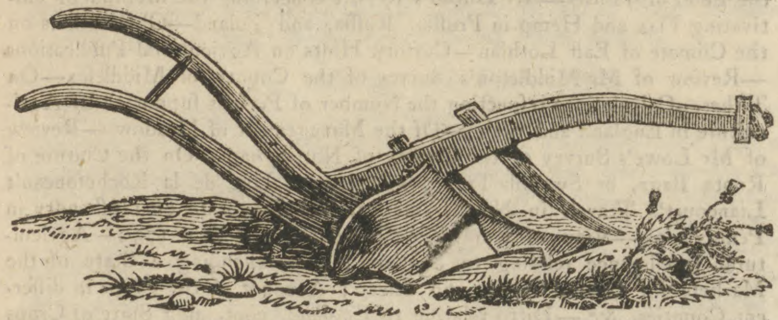
A PERIODICAL WORK,

EXCLUSIVELY DEVOTED TO

AGRICULTURE & RURAL AFFAIRS:

1800, 1801, 1802, 1803, 1804, 1805, 1806.

PUBLISHED QUARTERLY.



Ye generous BRITONS, venerate the PLOUGH,
And o'er your hills, and long-withdrawing vales,
Let Autumn ſpread her treaſures to the ſun. THOMSON.

☞ The deſign of the Farmer's Magazine is to collect and diſſeminate ingenious Theories, important and well-authenticated Facts, and accurate Experiments, which relate to the different branches of rural economy. It muſt be well known to every perſon in the leaſt acquainted with the different parts of the United Kingdom, that diſcoveries and improvements, particularly in Agriculture, travel very ſlowly. To remedy this, the Farmer's Magazine was firſt projected; and the Proprietors are happy to ſay, that, if they may judge from the almoſt unprecedented ſale of more than 4000 copies of each Number, the object of this publication is in a great degree anſwered. The work, in its plan and arrangement, is well calculated for the end the Proprietors had in view. It conſiſts of—1. Miſcellaneous Communications, chiefly of the moſt important practical nature.—2. The Review of Agricultural Publications.—3. Agricultural Intelligence from almoſt every diſtrict in Scotland, and from ſeveral in England. The utility and importance of this branch muſt be evident to every practical Farmer, who, at the moderate price of Two Shillings and Sixpence a quarter, may learn the ſtate of the crops, and the price of grain, cattle, &c. in the different parts of the kingdom, beſides being enabled to compare his own practice with that in other diſtricts, and thus to correct what is improper or deficient.

Edinburgh: Printed by D. WILLISON
1806.

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On the Figure in which Trees should be disposed in Plantations; with a Plate—Evil Tendency of ascertaining the Rent of Farms by the highest offer—Answer to the Letter of A. S. on Sheep-Smearing—On the Endurance of Leases—Fourcroy on the Influence of Water on Vegetation; with Postscript by the Translator—Instance of preserving a Tree nearly barked—Proposals for Instituting Evening Schools for the Instruction of Farm Servants—On the Comparative Value of Land in the Counties of Wigtoun and Haddington—On Free Martins—Uses of Black Currants displayed; with Recipe for making Black Currant Wine—On the Forming and Repairing of Roads—Report on Question, Whether discretionary Management can be exercised by Farmers not tied down by Covenants or Regulations—On Highland Husbandry, in Reply to *Senex*—Reply to Heritor's Account of Proceedings in the case of Culsamond—Cursory Remarks on Baron Hepburn's Outline View of the Corn Laws—Letter from Fifeshire Ploughman—On the Diseases of Calves, &c.—Observations on Potatoes and Turnips—On British Grasses most suitable for common Culture—Recipe for the Foot-Rot in Sheep—Review of Bell's Treatise on Leases, explaining the Nature and Effect of the Contract of Lease, and the legal Rights enjoyed by the Parties—Legal Polity of Scotland as it affects Occupiers of Land—Leading Article of Agricultural Intelligence—Scotish Intelligence—Account of Wheat sold in Haddington Market, from 1. Nov. 1805, to 24. Oct. 1806; with weekly, monthly, and annual average Prices thereof.—English Intelligence—Account of G. Culley esq.'s Sale of Sheep—On the High Price of Seed-Wheat in the London Market—Obituary; Death of William Forbes Leith, Esq.

☞ *No. XXIX., being the first Number of Volume VIII., will be published on Monday,* 9*th February* 1807.

D. Willison, printer, Edinburgh.

Buildings.

antique and rustic air of its Doric columns without bases; by the chastity of its little ornaments, a crook, a pipe, and a scrip, and those only over the doors; and by the simplicity of the whole both within and without; it is adapted with so much propriety to the thickets which conceal it from the view, that no one can wish it to be brought forward, who is sensible to the charms of the Arcadian scene which this building alone has created. On the other hand, a very spacious field, or sheep walk, will not be disgraced by a farm house, a cottage, or a Dutch barn; nor will they, though small and familiar, appear to be inconsiderable or insignificant objects. Numberless other instances might be adduced to prove the impossibility of restraining particular buildings to particular situations, upon any general principles: the variety in their forms is hardly greater than in their application. Only let not their uses be disguised, as is often absurdly attempted with the humbler kinds. "A barn ‡ dressed up in the habit of a country church, or a farm house figuring away in the fierceness of a castle, are ridiculous deceptions. A landscape daubed upon a board, and a wooden steeple stuck up in a wood, are beneath contempt."

‡ *Planting and Gardening*, p. 598.

Temples, those favourite and most costly objects in gardens, too generally merit censure for their inutility, their profusion, or the impropriety of their purpose. "Whether they be dedicated to Bacchus, Venus, Priapus, or any other demon of debauchery, they are in this age, enlightened with regard to theological and scientific knowledge, equally absurd. Architecture, in this part of its sphere, may more nobly, and with greater beauty and effect, be exercised upon a chapel, a mausoleum, a monument, judiciously disposed among the natural ornaments. The late Sir William Harbord has given us a model, of the first kind, at Gunton, in Norfolk; the parish church standing in his park, and being an old unsightly building, he had it taken down, and a beautiful temple, under the direction of the Adams erected upon its site for the same sacred purpose:—The mausoleum at Castle-Howard, in Yorkshire, the seat of the earl of Carlisle, is a noble structure:—And as an instance of the last sort, may be mentioned the Temple of Concord and Victory at Stowe, erected to the memory of the great Lord Chatham and his glorious war; a beautiful monumental building, suited to the greatness of the occasion."

Ibid, p. 599.

To the great variety above mentioned must be added, Mr Wheatley observes, the many changes which may be made by the means of ruins. They are a class by themselves, beautiful as objects, expressive as characters, and peculiarly calculated to connect with appendages into elegant groups. They may be accommodated with ease to irregularity of ground, and their disorder is improved by it. They may be intimately blended with trees and thickets; and the interruption is an advantage: for imperfection and obscurity are their properties, and to carry the imagination to something greater than is seen, is their effect. They may for any of these purposes be separated into detached pieces; contiguity is not necessary, nor even the appearance of it, if the relation be preserved; but straggling ruins have a bad effect, when the several parts are equally considerable. There should be one large mass to raise an idea of greatness, to attract the others about it, and to be a common centre of union to all: the smaller pieces then mark the original dimensions of one extensive structure; and no longer appear to be the remains of several little buildings.

Observations on Modern Gardening.

All remains excite an inquiry into the former state of the edifice, and fix the mind in a contemplation of the use it was applied to; besides the characters expressed by their style and position, they suggest ideas which would not arise from the buildings if entire. The purposes of many have ceased: an abbey, or a castle, if complete, can now be no more than a dwelling; the memory of the times, and of the manners to which they are adapted, is preserved only in history, and in ruins; and certain sensations of regret, of veneration, or compassion, attend the recollection. Nor are these confined to the remains of buildings which are in disuse; those of an old mansion raise reflections on the domestic comforts once enjoyed, and the ancient hospitality which reigned there. Whatever building we see in decay, we naturally contrast its present with its former state, and delight to ruminate on the comparison. It is true that such effects properly belong to real ruins; they are however produced in a certain degree by those which are fictitious: the impressions are not so strong, but they are exactly similar; and the representation, though it does not present facts to the memory, yet suggests subjects to the imagination. But, in order to affect the fancy, the supposed original design should be clear, the use obvious, and the form easy to be traced: no fragments should be hazarded without precise meaning, and an evident connexion; none should be perplexed in their construction, or uncertain as to their application. Conjectures about the form raise doubts about the existence of the ancient structure: the mind must not be allowed to hesitate; it must be hurried away from examining into the reality by the exactness and the force of the resemblance.

In the ruins of Tintern abbey § the original construction of the church is perfectly marked; and it is principally from this circumstance that they are celebrated as a subject of curiosity and contemplation. The walls are almost entire; the roof only is fallen in, but most of the columns which divided the aisles are still standing: of those which have dropped down, the bases remain, every one exactly in its place; and in the middle of the nave four lofty arches, which once supported the steeple, rise high in the air above all the rest, each reduced now to a narrow rim of stone, but completely preserving its form. The shapes even of the windows are little altered: but some of them are quite obscured, others partially shaded, by tufts of ivy; and those which are most clear are edged with its slender tendrils, and lighter foliage, wreathing about the sides and the divisions: it winds round the pillars; it clings to the walls; and in one of the aisles clusters at the top in branches, so thick and so large as to darken the space below. The other aisles, and the great nave, are exposed to the sky; the floor is entirely overspread with turf; and to keep it clear from weeds and bushes, is now its highest preservation. Monkish tomb stones and the monuments of benefactors long since forgotten, appear above the green sward; the bases of the pillars which have fallen, rise out of it; and maimed effigies, and sculpture worn with age and weather, Gothic capitals, carved cornices,

§ Between Chepstow and Monmouth.

Art. cornices, and various fragments, are ſcattered about, or lie in heaps piled up together. Other ſhattered pieces, though disjointed and mouldering, ſtill occupy their original places; and a ſtaircaſe much impaired, which led to a tower now no more, is ſuſpended at a great height, uncovered and inacceſſible: nothing is perfect; but memorials of every part ſtill ſubſiſt; all certain, but all in decay; and ſuggeſting at once every idea which can occur in a ſeat of devotion, ſolitude, and deſolation. Upon ſuch models fictitious ruins ſhould be formed: and if any parts are entirely loſt, they ſhould be ſuch as the imagination can eaſily ſupply from thoſe which are ſtill remaining. Diſtinct traces of the building which is ſuppoſed to have exiſted, are leſs liable to the ſuſpicion of artifice, than an unmeaning heap of confuſion. Preciſion is always ſatisfactory, but in the reality it is only agreeable; in the copy it is eſſential to the imitation.

A material circumſtance to the truth of the imitation is, that the ruins appear to be very old. The idea is beſides intereſting in itſelf: a monument of antiquity is never ſeen with indifference; and a ſemblance of age may be given to the repreſentation by the hue of the materials, the growth of ivy and other plants, and cracks and fragments ſeemingly occaſioned rather by decay than by deſtruction. An appendage evidently more modern than the principal ſtructure will ſometimes corroborate the effect: the ſhed of a cottager amidſt the remains of a temple, is a contraſt both to the former and to the preſent ſtate of the building; and a tree flouriſhing among ruins, ſhows the length of time they have lain neglected. No circumſtance ſo forcibly marks the deſolation of a ſpot once inhabited, as the prevalence of nature over it:

Campos ubi Troja fuit,

is a ſentence which conveys a ſtronger idea of a city totally overthrown, than a deſcription of its remains; but in a repreſentation to the eye, ſome remains muſt appear; and then the perverſion of them to an ordinary uſe, or an intermixture of a vigorous vegetation, intimates a ſettled deſpair of their reſtoration.

Sect. II. *Principles of Selection and Arrangement in the Subjects of Gardening.*

Planting and Gardening, p. 602.

I. Of ART. In the lower claſſes of rural improvements, art ſhould be ſeen as little as may be; and in the more negligent ſcenes of nature, every thing ought to appear as if it had been done by the general laws of nature, or had grown out of a ſeries of fortuitous circumſtances. But in the higher departments, art cannot be hid; and the *appearance* of deſign ought not to be excluded. A human production cannot be made perfectly natural; and held out as ſuch it becomes an impoſition. Our art lies in endeavouring to adapt the productions of nature to human taſte and perceptions; and if much art be uſed, do not *attempt* to hide it. Art ſeldom fails to pleaſe when executed in a maſterly manner: nay, it is frequently the deſign and execution, more than the production itſelf, that ſtrikes us. It is the artifice, not the deſign, which ought to be avoided. It is the labour and not the art which ought to be concealed. The rural artiſt ought, therefore, upon every occaſion, to endeavour to avoid labour; or, if indiſpenſably neceſſary, to conceal it. No trace ſhould be left to lead back the mind to the expenſive toil. A mound raiſed, a mountain levelled, or a uſeleſs temple built, convey to the mind feelings equally diſguſting.

Picturesque Beauty, &c.

13 Of Scenery. *Ibid.*

II. PICTURESQUE BEAUTY. Though the aids of art are as eſſential to gardening, as education is to manners; yet art may do too much: ſhe ought to be conſidered as the handmaid, not as the miſtreſs, of nature; and whether ſhe be employed in carving a tree into the figure of an animal, or in ſhaping a view into the form of a picture, ſhe is equally culpable. The nature of the place is ſacred. Should this tend to landſcape, from ſome principal point of view, aſſiſt nature and perfect it; provided this can be done without injuring the views from other points. But do not disfigure the natural features of the place:—do not ſacrifice its native beauties, to the arbitrary laws of landſcape painting.

Great Nature ſcorns controul; ſhe will not bear
One beauty foreign to the ſpot or ſoil
She gives thee to adorn: 'Tis thine alone
To mend, not change, her features. MASON.

Nature ſcarcely knows the thing mankind call a *landſcape*. The landſcape painter ſeldom, if ever, finds it perfected to his hands; ſome addition or alteration is almoſt always wanted. Every man who has made his obſervations upon natural ſcenery, knows that the miſletoe of the oak occurs almoſt as often as a perfect natural landſcape; and to attempt to make up artificial landſcape upon every occaſion is unnatural and abſurd.

If, indeed, the eye were fixed in one point, the trees could be raiſed to their full height at command, and the ſun be made to ſtand ſtill, the rural artiſt might work by the rules of light and ſhade, and compoſe his landſcape by the painter's law. But, whilſt the ſun continues to pour forth its light impartially, and the trees to riſe with ſlow progreſſion, it would be ridiculous to attempt it. Let him rather ſeek out, imitate, and aſſociate, ſuch ſtriking paſſages in nature as are immediately applicable to the place to be improved, with regard to rules of landſcape, merely human; —and let him,

————————in this and all
Be various, wild, and free, as Nature's ſelf. MASON.

Inſtead of ſacrificing the natural beauties of the place to one formal landſcape, let every ſtep diſcloſe freſh charms unſought for.

Wheatley's Obſervations.

III. Of CHARACTER. Character is very reconcilable with beauty; and, even when independent of it, has attracted ſo much regard, as to occaſion ſeveral frivolous attempts to produce it: ſtatues, inſcriptions, and even paintings, hiſtory and mythology, and a variety of devices, have been introduced for this purpoſe. The heathen deities and heroes have therefore had their ſeveral places aſſigned to them in the woods and lawns of a garden; natural caſcades have been disfigured with river gods, and columns erected only to receive quotations; the compartiments of a ſummer

14 Of emblematical characters.

Character. mer houſe have been filled with pictures of gambols and revels, as ſignificant of gaiety; the cypreſs, becauſe it was once uſed in funerals, has been thought peculiarly adapted to melancholy; and the decorations, the furniture, and the environs of a building, have been crowded with puerilities under pretence of propriety. All theſe devices are rather *emblematical* than expreſſive: they may be ingenious contrivances, and recal abſent ideas to the recollection; but they make no immediate impreſſion: for they muſt be examined, compared, perhaps explained, before the whole deſign of them is well underſtood. And though an alluſion to a favourite or well known ſubject of hiſtory, of poetry, or of tradition, may now and then animate or dignify a ſcene; yet as the ſubject does not naturally belong to a garden, the alluſion ſhould not be principal: it ſhould ſeem to have been ſuggeſted by the ſcene; a tranſitory image, which irreſiſtibly occurred; not ſought for, not laboured; and have the force of a metaphor, free from the detail of an allegory.

15 Of imitative characters. Another ſpecies of character ariſes from direct *imitation;* when a ſcene or an object, which has been celebrated in deſcription, or is familiar in idea, is repreſented in a garden. Artificial ruins, lakes, and rivers, fall under this denomination. The air of a ſeat extended to a diſtance, and ſcenes calculated to raiſe ideas of Arcadian elegance or of rural ſimplicity, with many more which have been occaſionally mentioned, or will obviouſly occur, may be ranked in this claſs. They are all repreſentations. But the materials, the dimenſions, and other circumſtances, being the ſame in the copy and the original, their effects are ſimilar in both: and if not equally ſtrong, the defect is not in the reſemblance; but the conſciouſneſs of an imitation checks that train of thought which the appearance naturally ſuggeſts. Yet an over-anxious ſolicitude to diſguiſe the fallacy is often the means of expoſing it: too many points of likeneſs ſometimes hurt the deception; they ſeem ſtudied and forced; and the affectation of reſemblance deſtroys the ſuppoſition of a reality. A hermitage is the habitation of a recluſe; it ſhould be diſtinguiſhed by its ſolitude, and its ſimplicity: but if it is filled with crucifixes, hour glaſſes, beads, and every other trinket which can be thought of, the attention is diverted from enjoying the retreat to examining the particulars: all the collateral circumſtances which agree with a character ſeldom meet in one ſubject; and when they are induſtriouſly brought together, though each be natural, the collection is artificial.

16 Of original characters. But the art of gardening aſpires to more than imitation: it can create *original* characters, and give expreſſions to the ſeveral ſcenes ſuperior to any they can receive from alluſions. Certain properties, and certain diſpoſitions, of the objects of nature, are adapted to excite particular ideas and ſenſations: many of them have been occaſionally mentioned, and all are very well known. They require no diſcernment, examination, or diſcuſſion; but are obvious at a glance, and inſtantaneouſly diſtinguiſhed by our feelings. Beauty alone is not ſo engaging as this ſpecies of character: the impreſſions it makes are more tranſient and leſs intereſting; for it aims only at delighting the eye, but the other affects our ſenſibility. An aſſemblage of the moſt elegant forms in the happieſt ſituations is to a degree indiſcriminate, if they have not been ſelected and arranged with a deſign to produce certain expreſſions; an air of magnificence, or of ſimplicity, of cheerfulneſs, tranquillity, or ſome other general character, ought to pervade the whole; and objects pleaſing in themſelves, if they contradict that character, ſhould therefore be excluded: thoſe which are only indifferent muſt ſometimes make room for ſuch as are more ſignificant; many will often be introduced for no other merit than their expreſſion; and ſome, which are in general rather diſagreeable, may occaſionally be recommended by it. Barrenneſs itſelf may be an acceptable circumſtance in a ſpot dedicated to ſolitude and melancholy.

The power of ſuch characters is not confined to the ideas which the objects immediately ſuggeſt; for theſe are connected with others, which inſenſibly lead to ſubjects far diſtant perhaps from the original thought, and related to it only by a ſimilitude in the ſenſations they excite. In a proſpect enriched and enlivened with inhabitants and cultivation, the attention is caught at firſt by the circumſtances which are gayeſt in their ſeaſon, the bloom of an orchard, the feſtivity of a hay field, and the carols of harveſt home; but the cheerfulneſs which theſe infuſe into the mind, expands afterwards to other objects than thoſe immediately preſented to the eye; and we are thereby diſpoſed to receive, and delighted to purſue, a variety of pleaſing ideas, and every benevolent feeling. At the ſight of a ruin, reflections on the change, the decay, and the deſolation before us, naturally occur; and they introduce a long ſucceſſion of others all tinctured with that melancholy which theſe have inſpired; or if the monument revive the memory of former times, we do not ſtop at the ſimple fact which it records, but recollect many more coeval circumſtances, which we ſee, not perhaps as they were, but as they are come down to us, venerable with age, and magnified by fame. Even without the aſſiſtance of buildings or other adventitious circumſtances, nature alone furniſhes materials for ſcenes which may be adapted to almoſt every kind of expreſſion: their operation is general, and their conſequences are infinite: the mind is elevated, depreſſed, or compoſed, as gaiety, gloom, or tranquillity, prevails in the ſcene; and we ſoon loſe ſight of the means by which the character is formed; we forget the particular objects it preſents; and giving way to their effects, without recurring to the cauſe, we follow the track they have begun, to any extent which the diſpoſition they accord with will allow. It ſuffices that the ſcenes of nature have a power to affect our imagination and our ſenſibility; for ſuch is the conſtitution of the human mind, that if once it is agitated, the emotion ſpreads far beyond the occaſion: when the paſſions are rouſed, their courſe is unreſtrained; when the fancy is on the wing, its flight is unbounded; and, quitting the inanimate objects which firſt gave them their ſpring, we may be led by thought above thought, widely differing in degree, but ſtill correſponding in character, till we riſe from familiar ſubjects up to the ſublimeſt conceptions, and are wrapt in the contemplation of whatever is great or beautiful, which we ſee in nature, feel in man, or attribute to divinity.

General Arrangement. IV. GENERAL ARRANGEMENT. Notwithſtanding the nature of the place, as already obſerved, ought

Hunting-Box.

Pract. Treat. on Planting and Gardening.

ought not to be ſacrificed to the manſion;—the houſe muſt ever be allowed to be a principal in the compoſition. It ought to be conſidered as the centre of the ſyſtem; and the rays of art, like thoſe of the ſun, ſhould grow fainter as they recede from the centre. The houſe itſelf being entirely a work of art, its immediate environs ſhould be highly finiſhed; but as the diſtance increaſes, the appearance of deſign ſhould gradually diminiſh, until nature and fortuitouſneſs have full poſſeſſion of the ſcene.

In general, the approach ſhould be to the back front, which, in ſuitable ſituations, ought to lie open to the paſture grounds. On the ſides more highly ornamented, a well kept gravel walk may embrace the walls; to this the ſhaven lawn and ſhrubbery ſucceed: next, the grounds cloſely paſtured; and laſtly, the ſurrounding country, which ought not to be conſidered as out of the artiſt's reach: for his art conſiſts not more in decorating particular ſpots, than in endeavouring to render the whole face of nature delightful.

Another reaſon for this mode of arrangement is, objects immediately under the eye are ſeen more diſtinctly than thoſe at a diſtance, and ought to be ſuch as are pleaſing in the detail. The beauties of a flower can be diſcerned on a near view only; whilſt at a diſtance a roughet of coppice wood, and the moſt elegant arrangement of flowering ſhrubs, have the ſame effect. The moſt rational entertainment the human mind is capable of receiving, is that of obſerving the operations of nature. The foliation of a leaf, the blowing of flowers, and the maturation of fruit, are among the moſt delightful ſubjects that a contemplative mind can be employed in. Theſe proceſſes of nature are ſlow; and except the object fall ſpontaneouſly under the eye of the obſerver, the inconveniences of viſiting it in a remote part, ſo far interfere with the more important employments of life, as to blunt, if not deſtroy, the enjoyment. This is a ſtrong argument in favour of ſhrubs and flowers being planted under or near our windows, eſpecially thoſe from whence they may be viewed during the hours of leiſure and tranquillity.

Ibid, p. 606.

Ornamented Cottage.

Further, the vegetable creation being ſubject to the animal, the ſhrub may be cropt, or the flower trodden down in its day of beauty. If therefore we wiſh to converſe with nature in private, intruders muſt be kept off,—the ſhrubbery be ſevered from the ground;—yet not in ſuch a manner as to drive away the paſturing ſtock from our ſight. For this reaſon, the ſhaven lawn ought not to be too extenſive, and the fence which incloſes it ſhould be ſuch as will not interrnpt the view: but whether it be ſeen or unſeen, ſuſpected or unſuſpected, is a matter of no great import: its utility in protecting the ſhrubs and flowers,—in keeping the horns of the cattle from the window, and the feet of the ſheep from the gravel and broken ground,—in preſerving that neatneſs on the outſide, which ought to correſpond with the finiſhings and furniture within,—render it of ſufficient importance to become even a part of the ornament.

PART II. EXECUTION OF THE GENERAL SUBJECTS.

IMPROVEMENTS in general may be claſſed under the following heads: The *Hunting-Box*, the *Ornamented Cottage*, the *Villa*, and the *Principal Reſidence*.

But before any ſtep can be taken towards the execution of the deſign, be it large or ſmall, a map or plan of the place, exactly as it lies in its unimproved ſtate, ſhould be made; with a correſponding ſketch, to mark the intended improvements upon. Not a hovel nor a twig ſhould be touched, until the artiſt has ſtudied maturely the natural abilities of the place, and has decidedly fixed in his mind, and finally ſettled on his plan, the propoſed alterations: and even then, let him "dare with caution."

1. *Of Improvements adapted to a* Hunting-Box.

Here art has little to do. Hunting may be called the amuſement of nature; and the place appropriated to it ought to be no farther altered from its natural ſtate than decency and conveniency require:—With men who live in the preſent age of refinement, "a want of decency is a want of ſenſe."

Ibid, p. 610, &c.

The ſtyle throughout ſhould be *maſculine*. If ſhrubs be required, they ſhould be of the hardier ſorts: the box, the holly, the lauruſtinus. The trees ſhould be the oak and the beech, which give in autumn an agreeable variety of foliage, and anticipate as it were the ſeaſon of diverſion. A ſuite of paddocks ſhould be ſeen from the houſe; and if a view of diſtant covers can be caught, the back-ground will be complete. The ſtable, the kennel, and the leaping-bar, are the factitious accompaniments; in the conſtruction of which ſimplicity, ſubſtantialneſs, and conveniency, ſhould prevail.

2. *Of the Styles of an* Ornamented Cottage.

Neatneſs and ſimplicity ought to mark the ſtyle of this rational retreat. Oſtentation and ſhow ſhould be cautiouſly avoided; even elegance ſhould not be attempted; though it may not be hid, if it offer itſelf ſpontaneouſly.

Nothing, however, ſhould appear vulgar, nor ſhould ſimplicity be pared down to baldneſs; every thing whimſical or expenſive ought to be ſtudiouſly avoided;—chaſteneſs and frugality ſhould appear in every part.

Near the houſe a ſtudied neatneſs may take place; but at a diſtance, negligence ſhould rather be the characteriſtic.

If a taſte for botany lead to a collection of native ſhrubs and flowers, a ſhrubbery will be requiſite; but in this every thing ſhould be native. A gaudy exotic ought not to be admitted; nor ſhould the lawn be kept cloſe ſhaven; its flowers ſhould be permitted to blow; and the herbage, when mown, ought to be carried off, and applied to ſome uſeful purpoſe.

In the artificial accompaniments, ornament muſt be ſubordinate; utility muſt preſide. The buildings, if any appear, ſhould be thoſe in actual uſe in rural economics. If the hovel be wanted, let it appear; and, as a ſide-ſcreen, the barn and rick-yard are admiſſible; whilſt the

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the dove-houſe and poultry-yard may enter more freely into the compoſition.

In fine, the ornamented cottage ought to exhibit cultivated nature in the firſt ſtage of refinement. It ranks next above the farm-houſe. The plain garb of ruſticity may be ſet off to advantage; but the ſtudied dreſs of the artiſt ought not to appear. That becoming neatneſs, and thoſe domeſtic conveniences, which render the rural life agreeable to a cultivated mind, are all that ſhould be aimed at.

3. *Of the Embelliſhments of a* VILLA.

This demands a ſtyle very different from the preceding. It ought to be elegant, rich, or grand, according to the ſtyle of the houſe itſelf, and the ſtate of the ſurrounding country; the principal buſineſs of the artiſt being to connect theſe two in ſuch a manner, that the one ſhall not appear naked or flaring, nor the other deſolate and inhoſpitable.

If the houſe be ſtately, and the adjacent country rich and highly cultivated, a ſhrubbery may intervene, in which art may ſhow her utmoſt ſkill. Here the artiſt may even be permitted to play at landſcape: for a place of this kind being ſuppoſed to be ſmall, the purpoſe principally ornamental, and the point of view probably confined ſimply to the houſe, ſide-ſcreens may be formed, and a fore-ground laid out ſuitable to the beſt diſtance that can be caught.

If buildings or other artificial ornaments abound in the offscape, ſo as to mark it ſtrongly, they ought alſo to appear more or leſs in the fore-ground: if the diſtance abound with wood, the fore-ground ſhould be thickened, leſt baldneſs ſhould offend; if open and naked, elegance rather than richneſs ought to be ſtudied, leſt heavineſs ſhould appear.

Ibid.

It is far from being any part of our plan to cavil unneceſſarily at artiſts, whether living or dead; we cannot, however, refrain from expreſſing a concern for the almoſt total neglect of the principles here in ornamenting the vicinages of villas. It is to be regretted, that in the preſent practice theſe principles ſeem to be generally loſt ſight of. Without any regard to uniting the houſe with the adjacent country, and, indeed, ſeemingly without any regard whatever to the offscape, one invariable plan of embelliſhment prevails; namely, that of ſtripping the fore-ground entirely naked, or nearly ſo, and ſurrounding it with a wavy border of ſhrubs and a gravel walk; leaving the area, whether large or ſmall, one naked ſheet of green ſward.

In ſmall confined ſpots, this plan may be eligible. But a ſimple border round a large unbroken lawn only ſerves to ſhow what more is wanted. Simplicity in general is pleaſing; but even ſimplicity may be carried to an extreme, ſo as to convey no other idea than that of poverty and baldneſs. Beſides, how often do we ſee in natural ſcenery, the holly, and the fox-glove flouriſhing at the foot of an oak, and the primroſe and the campion adding charms to the hawthorn ſcattered over the paſtured lawn? And we conceive that ſingle trees footed with evergreens and native flowers, and clumps as well as borders of ſhrubs, are admiſſible in ornamental as well as in natural ſcenery.

The ſpecies of ſhrub will vary with the purpoſe. If the principal intention be a winter retreat, evergreens and the early-blowing ſhrubs ſhould predominate; but in a place to be frequented in ſummer and autumn, the deciduous tribes ought chiefly to be planted.

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4. *Of the* PRINCIPAL RESIDENCE.

Here the whole art centres. The artiſt has here full ſcope for a diſplay of taſte and genius. He has an extent of country under his eye, and will endeavour to make the moſt of what nature and accident have ſpread before him.

Round a principal reſidence, a gentleman may be ſuppoſed to have ſome conſiderable eſtate, and it is not a ſhrubbery and a ground only which fall under the conſideration of the artiſt: he ought to endeavour to diſcloſe to the view, either from the houſe or ſome other point, as much as he conveniently can of the adjacent eſtate. The love of poſſeſſion is deeply planted in every man's breaſt; and places ſhould bow to the gratification of their owners. To curtail the view by an artificial ſide-ſcreen, or any other unnatural machinery, ſo as to deprive a man of the ſatisfaction of overlooking his own eſtate, is an abſurdity which no artiſt ought to be permitted to be guilty of. It is very different, however, where the property of another intrudes upon the eye: Here the view may, with ſome colour of propriety, be bounded by a woody ſcreen.

The grounds, however, by a proper management, may be made independent of whatever is external; and though proſpects are nowhere more delightful than from a point of view which is alſo a beautiful ſpot, yet if in the environs of ſuch a garden they ſhould be wanting, the elegant, picturesque, and various ſcenes within itſelf, almoſt ſupply the deficiency.

Mr Wheatley's deſcription of Stowe gardens.

"This (ſays Mr Wheatley) is the character of the gardens at Stowe: for there the views in the country are only circumſtances ſubordinate to the ſcenes; and the principal advantage of the ſituation is the variety of the ground within the incloſure. The houſe ſtands on the brow of a gentle aſcent: part of the gardens lie on the declivity, and ſpread over the bottom beyond it: this eminence is ſeparated by a broad winding valley from another which is higher and ſteeper; and the deſcents of both are broken by large dips and hollows, ſloping down the ſides of the hills. The whole ſpace is divided into a number of ſcenes, each diſtinguiſhed with taſte and fancy; and the changes are ſo frequent, ſo ſudden, and complete, the tranſitions ſo artfully conducted, that the ſame ideas are never continued or repeated to ſatiety.

Theſe gardens were begun when regularity was in faſhion; and the original boundary is ſtill preſerved, on account of its magnificence: for round the whole circuit, of between three or four miles, is carried a very broad gravel walk, planted with rows of trees, and open either to the park or the country; a deep ſunk fence attends it all the way, and comprehends a ſpace of near 400 acres. But in the interior ſcenes of the garden, few traces of regularity appear; where it yet remains in the plantations, it is generally diſguiſed: every ſymptom, almoſt, of formality, is obliterated from the ground; and an octagon baſon in the bottom is now converted into an irregular piece of water, which receives on one hand two beautiful ſtreams, and falls on the other down a caſcade into a lake.

In the front of the houſe is a conſiderable lawn, open to

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to the water: beyond which are two elegant Doric pavilions, placed in the boundary of the garden, but not marking it, though they correspond to each other; for still further back, on the brow of some rising grounds without the inclosure, stands a noble Corinthian arch, by which the principal approach is conducted, and from which all the gardens are seen, reclining back against their hills; they are rich with plantations; full of objects; and lying on both sides of the house almost equally, every part is within a moderate distance, notwithstanding the extent of the whole.

On the right of the lawn, but concealed from the house, is a perfect garden scene, called the *queen's amphitheatre*, where art is avowed, though formality is avoided. The fore-ground is scooped into a gentle hollow. The plantations on the sides, though but just rescued from regularity, yet in style are contrasted to each other: they are, on one hand, chiefly thickets, standing out from a wood; on the other, they are open groves, through which a glimpse of the water is visible. At the end of the hollow on a little knoll, quite detached from all appendages, is placed an open Ionic rotunda: beyond it, a large lawn slopes across the view; a pyramid stands on the brow; the queen's pillar, in a recess on the descent; and all the three buildings, being evidently intended for ornament alone, are peculiarly adapted to a garden-scene. Yet their number does not render it gay: the dusky hue of the pyramid, the retired situation of the queen's pillar, and the solitary appearance of the rotunda, give it an air of gravity; it is encompassed with wood; and all the external views are excluded; even the opening into the lawn is but an opening into an inclosure.

At the king's pillar, very near to this, is another lovely spot; which is small, but not confined; for no termination appears; the ground one way, the water another, retire under the trees out of sight, but nowhere meet with a boundary. The view is first over some very broken ground, thinly and irregularly planted; then between two beautiful clumps, which feather down to the bottom; and afterwards across a glade, and through a little grove beyond it, to that part of the lake where the thickets close upon the brink, spread a tranquillity over the surface, in which their shadows are reflected. Nothing is admitted to disturb that quiet: no building obtrudes; for objects to fix the eye are needless in a scene which may be comprehended at a glance; and none would suit the pastoral idea it inspires, of elegance too refined for a cottage, and of simplicity too pure for any other edifice.

The situation of the rotunda promises a prospect more enlarged; and in fact most of the objects on this side of the garden are there visible: but they want both connexion and contrast; each belongs peculiarly to some other spot: they are all blended together in this, without meaning; and are rather shown on a map, than formed into a picture. The water only is capital; a broad expanse of it is so near as to be seen under the little groups on the bank without interruption. Beyond it is a wood, which in one place leaves the lake, to run up behind a beautiful building, of three pavilions joined by arcades, all of the Ionic order: it is called *Kent's Building*. And never was a design more happily conceived: it seems to be characteristically proper for a garden; it is so elegant, so varied, and so purely ornamental: it directly fronts the rotunda, and a narrow rim of the country appears above the trees beyond it. But the effect even of this noble object is fainter here than at other points: its position is not the most advantageous; and it is but one among many other buildings, none of which are principal.

The scene at the temple of Bacchus is in character directly the reverse of that about the rotunda, though the space and the objects are nearly the same in both: but in this, all the parts concur to form one whole. The ground from every side shelves gradually towards the lake; the plantations on the further bank open to show Kent's building, rise from the water's edge towards the knoll on which it stands, and close again behind it. That elegant structure, inclined a little from a front view, becomes more beautiful by being thrown into perspective; and though at a greater distance, is more important than before, because it is alone in the view: for the queen's pillar and the rotunda are removed far aside; and every other circumstance refers to this interesting object: the water attracts, the ground and the plantations direct, the eye thither: and the country does not just glimmer in the offscape, but is close and eminent above the wood, and connected by clumps with the garden. The scene altogether is a most animated landscape; and the splendor of the building; the reflection in the lake; the transparency of the water, and picturesque beauty of its form, diversified by little groups on the brink, while on the broadest expanse no more trees cast their shadows than are sufficient to vary the tints of the surface; all these circumstances, vying in lustre with each other, and uniting in the point to which every part of the scene is related, diffuse a peculiar brilliancy over the whole composition.

The view from Kent's building is very different from those which have been hitherto described. They are all directed down the declivity of the lawn. This rises up the ascent: the eminence being crowned with lofty wood, becomes thereby more considerable; and the hillocks into which the general fall is broken, sloping further out this way than any other, they also acquire an importance which they had not before; that, particularly, on which the rotunda is placed, seems here to be a profound situation; and the structure appears to be properly adapted to so open an exposure. The temple of Bacchus, on the contrary, which commands such an illustrious view, is itself a retired object, close under the covert. The wood rising on the brow, and descending down one side of the hill, is shown to be deep; is high, and seems to be higher than it is. The lawn too is extensive; and part the boundary being concealed, it suggests the idea of a still greater extent. A small portion only of the lake indeed is visible; but it is not here an object: it is a part of the spot; and neither termination being in sight, it has no diminutive appearance: if more water had been admitted, it might have hurt the character of the place, which is sober and temperate; neither solemn nor gay; great and simple, but elegant; above rusticity, yet free from ostentation.

These are the principal scenes on one side of the gardens. On the other, close to the lawn before the house, is

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is the winding valley above mentioned: the lower part of it is aſſigned to the Elyſian fields. Theſe are watered by a lovely rivulet; are very lightſome, and very airy, ſo thinly are the trees ſcattered about them; are open at one end to more water and a larger glade; and the reſt of the boundary is frequently broken to let in objects afar off, which appear ſtill more diſtant from the manner of ſhowing them. The entrance is under a Doric arch, which coincides with an opening among the trees, and forms a kind of viſta, through which a Pembroke bridge juſt below, and a lodge built like a caſtle in the park, are ſeen in a beautiful perſpective. That bridge is at one extremity of the gardens; the queen's pillar is at another; yet both are viſible from the ſame ſtation in the Elyſian fields: and all theſe external objects are unaffectedly introduced, diveſted of their own appurtenances, and combined with others which belong to the ſpot. The temple of Friendſhip is alſo in ſight, juſt without the place; and within it are the temples of ancient Virtue, and of the Britiſh worthies; the one in an elevated ſituation, the other low down in the valley, and near to the water: both are decorated with the effigies of thoſe who have been moſt diſtinguiſhed for military, civil, or literary merit; and near to the former ſtands a roſtral column, ſacred to the memory of Captain Grenville, who fell in an action at ſea: by placing here the meed of valour, and by filling theſe fields with the repreſentations of thoſe who have deſerved beſt of mankind, the character intended to be given to the ſpot is juſtly and poetically expreſſed; and the number of the images which are preſented or excited, perfectly correſponds with it. Solitude was never reckoned among the charms of Elyſium; it has been always pictured as the manſion of delight and of joy: and in this imitation, every circumſtance accords with that eſtabliſhed idea. The vivacity of the ſtream which flows through the vale; the glimpſes of another approaching to join it; the ſprightly verdure of the green ſward, and every buſt of the Britiſh worthies reflected in the water; the variety of the trees; the lightneſs of the greens; their diſpoſition; all of them diſtinct objects, and diſperſed over gentle inequalities of the ground; together with the multiplicity of objects both within and without, which embelliſh and enliven the ſcene; give it a gaiety, which the imagination can hardly conceive, or the heart wiſh to be exceeded.

Cloſe by this ſpot, and a perfect contraſt to it, is the alder grove; a deep receſs in the midſt of a ſhade, which the blaze of noon cannot brighten. The water ſeems to be a ſtagnated pool, eating into its banks; and of a peculiar colour, not dirty but clouded, and dimly reflecting the dun hue of the horſe-cheſnuts and alders which preſs upon the brink: the ſtems of the latter, riſing in cluſters from the ſame root, bear one another down, and ſlant over the water. Miſhapen elms and ragged firs are frequent in the wood which encompaſſes the hollow; the trunks of dead trees are left ſtanding amongſt them: and the uncouth ſumach, and the yew, with elder, nut, and holly, compoſe the underwood: ſome limes and laurels are intermixed; but they are not many; the wood is in general of the darkeſt greens; and the foliage is thickened with ivy, which not only twines up the trees, but creeps alſo over the falls of the ground: theſe are ſteep and abrupt: the gravel-walk is covered with moſs; and a grotto at the end, faced with broken flints and pebbles, preſerves, in the ſimplicity of its materials, and the duſkineſs of its colour, all the character of its ſituation: two little rotundas near it were better away; one building is ſufficient for ſuch a ſcene of ſolitude as this, in which more circumſtances of gloom concur than were perhaps ever collected together.

Immediately above the alder-grove is the principal eminence in the gardens. It is divided by a great dip into two pinnacles; upon one of which is a large Gothic building. The ſpace before this ſtructure is an extenſive lawn: the ground on one ſide falls immediately into the dip; and the trees which border the lawn, ſinking with the ground, the houſe riſes above them, and fills the interval: the vaſt pile ſeems to be ſtill larger than it is; for it is thrown into perſpective, and between and above the heads of the trees, the upper ſtory, the porticoes, the turrets, and balluſtrades, and all the ſlated roofs, appear in a noble confuſion. On the other ſide of the Gothic building, the ground ſlopes down a long continued declivity into a bottom, which ſeems to be perfectly irriguous. Divers ſtreams wander about it in ſeveral directions: the conflux of that which runs from the Elyſian fields with another below it, is full in ſight; and a plain wooden bridge thrown over the latter, and evidently deſigned for a paſſage, impoſes an air of reality on the river. Beyond it is one of the Doric porticoes which front the houſe; but now it is alone; it ſtands on a little bank above the water, and is ſeen under ſome trees at a diſtance before it: thus grouped, and thus accompanied, it is a happy incident, concurring with many other circumſtances to diſtinguiſh this landſcape by a character of cheerfulneſs and amenity.

From the Gothic building a broad walk leads to the Grecian valley, which is a ſcene of more grandeur than any in the gardens. It enters them from the park, ſpreading at firſt to a conſiderable breadth; then winds; grows narrower, but deeper; and loſes itſelf at laſt in a thicket, behind ſome lofty elms, which interrupt the ſight of the termination. Lovely woods and groves hang all the way on the declivities: and the open ſpace is broken by detached trees; which, near the park, are cautiouſly and ſparingly introduced, leſt the breadth ſhould be contracted by them; but as the valley ſinks, they advance more boldly down the ſides, ſtretch acroſs or along the bottom, and cluſter at times into groups and forms, which multiply the varieties of the larger plantations. Thoſe are ſometimes cloſe coverts, and ſometimes open groves: the trees riſe in one upon high ſtems, and feather down to the bottom in another; and between them are ſhort openings into the park or the gardens. In the midſt of the ſcene, juſt at the bend of the valley, and commanding it on both ſides, upon a large, eaſy, natural riſe, is placed the temple of Concord and Victory: at one place its majeſtic front of ſix Ionic columns, ſupporting a pediment filled with bas relief, and the points of it crowned with ſtatues, faces the view; at another, the beautiful colonnade, on the ſide, of 10 lofty pillars, retires in perſpective. It is ſeen from every part; and impreſſing its own character of dignity on all around, it ſpreads an awe over the whole: but no gloom, no melancholy, attends it: the ſenſations it excites are rather

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ther placid; but full of refpect, admiration, and folemnity: no water appears to enliven, no diftant profpect to enrich the view; the parts of the fcene are large, the idea of it fublime, and the execution happy; it is independent of all adventitious circumftances, and relies on itfelf for its greatnefs.

The fcenes which have been defcribed are fuch as are moft remarkable for beauty or character; but the gardens contain many more; and even the objects in thefe, by their feveral combinations, produce very different effects, within the diftance fometimes of a few paces, from the unevennefs of the ground, the variety of the plantations, and the number of the buildings. The multiplicity of the laft has indeed been often urged as an objection to Stowe; and certainly, when all are feen by a ftranger in two or three hours, twenty or thirty capital ftructures, mixed with others of inferior note, do feem too many. But the growth of the wood every day weakens the objection, by concealing them one from the other: each belongs to a diftinct fcene; and if they are confidered feparately, at different times, and at leifure, it may be difficult to determine which to take away. Yet ftill it muft be acknowledged that their frequency deftroys all ideas of filence and retirement. Magnificence and fplendor are the characteriftics of Stowe: it is like one of thofe places celebrated in antiquity, which were devoted to the purpofes of religion, and filled with facred groves, hallowed fountains, and temples dedicated to feveral deities; the refort of diftant nations, and the object of veneration to half the heathen world: this pomp is, at Stowe, blended with beauty; and the place is equally diftinguifhed by its amenity and its grandeur.

In the midft of fo much embellifhment as may be introduced into this fpecies of garden, a plain field, or a fheep-walk, is fometimes an agreeable relief, and even wilder fcenes may occafionally be admitted. Thefe indeed are not properly parts of a garden, but they may be comprehended within the verge of it; and the proximity to the more ornamented fcenes is at leaft a convenience, that the tranfition from the one to the other may be eafy, and the change always in our option. For though a fpot in the higheft ftate of improvement be a neceffary appendage to a feat; yet, in a place which is perfect, other characters will not be wanting: if they cannot be had on a large fcale, they are acceptable on a fmaller; and fo many circumftances are common to all, that they may often be intermixed; they may always border on each other."

Practical Treatife on Planting and Gardening, p. 615.

But on this head it would be in vain to attempt to lay down particular rules: different places are marked by fets of features as different from each other as are thofe in men's faces. Much muft be left to the fkill and tafte of the artift; and let thofe be what they may, nothing but mature ftudy of the natural abilities of the particular place to be improved can render him equal to the execution, fo as to make the moft of the materials that are placed before him.

Some few general rules may neverthelefs be laid down. The approach ought to be conducted in fuch a manner, that the ftriking features of the place fhall burft upon the view at once: no trick however fhould be made ufe of: all fhould appear to fall in naturally. In leading towards the houfe, its direction fhould not be fully in front, nor exactly at an angle, but fhould

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pafs obliquely upon the houfe and its accompaniments; fo that their pofition with refpect to each other, as well as the perfpective appearance of the houfe itfelf, may vary at every ftep: and having fhown the front and the principal wing, or other accompaniment, to advantage, the approach fhould wind to the back front, which, as has been already obferved, ought to lie open to the park or paftured grounds.

The improvement and the rooms from which they are to be feen fhould be in unifon. Thus, the view from the drawing-room fhould be highly embellifhed, to correfpond with the beauty and elegance within: every thing here fhould be feminine, elegant, beautiful, fuch as attunes the mind to politenefs and lively converfation. The breakfafting room fhould have more mafculine objects in view: wood, water, and an extended country for the eye to roam over; fuch as allures us imperceptibly to the ride or the chafe. The eating and banqueting rooms need no exterior allurements.

There is a harmony in tafte as in mufic: variety, and even wildnefs upon fome occafions, may be admitted; but difcord cannot be allowed. If, therefore, a place be fo circumftanced as to confift of properties totally irreconcileable, the parts ought, if poffible, to be feparated in fuch a manner, that, like the air and the recitative, the adagio and the allegro, in mufic, they may fet off each other's charms by the contraft.— Thefe obfervations, in the elegant performance whence they are extracted, the author illuftrates by the following defcription and propofed improvement of Perfefield, the feat of Mr Morris, near Chepftow in Monmouthfhire; a place upon which nature has been peculiarly lavifh of her favours, and which has been fpoken by Mr Wheatley, Mr Gilpin, and other writers, in the moft flattering terms.

Defcription of Perfefield, *ibid.* p. 616, &c.

"Perfefield is fituated upon the banks of the river Wye, which divides Gloucefterfhire and Monmouthfhire, and which was formerly the boundary between England and Wales. The general tendency of the river is from north to fouth; but about Perfefield it defcribes by its winding courfe the letter S, fomewhat compreffed, fo as to reduce it in length and increafe its width. The grounds of Perfefield are lifted high above the bed of the river, fhelving, and form the brink of a lofty and fteep precipice, towards the fouthweft.

"The lower limb of the letter is filled with Perfewood, which makes a part of Perfefield; but is at prefent an impenetrable thicket of coppice-wood. This dips to the fouth-eaft down to the water's edge; and, feen from the top of the oppofite rock, has a good effect.

"The upper limb receives the farms of Llancot, rich and highly cultivated, broken into inclofures, and fcattered with groups and fingle trees; two well looking farm-houfes in the centre, and a neat white chapel on one fide: altogether a lovely little paradifaical fpot. The lowlinefs of its fituation ftamps it with an air of meeknefs and humility; and the natural barriers which furround it add that of peacefulnefs and fecurity. The picturefque farms do not form a low flat bottom, fubject to be overflowed by the river; but take the form of a gorget, rifing fulleft in the middle, and falling on every fide gently to the brink of the Wye;

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except on the east side, where the top of the gorget leans in an easy manner against a range of perpendicular rock; as if to show its disk with advantage to the walks of Persefield.

"This rock stretches across what may be called the *Isthmus*, leaving only a narrow pass down into the fields of Llancot, and joins the principal range of rocks at the lower bend of the river.

"To the north, at the head of the latter, stands an immense rock (or rather a pile of immense rocks heaped one above another) called *Windcliff;* the top of which is elevated as much above the ground of Persefield as those are above the fields of Llancot.

"These several rocks, with the wooded precipices on the side of Persefield, form a circular inclosure, about a mile in diameter, including Perse-wood, Llancot, the Wye, and a small meadow lying at the foot of Windcliff.

"The grounds are divided into the upper and lower lawn, by the approach to the house: a small irregular building, standing near the brink of the precipice, but facing down the lower lawn, a beautiful ground, falling 'precipitately every way into a valley which shelves down in the middle,' and is scattered with groups and single trees in an excellent style.

"The view from the house is soft, rich, and beautifully picturesque; the lawn and woods of Persefield and the opposite banks of the river; the Wye, near its mouth, winding through 'meadows green as emerald,' in a manner peculiarly graceful; the Severn, here very broad, backed by the wooded and highly cultivated hills of Gloucestershire, Wiltshire, and Somersetshire. Not one rock enters into the composition. The whole view consists of an elegant arrangement of lawn, wood, and water.

"The upper lawn is a less beautiful ground, and the view from it, though it command the 'cultivated hills and rich valleys of Monmouthshire,' bounded by the Severn and backed by the Mendip-hills, is much inferior to that from the house.

"To give variety to the views from Persefield, to disclose the native grandeur which surrounds it, and to set off its more striking features to advantage, walks have been cut through the woods and on the face of the precipice which border the grounds to the south and east. The viewer enters these walks at the lower corner of the lower lawn.

"The first point of view is marked by an alcove, from which are seen the bridge and the town of Chepstow, with its castle situated in a remarkable manner on the very brink of a perpendicular rock, washed by the Wye; and beyond these the Severn shows a small portion of its silvery surface.

"Proceeding a little farther along the walk, a view is caught which the painter might call a complete landscape: The castle, with the serpentine part of the Wye below Chepstow, intermixed in a peculiar manner with the broad waters of the Severn, forms the fore-ground; which is backed by distant hills: the rocks, crowned with wood, lying between the alcove and the castle, to the right, and Castlehill farm, elevated upon the opposite banks of the river, to the left, form the two side-screens. This point is not marked, and must frequently be lost to the stranger.

"The grotto, situated at the head of Perse-wood, commands a near view of the opposite rocks; magnificent beyond description! The littleness of human art was never placed in a more humiliating point of view; the castle of Chepstow, a noble fortress, is, compared with these natural bulwarks, a mere house of cards.

"Above the grotto, upon the isthmus of the Persefield side, is a shrubbery; strangely misplaced! an unpardonable intrusion upon the native grandeur of this scene. Mr Gilpin's observations upon this, as upon every other occasion, are very just. He says, 'It is a pity the ingenious embellisher of these scenes could not have been satisfied with the great beauties of nature which he commanded. The shrubberies he has introduced in this part of his improvements I fear will rather be esteemed paltry.'—'It is not the shrub which offends; it is the formal introduction of it. Wild underwood may be an appendage of the grandest scene; it is a beautiful appendage. A bed of violets or of lilies may enamel the ground with propriety at the foot of an oak; but if you introduce them artificially in a border, you introduce a trifling formality, and disgrace the noble object you wish to adorn.'

"The walk now leaves the wood, and opens upon the lower lawn, until coming near the house it enters the alarming precipice facing Llancot; winding along the face of it in a manner which does great honour to the artist. Sometimes the fragments of rock which fall in its way are avoided, at other times partially removed, so as to conduct the path along a ledge carved out of the rock; and in one instance, a huge fragment, of a somewhat conical shape and many yards high, is perforated; the path leading through its base. This is a thought which will hand down to future times the greatness of Mr Morris's taste; the design and the execution are equally great; not a mark of a tool to be seen; all appears perfectly natural. The arch-way is made winding, so that on the approach it appears to be the mouth of a cave; and, on a nearer view, the idea is strengthened by an allowable deception; a black dark hole on the side next the cliff, which, seen from the entrance before the perforation is discovered, appears to be the darksome inlet into the body of the cave.

"From this point, that vast inclosure of rocks and precipices which marks the peculiar magnificence of Persefield is seen to advantage. The area, containing in this point of view the fields of Llancot and the lower margin of Perse-wood, is broken in a manner peculiarly picturesque by the graceful winding of the Wye; here washing a low grassy shore, and there sweeping at the feet of the rocks, which rise in some places perpendicular from the water; but in general they have a wooded offset at the base; above which they rise to one, two, or perhaps three or four hundred feet high; exposing one full face, silvered by age, and bearded with ivy, growing out of the wrinkle-like seams and fissures. If one might be allowed to compare the paltry performances of art with the magnificent works of nature, we should say, that this inclosure resembles a prodigious fortress which has lain long in ruins. It is in reality one of nature's strong-holds; and as such has probably been frequently made use of. Across the isthmus on the Gloucestershire side there are the remains of a deep intrenchment, called to this day the *Bulwark;*

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Bulwark; and tradition ftill teems with the extraordinary warlike feats that have been performed among this romantic fcenery.

"From the perforated rock, the walk leads down to the cold-bath (a complete place), feated about the mid-way of the precipice, in this part lefs fteep; and from the cold-bath a rough path winds down to the meadow, by the fide of the Wye, from whence the precipice on the Perfefield fide is feen with every advantage; the giant fragments, hung with fhrubs and ivy, rife in a ghaftly manner from amongft the underwood, and fhow themfelves in all their native favagenefs.

"From the cold-bath upward, a coach-road (very fteep and difficult) leads to the top of the cliff, at the upper corner of the upper lawn. Near the top of the road is a point which commands one of the moft pleafing views of Perfefield: The Wye fweeping through a graffy vale which opens to the left:—Llancot backed by its rocks with the Severn immediately behind them; and, feen in this point of view, feems to be divided from the Wye by only a fharp ridge of rock, with a precipice on either fide; and behind the Severn, the vale and wooded hills of Gloucefterfhire.

"From this place a roads leads to the top of Windcliff—aftonifhing fight! The face of nature probably affords not a more magnificent fcene! Llancot in all its grandeur, the ground of Perfefield, the caftle and town of Chepftow, the graceful windings of the Wye below, and its conflux with the Severn; to the left the foreft of Dean; to the right, the rich marfhes and picturefque mountains of South Wales; a broad view of the Severn, opening its fea-like mouth; the conflux of the Avon, with merchant fhips at anchor in King-road, and veffels of different defcriptions under fail; Auft-Cliff, and the whole vale of Berkeley, backed by the wooded fwells of Gloucefterfhire, the view terminating in clouds of diftant hills, rifing one behind another, until the eye becomes unable to diftinguifh the earth's billowy furface from the clouds themfelves."

The leading principle of the improvement propofed by our author is, to "feparate the fublime from the beautiful; fo that in viewing the one, the eye might not fo much as fufpect that the other was near.

"Let the hanging walk be conducted entirely along the precipices, or through the thickets, fo as to difclofe the natural fcenery, without once difcovering the lawn or any other acquired foftnefs. Let the path be as rude as if trodden only by wild beafts and favages, and the refting places, if any, as ruftic as poffible.

"Erafe entirely the prefent fhrubbery, and lay out another as elegant as nature and art could render it before the houfe, fwelling it out into the lawn towards the ftables; between which and the kitchen-garden make a narrow winding entrance.

"Convert the upper lawn into a deer-paddock, fuffering it to run as wild, rough, and foreft-like, as total negligence would render it.

"The viewer would then be thus conducted: He would enter the hanging-walk by a fequeftered path at the lower corner of the lawn, purfuing it through the wood to beneath the grotto, and round the head-land, or winding through Perfe-wood, to the perforated rock and the cold-bath, without once conceiving an idea (if poffible) that art, or at leaft that much art, had been made ufe of in difclofing the natural grandeur of the furrounding objects; which ought to appear as if they prefented themfelves to his view, or at moft as if nothing was wanted but his own penetration and judgement to find them out. The walk fhould therefore be conducted in fuch a manner, that the breaks might be quite natural; yet the points of view obvious, or requiring nothing but a block or ftone to mark them. A ftranger at leaft wants no feat here; he is too eager in the early part of his walk, to think of iounging upon a bench.

"From the cold bath he would afcend the fteep, near the top of which a commodious bench or benches might be placed: the fatigue of afcending the hill would require a refting-place; and there are few points which afford a more pleafing view than this; it is grand, without being too broad and glaring.

"From thefe branches he would enter the foreft part. Here the idea of Nature in her primitive ftate would be ftrengthened: the roughneffes and deer to the right, and the rocks in all their native wildnefs to the left. Even Llancot might be fhut out from the view by the natural fhrubbery of the cliff. The Lover's Leap, however (a tremendous peep), might remain; but no benches, nor other work of art, fhould here be feen. A natural path, deviating near the brink of the precipice, would bring the viewer down to the lower corner of the park; where benches fhould be placed in a happy point, fo as to give a full view of the rocks and native wildneffes, and at the fame time hide the farm houfes, fields, and other acquired beauties of Llancot.

"Having fatiated himfelf with this favage fcene, he would be led, by a ftill ruftic path, through the labyrinth—when the fhrubbery, the lawn, with all its appendages, the graceful Wye, and the broad filver Severn, would break upon the eye with every advantage of ornamental nature: the tranfition could not fail to ftrike.

"From this foft fcene he would be fhown to the top of Windcliff, where in one vaft view he would unite the fublime and beautiful of Perfefield."

Only one particular remains now to be noticed. A place which is the refidence of a family all the year is very defective, if fome portion of it be not fet apart for the enjoyment of a fine day, for air, and exercife, in winter. To fuch a fpot fhelter is abfolutely effential; and evergreens being the thickeft covert, are therefore the beft: their verdure alfo is then agreeable to the eye; and they may be arranged fo as to produce beautiful mixture of greens, with more certainty than deciduous trees, and with almoft equal variety: they may be collected into a wood; and through that wood gravel-walks may be led along openings of a confiderable breadth, free from large trees which would intercept the rays of the fun, and winding in fuch a manner as to avoid any draft of wind, from whatever quarter it may blow. But when a retreat at all times is thus fecured, other fpots may be adapted only to occafional purpofes; and be fheltered towards the north or the eaft on one hand, while they are open to the fun on the other. The few hours of cheerfulnefs and warmth which its beams afford are fo valuable as to juftify the facrifice even of the principles of beauty to the enjoyment of them; and therefore no objections

Principal Residence. objections of sameness or formality can prevail against the pleasantness of a straight walk, under a thick hedge or a south wall. The eye may, however, be diverted from the skreen by a border before it, where the aconite and the snowdrop, the crocus and hepatica, brought forward by the warmth of the situation, will be well-come harbingers of spring; and on the opposite side of the walk little tufts of laurustines, and of variegated evergreens, may be planted. The spot thus enlivened by a variety of colours, and even a degree of bloom, may be still further improved by a green-house. The entertainment which exotics afford peculiarly belongs to this part of the year; and if amongst them be interspersed some of our earliest flowers, they will there blow before their time, and anticipate the gaiety of the season which is advancing. The walk may also lead to the stoves, where the climate and the plants are always the same. And the kitchen-garden should not be far off; for that is never quite destitute of produce, and always an active scene: the appearance of business is alone engaging; and the occupations there are an earnest of the happier seasons to which they are preparative. By these expedients even the winter may be rendered cheerful in a place where shelter is provided against all but the bitterest inclemencies of the sky, and agreeable objects and interesting amusements are contrived for every hour of tolerable weather. Principal Residence.

PART III. PRACTICAL GARDENING.

WE now proceed to treat of horticulture or practical gardening. And although it may not appear to be the most perfect arrangement; yet as it is probably the most convenient and useful in the directions to be given for the practical management of the garden, we shall consider the work to be done for each month of the year in the kitchen garden, the fruit garden, the flower garden and the nursery, under so many separate sections.

JANUARY.

Sect. I. *Kitchen Garden.*

17 Sow radishes. In the beginning, or any time in the course of this month, when the weather is open, sow some short-top'd radishes on a border exposed to the south, and protected by a wall or other fence; and about the middle or latter end of the month, you may sow some more of the same sort, and also some salmon radishes to succeed the short-top'd. The seed should be sown pretty thick at this season, because vegetation being slow at this period they will be longer exposed to the depredation of birds, and if the weather prove severe, many of them will be cut off after they have appeared above ground. Sow the seed evenly over the surface, and rake it in with a large wide-toothed rake, or if sown in beds, cover it with earth to the depth of half an inch from the alleys. A covering of straw about two inches thick would greatly promote their growth, and protect them from frost and birds. After the plants have come above ground, the covering of straw should be drawn off with a light rake in the early part of the day, and replaced in the evening.

Garden mats are frequently used to cover radishes, a number of small pins being previously stuck into the ground to support them an inch or two from the surface, and prevent them from pressing down the young plants. The covering ought to be continued for a longer or shorter time, according to the severity of the weather; but when the plants have pushed out their rough leaves it may safely be discontinued. Radishes sown under common hot-bed frames, without the assistance of warm dung, will succeed very well, and come on much earlier than those sown in the open air: due attention, however, must be paid to give them air whenever the weather is mild, by raising the glasses, or removing them altogether during warm days. If wanted very early, recourse must be had to a slight hot-bed.

At any time in this month, when the weather is mild and dry, let a spot of ground in a warm situation be prepared for sowing a few early carrots, by digging the ground a full spade deep, and breaking the earth well; and when the seed is sown, let it be raked in. When carrots are wanted very early, they may be reared in a slight hot-bed. 18 Carrots.

About the beginning, or any time in the month, when the weather is mild, you may sow some spinach; but if the weather will permit, some ought to be sown, both in the beginning and towards the end of the month. The smooth-seeded or round-leaved spinach should chiefly be sown now. It is preferred, on account of its leaves being thicker, larger, and more succulent than the prickly-seeded; though some of the latter ought also to be sown, because it is hardier, and better able to sustain the severity of the weather. They may be sown either broadcast and raked in, or in shallow drills about an inch deep, and nine or ten inches asunder. It is a frequent practice to sow spinach in drills between the rows of early beans and cabbages. 19 Spinach.

You may sow some seed of cress, mustard, radish, rape, &c. and likewise some lap lettuce in a warm situation exposed to the sun. They form an agreeable salad when cut young. The ground on which they are to be sown ought to be sloped to the south, and covered with a common hot-bed frame, which should be sunk in the ground, so far as to allow the glasses to approach to within six or eight inches of the sown surface. 20 Small salad.

But small salad will succeed best in a slight hot-bed of warm dung formed to the depth of 18 or 20 inches; air must be admitted freely, whenever the weather will permit, by raising or removing the glasses.

About the middle, or towards the latter end of the month, sow parsley seed in any dry situation, in shallow drills nine inches asunder, and cover it in with earth to the depth of a quarter of an inch, or in single rows along the borders of the kitchen garden. There are two sorts, the plain-leaved and curled-leaved; the latter is preferred as garnishing on account of its large bushy leaves, 21 Parsley.

leaves, but both are equally good as pot herbs. This ſeed lies very long in the ground before it vegetates.

22 Peas. Sow ſome early peas in a warm ſituation, to ſucceed thoſe ſown in November and December. The principal early peas are the Charlton hotſpur, golden hotſpur, Reading hotſpur, Maſters hotſpur, &c. the two firſt of which are reckoned the earlieſt. Sow them in rows two feet and a half aſunder, but when they are to be ſupported by ſticks they ought to be three feet aſunder. Some marrowfat peas ſhould likewiſe be ſown at this ſeaſon for a firſt crop of late peas: the dwarf marrowfat is the moſt proper, but any other late pea will ſucceed very well, ſuch as the Spaniſh moratto, tall marrowfat, Pruſſian prolific, ſugar pea, dwarf ſugar, egg pea, pearl pea, &c. Theſe ſhould be ſown in rows three feet aſunder; but when it is intended that they ſhould be ſupported by ſticks, the rows ſhould be three feet and a half apart.

23 Beans. Any time in the courſe of the month, if the weather be mild, a main crop of beans may be ſown. The Sandwich bean, toker, Windſor, broad Spaniſh, broad long-pod, &c. are the kinds moſt commonly uſed. After the ground has been well dug, put in the beans to the depth of about two inches, with a dibble, in rows three feet apart, and at the diſtance of four or five inches from each other in the rows: or they may be ſown in drills to the ſame depth and diſtance. If no early beans were ſown in November or December, they ought to be ſown the earlieſt opportunity this month: the early Mazagan and Liſbon beans are the beſt. They ought to be planted in a warm border; if at the foot of a ſouth wall, they will come on earlier. Theſe may be planted cloſer than the larger beans, two feet, or two feet and a half, between the rows, being ſufficient. When peas or beans are wanted very early, they may be ſown in hot-beds or ſtoves, and when ſomewhat advanced, they may either be planted out into other hot-beds, into peach and vine-houſes, or into any warm ſituation in the open air.

24 Lettuce. In the beginning, and again towards the end of the month, you may ſow ſome lettuce. The kinds commonly uſed are the green and white cos, brown Dutch, Cilicia, and common cabbage lettuce. Prepare a piece of ground in a warm ſituation; ſow the ſeeds moderately thick, and rake them in as evenly as poſſible. They may alſo be ſown under hand glaſſes or in common hot-bed frames, to be occaſionally covered with glaſſes or mats: but in either caſe, air muſt be freely admitted, whenever the weather will permit. When wiſhed for very early, they may be ſown in a ſlight hot-bed, and planted out in the open air in March or April.

Take care of lettuce plants which have ſtood the winter.—If you have lettuce plants in frames or under hoops, covered with mats, give them plenty of air when the weather is moderate. Remove all decayed leaves, and deſtroy ſnails which frequently infeſt them; and when the froſt is ſevere, take care to protect them well with mats.

25 Examine cauliflower plants. The cauliflower plants raiſed laſt autumn, which have ſtood during the winter in frames, ſhould be looked over in open weather. If any decayed leaves appear, pick them off; ſtir up the earth between the plants, and remove all weeds. In mild weather, give them plenty of air during the day, by puſhing down, or removing the glaſſes altogether: but cover them during the night, unleſs when the weather is particularly mild: when it is froſty, or rains much, they ought to be covered during the day. But if the froſt is very ſevere, the frames ſhould be protected at night with a covering of mats, and even during the day, ſhould the froſt be intenſe, without ſunſhine; and ſome ſtraw, dried leaves, or ſomething of that nature, ſhould likewiſe be laid all round the outſide of the frame, to prevent the froſt from penetrating its ſides.

Cauliflowers under bell and hand glaſſes require the ſame attention: during mild weather, the covers ſhould either be taken off altogether, or raiſed (or tilted) on the ſouth ſide, ſo as to admit the air freely during the day and ſhut again at night, unleſs the weather ſhould be very mild, in which caſe they may remain a little tilted on one ſide; but ſhould intenſe froſt prevail, they ſhould be kept ſhut, and covered with ſtraw or ſomething of that nature. The free admiſſion of the air will prevent the plants from becoming weak, and make them leſs apt to run up to flower before they have acquired ſufficient ſize. In mild winters, ſlugs very frequently injure cauliflower plants; they ought, therefore, to be carefully looked for and deſtroyed.

About the end of the month, if the weather is mild, plant out a few early cabbages, on a ſpot of ground well dug and manured with rotten dung, at the diſtance of a foot and a half from each other, or even cloſer, as they are to be cut early, and before they acquire a great ſize. The early York, Batterſea, and ſugar-loaf, are the kinds which ſhould be planted at this ſeaſon. 26 Plant cabbages.

Tranſplant ſome full grown cabbages and ſavoys, for ſeed, about the beginning of the month; though the early part of winter is the moſt proper time for doing ſo. See NOVEMBER. 27 Tranſplant cabbages, &c. for ſeed.

In open dry weather, earth up ſuch celery as has advanced much above ground; let the earth be well broken, and laid up almoſt to the tops of the plants, but care muſt be taken not to bruiſe them. This will afford them protection againſt froſt, which might prove very injurious to them at this ſeaſon. 28 Earth-up celery.

Where celery is wanted daily, a quantity of ſtraw or ſomething of that nature, ſhould be laid over the rows on the approach of froſt, which will prevent the froſt from penetrating the ground, and on the removal of the covering, the celery may be dug up: or when ſevere weather threatens to ſet in, a quantity of celery may be taken up, placed in ſome ſituation ſheltered from the weather, and covered as far as the blanched part extends with ſand.

In open dry weather prepare ſome full grown endive for blanching. When the plants are perfectly dry tie up their leaves cloſe together, and they will be completely blanched in about a fortnight. As endive is very apt to rot in wet weather at this ſeaſon, when blanched in the open air, a quantity of it ought to be tranſplanted into a ridge of dry earth, in ſome ſituation where it may be ſheltered from rain. 29 Blanch endive.

In open dry weather, the earth ſhould be drawn up about ſuch peas and beans as may have advanced an inch or two above ground, which will both ſtrengthen them protect them againſt froſt. 30 Earth up peas and beans.

If

January. Kitchen Garden.

31 Artichokes.

If artichokes have not been earthed up before this, that work ſhould now be done the firſt opportunity. See November.

32 Management of muſhroom beds.

Muſhroom beds ought to be well covered at this ſeaſon, and protected both from rain and froſt. The covering of ſtraw ſhould be at leaſt a foot thick, and if the rain ſhould at any time have penetrated nearly through it, it ought to be removed, and a covering of dry ſtraw put in its place; for if the bed ſhould get wet, the ſpawn would be injured, and the future crop deſtroyed.

Sometimes it is deſirable to have ſome of the ordinary kitchen garden crops, at an earlier period, than that at which they are produced in the open air. For this purpoſe recourſe is had to hot-beds; there are likewiſe ſome things reared in the kitchen garden, ſuch as cucumbers and melons, which cannot be obtained in this country without their aid. The principal crops, beſides cucumbers and melons, for which hot-beds may be prepared in this month, are aſparagus, ſmall ſalad, mint, tanſey, peas, and beans for tranſplanting; radiſhes, early carrots, early potatoes, and kidney beans. Hot-beds are formed either of freſh horſe dung, or of tanners bark; the hot-beds uſed this month, as ſeed-beds for early cucumbers and melons, are almoſt always formed of horſe dung. Procure a ſufficient quantity of freſh horſe dung, according to the ſize and number of the hot-beds you mean to form, lay it up in a heap to ferment for ten or twelve days, longer or ſhorter according to the condition of the dung or the ſtate of the weather, during which time it ought to be turned over once or twice with a fork, that it may be thoroughly mixed and equally fermented. After the violent fermentation is over, and the rank ſteam has eſcaped, it will be in proper condition to form a hot-bed. Dung that is very much mixed with ſtraw, or is too dry, ought to be rejected. About a cart-load may be ſufficient for a common hot-bed frame of one light, and ſo on in proportion for one of two or three lights. Hot-beds ſhould be formed in a ſituation ſheltered from the wind, and expoſed to the morning and mid-day ſun. Some dig a trench about a foot deep, and a few inches longer and wider than the frame with which they mean to cover the bed; others form hot-beds on the ſurface of the ground. At this ſeaſon of the year the laſt mode is to be preferred, becauſe it affords an opportunity of lining the bed with freſh hot dung quite down to the bottom, to augment the heat when it declines; in this way water is likewiſe prevented from ſettling about the bottom of the bed, which is often the caſe, when the bed is formed in a trench, which would inevitably check the fermentation, and conſequently deſtroy the heat of the bed. Mark out a ſpace on the ground, a few inches longer and wider than the frame which you intend to put on the bed. Spread the dung when in proper condition, regularly with a fork, beating it down gently from time to time with the fork; when the dung is trodden down, it is apt to heat too violently, and does not ſucceed ſo well as when the dung is allowed to ſettle gradually. The dung ought to be raiſed to three feet and an half, or thereabouts. In this way hot-beds may be formed, which will preſerve their heat for a conſiderable time; When ſlighter hot-beds are required, the dung may be raiſed to one foot and an half, or two feet: theſe ſlight hot-beds anſwer very well for raiſing early crops.

33 Sow cucumber and melon ſeeds.

Having prepared a hot-bed according to the directions juſt given for a larger or ſmaller frame, in proportion to the quantity of ſeed you intend to ſow, ſuch a one as may be covered with a frame of one light will be ſufficient to raiſe plants for an ordinary crop. Let the frame and lights be put on, and kept cloſe, till the heat begin to riſe, then raiſe the glaſs, that the ſteam may paſs off. Three or four days after the bed has been formed, it may be covered with earth prepared for that purpoſe, to the depth of about three inches; before the earth is put on, if the dung ſhall have ſettled unequally, the ſurface of the bed ought to be made perfectly level. Rich light dry earth is beſt adapted to this purpoſe: that it may be dry enough, it ought to have been protected from the rain by ſome ſhade during the winter; for, ſhould it be wet, it is apt to prevent the ſeeds from germinating, or to injure the young plants. Fill two or three ſmall flower-pots with ſome of the ſame earth, and place them in the hot-bed till the earth in them be warmed, and then ſow the ſeeds.

Sow the ſeeds, and cover them about half an inch deep; the bottom of the pots ought to be plunged a little way into the earth with which the bed is covered, ſome of which ought to be drawn up round the pots. A few days after ſowing the ſeeds in the pots, ſome ſeeds may be ſown in the earth of the bed. By ſowing in pots, if the bed ſhould overheat (which is ſometimes the caſe) you have it in your power to withdraw and remove the pots out of danger.

After ſowing the ſeeds, put on the lights; when the ſteam riſes copiouſly, give the hot-bed air by raiſing the glaſſes a little. The hot-bed ought to be covered every evening about ſunſet with mats, which ſhould be taken off again in the morning about nine o'clock, ſooner or later according to the ſtate of the weather. A ſingle mat will be ſufficient at firſt, as the warmth of the bed will be ſtrong. The ends of the mats ought not to hang down over the ſides of the frame, becauſe the rank ſteam proceeding from the bed would be confined, and might injure the plants. The plants will appear, in two or three days after the ſeeds have been ſown, when care muſt be taken to raiſe the glaſſes a little to admit freſh air, and to allow the ſteam of the bed to eſcape; if this be not properly attended to, and if the beds be kept too cloſe, the plants will either be deſtroyed altogether, or become weak and yellowiſh. About the time the firſt ſown ſeeds appear above ground, a few more ought to be ſown in the earth of the bed. As thoſe tender plants are liable to ſuffer from various cauſes at this ſeaſon, it would be proper to ſow a little ſeed at three different periods, at ſhort intervals, that if one ſowing ſhould miſcarry, another may ſucceed. Three or four days after the plants have come up, they ought to be planted out into ſmall pots.

The day before the plants are to be tranſplanted, pots filled with light rich dry earth ſhould be put into the bed, that the earth which they contain may be brought to a proper temperature. Take the plants carefully up, raiſing them with your finger and thumb, with all the roots as entire as poſſible, and with as much of the earth as will readily adhere about the fibres. Plant three cucumbers and two melons in each pot, and draw the earth well up about the ſtems. If the earth in the pots be very dry, a little water ſhould be given.

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given after the tranſplanting has been finiſhed. The pots ought to be plunged cloſe to one another in the earth of the bed, and all the ſpaces between them ought to be carefully filled with earth, to prevent the rank ſteam of the dung from riſing up, which would certainly kill the plants. The bed ought to be carefully examined every day to ſee that the roots of the plants do not receive too much heat. If anything like that appear, draw up the pots a little, taking care to replunge them to the rim after the danger is over. When the plants are fairly rooted, if the earth appears dry, give them a little water in the warmeſt time of the day; let the watering be occaſionally repeated very moderately, according as the earth in the pots becomes dry. All the water given to the plants at this ſeaſon ought to ſtand for a few hours within the bed, that it may acquire the ſame temperature with the earth in which the plants grow, as very cold water would chill the plants too much. In order to preſerve a proper heat in the bed as long as poſſible, the ſides of it ought to be covered with ſtraw or dry leaves, which will defend the bed from cold piercing winds, heavy rains, and ſnow. Should the bed be unprotected when any of theſe prevail, the heat would be diminiſhed, and the plants receive a check. If a lively heat be kept up, you may admit air to the the plants every day, by raiſing the glaſſes in proportion to the heat of the bed and temperature of the external air. If the air be very cold, it will be neceſſary to fix a piece of mat or ſome ſuch thing to the edge of the ſaſh, which may hang down over the opening, and prevent the cold air from ruſhing too freely into the bed. About a fortnight after the bed has been formed, it ought to be examined carefully, to diſcover whether the heat of the bed ſtill continues ſtrong enough; if not, the dry leaves and ſtraw ought to be removed from the front and back of the bed if any had been placed there, and a quantity of freſh horſe dung ſhould be ſupplied. The lining thus applied ſhould not exceed 15 or 18 inches in thickneſs, and ſhould be raiſed a few inches higher than the bed. When too thick a lining is applied, it is apt to throw in too great a heat, and injure the plants. A quantity of earth ſhould be laid on the top of the dung thus applied to the depth of two inches, to keep down the rank ſteam. The lining will ſoon increaſe the heat of the bed, and maintain it for ten days or a fortnight longer. At the expiration of that time, when the heat begins to fail, the two ſides of the bed ſhould receive a lining of the ſame thickneſs, which will again augment the heat of the bed, and preſerve it in good condition for upwards of a fortnight longer. By lining firſt the one ſide and then the other at the interval of about a week or ten days, the heat of the bed may be made to laſt longer than when both linings are applied at the ſame time. Either method may be followed, according to the degree of external cold which may prevail, or according to the degree of warmth required to be maintained in the bed. After performing the lining, if very cold, wet, or ſnowy weather prevail, it may be proper to lay a quantity of long dry litter all round the general lining, which will protect the whole of the bed, and keep it in a proper temperature. By the proper management of this ſeed-bed, and by the due application of linings, the growth of young plants may be promoted till they are fit to be planted out into other hot-beds, where they are to remain and produce fruit. Where there is plenty of hot dung and every other convenience, a ſecond bed may be prepared, into which the young plants may be transferred and nurſed till they become perfectly fit for final tranſplantation. Due attention muſt be paid to have this ſecond nurſery-bed in proper condition for the reception of the pots containing the young plants. It is to be formed, earthed over, and taken care of, according to the directions given for the management of the ſeed-bed. When the plants have got their two firſt rough leaves, two or three inches broad, and have puſhed out their two firſt running buds, they are in a proper ſtate for planting out into larger hot-beds. For the farther management of cucumbers and melons, ſee FEBRUARY.

It is proper that none but ſuch ſeeds, both of cucumbers and melons, as have been kept for ſome time, ſhould be ſown; thoſe which have been kept for two or three years are to be preferred, becauſe the plants which proceed from them are thought to be, not only more fruitful, but to produce their fruit ſooner. Plants which are produced from recent ſeeds commonly puſh vigorouſly, and their ſhoots grow to a great length before they ſhow a ſingle fruit. The beſt ſorts of cucumbers for producing an early crop, are the early ſhort prickly and long green prickly; the former of theſe is the earlier, the other produces the beſt crop and the largeſt fruit. There are ſeveral ſorts of melons ſown for an early crop, viz. the romana, cantaloupe, polignac, &c. The romana is a very good bearer, and produces early, and is a very well-flavoured, though ſmall fruit. The cantaloupe is a very well-flavoured melon, acquires a good ſize, and ripens early. The polignac is alſo a very good melon. It is better, however, to ſow two or three kinds, if they are eaſily to be had, for the ſake of gaining greater variety.

Hot-beds may be formed any time this month for forcing aſparagus: they are to be formed in the ſame way as hot-beds for cucumbers and melons; the dung, however, need not be raiſed to the ſame height, from two and an half to three feet will be ſufficient. After a bed has been formed, it ſhould be covered with earth to the depth of ſix or ſeven inches, and the aſparagus plants immediately put in; but the frame and glaſſes are not to be put on till after the violent heat of the bed ſhall have ſubſided, and the rank ſteam eſcaped. A ſufficient quantity of aſparagus plants, proper for forcing, muſt be provided; viz. ſuch as have been raiſed from ſeed and planted out in the open ground for two or three years, as directed elſewhere; ſix hundred will be ſufficient for a frame of three lights, and ſo on in proportion, for a larger or ſmaller frame. The ſtrongeſt and moſt vigorous plants ought to be choſen, and ſhould be planted very cloſe together, that the quantity produced may repay the trouble and expence of forcing. Having marked the ſize of the frame on the ſurface of the bed, raiſe a ridge of earth a few inches high, againſt which place the firſt row of plants, and draw a little earth over the roots of each; next to them another row may be planted as cloſe as poſſible, and ſo on till the whole ſpace is covered, ſome moiſt earth ſhould be applied all round the outſide of the ſpace, occupied by the plants, and raiſed an inch or two above their tops. Then the whole ſhould be covered with a quantity

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quantity of rich light earth, to the depth of about two inches, and left in that situation till the buds begin to appear above ground. They should then receive an additional covering of rich light earth to the depth of three or four inches. A wreath of strong straw band is previously fixed by some round the bed, which both supports the last covering of earth and the frame. The straw ropes should be about four inches thick, and fixed down all round the edge of the bed, exactly in that place where the frame is to be put. Should there be no reason to suspect overheating or burning, the frame may be immediately put on; care should be taken to raise up or shove down the glasses to allow the rank steam to escape, particularly about the time the buds begin to appear. If much rain or snow should fall after the bed has been formed, and before the frame is put on, it will be necessary to cover the bed with mats or with straw. The heat of the bed likewise during that time should be carefully examined; with that view, two or three sticks, called *watch sticks*, should be stuck in the dung, which should be pulled out two or three times in the course of the day, and examined by applying the hand to their extremities; if they are found very hot, and there should be any danger of burning, it may be moderated by boring several wide holes in the dung on each side of the bed, and in the earth immediately under the roots of the plants, to admit air, and let the rank steam pass off: these holes should be shut after the heat of the bed is become moderate. The outside of the bed should be protected during wet, or very cold windy weather, and when its heat begins to decay, it ought to be revived by means of lining, as directed in cucumber and melon beds. After the asparagus begins to appear above ground, due attention should be paid to the regular admission of air, whenever the weather is at all moderate; and care must be taken to cover the beds with mats during severe weather, and constantly during the night. In four or five weeks after the formation of the bed, the asparagus will be fit for cutting, and will continue to produce abundantly for two or three weeks longer. During that time three or four hundred may be collected every week from a three light frame. They must not be cut, as is the case when asparagus is collected in the open air, the fingers must be introduced into the earth, and the buds are to be broken off close to the roots.

34 Sow carrots.

When carrots are required early, make a hot-bed about two feet thick of dung, and cover it to the depth of six inches with light rich earth. Sow the seed thin, and cover it to the depth of a quarter of an inch. Admit air freely in mild weather through the day, and cover them during the night. When about an inch or two high, thin them to about three inches asunder, they will be fit for drawing in April or May.

Sow rape, cresses, mustard, and radish, in a slight hot-bed. The dung should not exceed the thickness of eighteen inches or two feet, and should be covered with five or six inches of light dry earth. The seeds may be sown very thick, either in drills or all over the surface of the bed, and covered slightly. The bed should be covered with a frame and glasses, and protected during the night and severe weather with mats. Whenever the weather will permit, air must be admitted, otherwise the plants will be apt to die as fast as they come up.

Where mint, tansey, and terragon, are required very early, a slight hot-bed may be prepared and covered with earth to the depth of five or six inches, in which the roots of mint, tansey, and terragon, may be planted and covered with a frame and glasses.

35 Early peas and beans.

About the beginning of this month, some peas and beans may be sown in a hot-bed, either for transplanting into a warm border in the open air, or into other hot-beds where they are to remain, and produce a crop; the early framing pea is best for this purpose.

36 Early potatoes.

A hot-bed may be formed, in which some early dwarf potatoes may be planted, either to be planted out afterwards, or to remain to produce a crop.

37 Early kidney beans.

Sow some early kidney beans in a hot-bed, or in pots to be placed in a hot-house. Fill moderate sized pots (24s) with rich light earth, and sow three or four beans in each pot. When the plants have come up, give them a moderate quantity of water; they will produce a crop in March and April.

Sect. II. *Fruit Garden.*

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38 Apple and pear trees to be pruned.

If any apple or pear trees remain unpruned on walls or espaliers, that work may be performed any time this month, even though the weather should be frosty: some people indeed think it improper to prune trees during frost, lest the trees should receive injury by having their cut surfaces exposed to the action of the frost; but their apprehensions are chimerical.

Apple and pear trees produce their flower buds on short branches, (or spurs as they are termed,) which proceed from the sides of the branches of one or more years standing, and which every year increase in number, while the branches from which they proceed continue vigorous: if these branches, which throw out spurs, be shortened or cut at their extremities, they commonly push out a number of smaller branches, which acquire considerable length, but form no flower buds; it is therefore proper in pruning these trees, to take care never to shorten a leading branch where there is room on the wall or espalier to allow it to be extended, unless when a supply of new wood is wanted to fill up a vacancy. In young trees which have not yet formed a sufficient head, select the most vigorous and best placed shoots, and train them to the wall or espalier, at the distance of from four to six inches from one another; any branches that intervene between them are to be removed close to their origin, and all those branches which do not apply well to the wall or espaliers may likewise be removed. When the branches are too thin, and a supply of wood is wanted, one or more of the last year's shoots may be cut down to within a few inches of its origin; four or five buds are commonly left. These branches so shortened, commonly push out three or four shoots the ensuing season. The young branches that have been laid in at full length, will in two or three years produce a good many spurs or short branches along their sides, from which a crop of fruit may be expected. In old trees, that have been already trained, all the vigorous bearing branches are to be retained, unless where they may happen to be too crowded, then the branch intended to be removed should be cut out close to its insertion. When any of the old bearing branches seem to be worn out, or decayed, they should be pruned out near-

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near to their inſertion; from the ſtump that is left ſome ſhoots will be puſhed out the following ſeaſon, the beſt of which may be retained, to ſupply the place of the branch removed. All the leading branches ought to be looked over, and the ſuperfluous fore-right and miſplaced ſhoots of laſt year's growth which will not eaſily apply to the wall, ought to be cut off cloſe to their inſertion into the main branch; the moſt vigorous and beſt placed ſhoots ſhould be trained at full length to the wall or eſpalier at the diſtance of from four to ſix inches from one another. When there happens to be any vacant ſpace on the wall or eſpalier, ſome of the laſt year's ſhoots may be ſhortened, as directed in the pruning of young trees.

In looking over the leading branches, all the ſpurs which produce flower buds ought to be carefully retained; and any ſtumps which may have been left, after former prunings, ought to be cut away quite cloſe to the branch from which they proceed, for they conſtantly produce a redundancy of branches which create confuſion, ſhade the fruit from the ſun, and rob it of its proper nouriſhment.

39 Plum and cherry.

This is a proper ſeaſon to prune plum and cherry trees either on walls or eſpaliers: the ſame directions which have been given for pruning apples and pears will apply to the pruning of plums and cherries, as they likewiſe produce their fruit on ſpurs, puſhed out from nearly the extremity of the ſhoots, which are two or three years old. It is improper in pruning to ſhorten the branches, becauſe the very part would be removed from which the fruit buds ſhould proceed next or ſubſequent ſeaſon.

40 Peach, nectarine, &c.

Theſe trees produce their fruit on the young branches of laſt year. A plentiful ſupply of laſt year's ſhoots muſt therefore be retained to be nailed to the wall, at the diſtance of from three inches to half a foot from one another; the moſt vigorous and beſt placed ſhoots are to be ſelected for this purpoſe, and all fore-right, weakly or ſuperfluous ſhoots are to be removed, likewiſe ſome of the laſt year's bearers. That the pruning knife may be uſed more freely, it would be proper not only to unnail the ſhoots which had been laid in laſt year, but even ſome of the principal branches. In ſelecting the branches, attention muſt be paid not only to their poſition and proper diſtance, but likewiſe to the quantity of flower buds they contain. Theſe buds are diſtinguiſhable from thoſe which produce branches by their roundneſs; and towards ſpring when the buds begin to ſwell, by their ſize: thoſe which produce branches being generally ſmall, flat and pointed. It frequently happens that one of each is produced at the ſame eye (as it is termed), or ſometimes two flower buds, with a branch bud between them. All very ſtrong thick branches are to be rejected, as well as thoſe that are long, ſmall, and feeble, becauſe the very vigorous branches are much more apt to run to wood, than to produce fruit. Thoſe branches which are ſelected as the fitteſt to be retained, ought to be ſhortened (due regard being paid to their vigour, and to the number and ſituation of the flower buds they contain), which will make them puſh out two or three branches the enſuing ſummer, the beſt of which may be retained for next year's bearers.

In weak trees that are not diſpoſed to puſh vigorouſly, the ſmaller ſhoots may be ſhortened to the length of ſix or eight inches; the more vigorous ſhoots may be left from ten to fifteen inches long, or thereby. In trees of moderate growth the branches ought to be left proportionally longer, the ſmaller ones from half a foot to ten inches, the more vigorous from one foot to a foot and an half. In very vigorous trees, the branches ought to be ſhortened but little, and ſome of them not at all, the ſmaller ſhoots may be ſhortened to the length of a foot or fifteen inches; the more vigorous ſhoots ſhould have only about a third or fourth part of their length cut off; and the moſt vigorous ſhould not be ſhortened at all, for the more they are ſhortened, the more they are diſpoſed to puſh vigorouſly and run to wood, and on that account produce few fruit. As the flower buds are ſometimes ſituated near the extremity, at other times near the bottom of the branch, this circumſtance in a certain degree muſt regulate the ſhortening the branch, as care muſt be taken to leave a ſufficient quantity of flower buds, where fruit is the object. Care muſt likewiſe be taken to have a bud which is expected to produce a branch, at the eye which is next the cut extremity; it is of no moment whether it be alone or in company with one or two flower buds, but it is abſolutely neceſſary to have one to produce a leading branch, without which the fruit will not thrive. When three or four laſt year's ſhoots are found on a branch of the preceding year, the one at the upper and lower extremities is frequently preſerved; in that caſe the intermediate ones ought to be cut away cloſe to the branch: but ſhould any of the intermediate ones be ſelected as the moſt proper to be retained, the branch of the preceding year ſhould be cut off cloſe by the uppermoſt of the ſhoots which has been fixed on, and all thoſe ſhoots which are to be removed ſhould be cut away cloſe to the branch from which they proceed. After each tree has been gone over, it ought to be carefully nailed to the wall or fixed to the eſpalier.

Vines if cut when in a growing ſtate are apt to bleed very copiouſly. This bleeding is detrimental to them, and is ſtopt with great difficulty. If vines are pruned a ſhort time before the riſe of the ſap, they are likewiſe liable to bleed at the recently cut extremities; it would therefore be improper any time this month to prune vines which grow in the hot-houſe or in a vinery which is to be early forced; but ſuch as grow on open walls or in vineyards may be ſafely cut any time this month. Though it would certainly be adviſable to prune as ſoon after the fall of the leaf as may be, as in that caſe the cut extremities would have ſufficient time to heal, and all danger of bleeding would be removed. 41 Vines and figs.

Fig trees may be pruned any time this month, though perhaps it would be as well to defer it till next or following month. For the method, ſee FEBRUARY.

Gooſeberries and currants may ſtill be pruned. See NOVEMBER.

Gooſeberries and currants may be planted if the ſeverity of the froſt does not render the ground too hard; indeed they may be planted any time from the fall of the leaf in autumn till the puſhing out of their buds in ſpring. It is uſual to plant them in rows along the borders, or to divide the plots in the kitchen garden; in which caſe they ought to be planted two or three yards apart, and the diſtance between the rows muſt depend on the ſize of the plots they are to ſeparate (10, 15 or 18 yards). They ought to be trained up with a ſingle 42 Plant gooſeberries and currants.

ſingle ſtalk to the height of 10 or 15 inches, which will allow the kitchen crops that may be planted near them to grow freely, and will render the operations of hoeing, weeding, and raking under the buſhes eaſy. They are frequently planted out in compartments by themſelves, in which caſe the buſhes ought to ſtand at the diſtance of from five to eight feet in the rows, and the rows ought to be eight or nine feet apart.

When plenty of room is allowed between the buſhes, they grow freely, and produce larger fruit; free admiſſion is likewiſe afforded to the ſun and air, without which, the fruit would not acquire its proper flavour: hoeing, and digging between the buſhes, is more eaſily performed, and crops of different kinds of kitchen garden productions may be reared in the intervals. Currants are very frequently planted againſt walls, and rails to which they are regularly trained. Gooſeberries alſo are ſometimes planted againſt walls and rails, thoſe againſt walls yield early and well flavoured fruit. The variety of gooſeberries is very great, and every ſeaſon adds new varieties to thoſe already known. The principal kinds are the early rough green, ſmall early red, ſmooth green, large Dutch red, common hairy red, ſmooth black, rough white, white cryſtal, large yellow, rough yellow, large amber, large tawny, &c.

The different kinds of currants are the black, common white, large Dutch white or grape currant, common red and champaigne.

43 Raſpberries.

Raſpberries may be pruned or planted during this or any of the winter months; they produce their fruit on ſmall branches which proceed from the ſhoots of the former year. Every year they puſh up a number of ſhoots from the root, which bear fruit the ſubſequent ſummer, and then die. In dreſſing raſpberries, all the old dead ſtalks muſt be cut away cloſe by the ground, and all the young ones except four or five of the ſtrongeſt, which ſhould be ſhortened a little. All theſe ſhoots become ſmall towards their extremity and bend a little; it is the common practice to cut off the bent part, but ſome ſhorten them one-third, others one-fourth. After the ſhoots have been ſhortened, they ought to be intertwined or ſurrounded by a bandage of ſome kind to keep them together, for the ſake of mutual ſupport, becauſe when they are allowed to ſtand ſingle they are apt to be weighed down in ſummer by the weight of their own leaves and fruit, particularly when loaded with rain, or to be beaten down by the wind; in which caſe they may frequently lie one over the other, create confuſion, and exclude the ſun and air from thoſe that are undermoſt, or may lie ſo cloſe to the ground as to have their fruit deſtroyed. After the plants are pruned, the ground between them ought to be dug, and all ſtraggling ſhoots which advance to a diſtance from the main plants ought to be taken up.

Raſpberries may be planted any time this month when the weather is moderate: when new plantations of them are wanted, they ought to be formed in open ſituations, if high flavoured fruit be wiſhed for; but raſps will thrive very well and produce good crops in ſhadowy ſituations. The ground in which they are to be planted ought to be well dug, and if a little rotten dung be added, the plants will ſucceed the better. They ought to be planted at the diſtance of three feet from each other, in rows four or five feet apart. The offsets which are dug up from between the rows of old plantations of raſpberries are commonly made uſe of for this purpoſe. Any of the laſt years ſhoots that are well rooted and tolerably vigorous will anſwer perfectly well. Thoſe which have two or three buds, formed on the roots, from which young ſhoots are to proceed the following ſummer, are generally to be preferred to thoſe which have fewer though equally vigorous. They ought to be taken up careſully with all their roots, and after the ſtem has been ſhortened a little (about one-third) they may be planted at the diſtances already mentioned. Plantations formed now will yield ſome fruit the enſuing ſummer, and a plentiful crop the following ſeaſon. The kinds of raſpberries commonly uſed are the white, double bearing, (which bears two crops, one in ſummer the other in autumn), the ſmooth ſtalk, the Antwerp (very large).

44 Prepare for planting fruit trees.

If the weather be mild, all kind of fruit trees may be planted any time this month; but if it ſhould be deemed more adviſeable to defer planting till next month, the ground may be prepared for their reception any time during open weather. The borders on which fruit trees are to be planted, which are to be trained againſt walls or eſpaliers, ſhould be trenched or dug two ſpades deep. For planting and preparing ground for fruit trees, ſee OCTOBER.

45 Protect the roots, &c.

The roots of the more tender ſorts of fruit trees, viz. peaches, nectarines, apricots, and indeed of all ſorts of ſtoned fruit, which may have been planted any time in the courſe of the winter, will require to be protected during froſt by a covering of ſtraw, or litter mixed with dung, or ſomething of that nature, applied to a conſiderable diſtance round the ſtem, ſo as to cover the ground completely, and prevent the froſt from penetrating.

Protect fig trees during froſty weather with a covering of mats, or ſomething of that nature, becauſe their ſhoots being ſucculent, particularly towards their extremities, are apt to be deſtroyed by the froſt. This is of the more conſequence as the fruit is produced from the young ſhoots only, and chiefly from their extremities, the parts moſt liable to ſuffer.

46 Force fruit trees.

Where there are vineries, peach, cherry-houſes, &c. the glaſſes ought to be put on about the beginning of the month when it is intended to force early, and fires ought to be applied about the middle or towards the end of it. See *Forcing*, FEBRUARY.

47 and ſtrawberries.

Towards the beginning, middle, or end of the month, hot-beds may be made for forcing ſtrawberries, which, if properly managed, will produce ripe fruit in March or April. The hot-beds are to be formed according to the directions given under the article *Melon*, and *Cucumber*. See *Kitchen Garden*, JANUARY. The dung ſhould be raiſed at leaſt to the height of three feet, and the frame and glaſſes put on as ſoon as the bed is made, which will both protect it from rain or ſnow, and draw up the ſteam ſooner. As ſoon as the violent heat is over, the ſurface of the bed ſhould be covered to the depth of four or five inches with dry earth, or with a quantity of decayed tanners bark taken from an old tan-bed. The pots containing the plants ſhould be plunged up to the rims into the earth or tan with which the bed is covered. They ſhould be placed as cloſe together as poſſible, and care taken to fill up all the interſtices with earth or tan. When all the pots are plunged, put on the glaſſes and keep them cloſe till the

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the ſteam riſe in the bed, when it will be neceſſary to raiſe them a little behind, to allow the ſteam to paſs off. The alpine and ſcarlet ſtrawberry are commonly made uſe of for this purpoſe.

The plants ſhould be two years old, and if potted the preceding autumn, they will ſucceed the better; but if a quantity of plants were not put into pots laſt autumn for this purpoſe, that work may be done any time this month during open weather. For the method, ſee SEPTEMBER. Or the plants may be taken up now with balls of earth, and placed in the beds without being put into pots. When the plants begin to puſh, let them have plenty of air during favourable weather, for ſhould they be kept too cloſe they will become weakly, and either produce no flowers at all, or their flowers will drop off without yielding fruit. They ſhould likewiſe be frequently watered and protected during the night in ſevere weather with a covering of mats. When the heat of the bed begins to decay, it ſhould be renowed by proper linings of freſh dung, applied as directed for melon-beds. As to the ſize of hot-beds nothing need be ſaid, as that muſt be regulated by the number of plants intended to be forced. Hot-beds formed of tanners bark, particularly where there are pits conſtructed on purpoſe, will anſwer better than thoſe of horſe-dung, becauſe they afford a more equable heat. Where there are pine-houſes, or hot-houſes of any kind, plenty of ſtrawberries may be obtained early, without much trouble, by placing pots filled with the plants in them anywhere near the glaſs.

SECT. III. *The Flower Garden or Pleaſure Ground.*

48 Protect flowers in pots.

DOUBLE flowers, as ſweetwilliams, wallflowers, ſtocks, roſe campion, and auriculas, carnations, &c. kept in pots ought to be protected in ſevere weather, either by common garden frames, or by coverings of mats ſupported on hoops. Due attention muſt be paid to give them air whenever the weather is mild. Where there are no conveniences of the above deſcription, the pots may be plunged up to their rims in well-ſheltered borders cloſe to a ſouth wall. The pots containing hardy plants ſhould likewiſe be plunged in the earth in ſome dry ſituation up to the rims, to protect the roots from froſt.

49 Bulbous roots in beds.

During ſevere froſty weather the beds in which the finer ſorts of hyacinths, tulips, rununculuſes, anemones, &c. have been planted ſhould be protected by a covering of mats or ſtraw; but if the plants have begun to make their appearance above ground, the beds ſhould be arched over with low hoops and covered with mats, which ought to be fixed down to prevent their being blown off by the wind; and they ſhould be removed occaſionally during mild weather

50 Plant bulbous roots.

If any hyacinth, tulip, narciſſus, crown imperial, crocus, or ſnowdrop roots remain unplanted, they ought now to be put into the ground. For the method of planting them ſee OCTOBER.

51 Sow hardy annuals.

About the latter end of the month, if the weather is mild, ſow a few ſweet peas in any warm ſheltered ſituation for flowering early, alſo ſome ſeeds of candytuft, larkſpur, adonis, dwarf ſunflower, perſicaria, venus navel-wort, venus looking-glaſs, lobel's-catchfly, and panſy violet.

52 Force flowers in the hot-houſe.

Pots of pinks, carnations, roſes, Perſian or common lilach, hyacinth, polyanthus, narciſſus, Italian narciſſus, dwarf tulip, jonquil, lily of the valley, &c. may be placed in the hot-houſe, where they will flower early. As ſoon as they come into blow they ſhould be removed into a green-houſe, or the apartments of a dwelling-houſe, where they will continue longer in flower than they would do if left in the ſtove, where the great heat would accelerate their decay. All thoſe ſhould have been put into pots the preceding autumn, or at leaſt ſome time previous to their being introduced into the hot-houſe. The roſes in particular require to be well rooted in the pots before they are forced.

January. Nurſery.

53 Management of ſhrubs.

Shrubs may now be pruned, which ſhould be performed with a knife and not with garden ſheers. All irregular ſhoots which extend far beyond the reſt of the branches ſhould be cut off. A few branches ſhould alſo be cut out wherever they are too much crowded together, likewiſe all dead and decayed ones. After the pruning has been finiſhed, the ground in the ſhrubbery ought to be dug over, and all ſuckers removed. Where the ſhrubs are too much crowded together, ſome of them ought to be taken out; and where any of them have died, or if they ſtand too diſtant, ſome young ones may now be planted to fill up the vacancies.

54 Of graſs walks and lawns.

Graſs walks and lawns ſhould be kept neat by frequent poling and rolling. Poling may be perf rmed in open dry weather, with a long taper aſh pole about twelve or fifteen feet long, which breaks and ſcatters the worm caſts. After this, in moderately dry weather, roll with a wooden roller, to which all the looſe worm-caſts will adhere. Walks or lawns may alſo be made this month during open weather. Good turf may be obtained from commons or downs where ſheep feed, or from fields which have been long under paſture. Each turf ſhould be marked out a yard long and a foot in breadth, and cut to the thickneſs of an inch with a turfing iron. As the cutting proceeds, they ſhould be rolled up compactly with the graſs ſide in. If they are not cloſely rolled up they will be apt to break in carrying. They muſt be laid on the walk or lawn cloſe to one another after the ſurface has been rendered level and compact by proper treading, that it may not ſettle unequally. When they have been put on they muſt be beat down with a wooden rammer, and afterwards rolled with a large iron or wooden roller.

55 Of gravel walks.

Gravel walks ſhould be cleared of weeds and all decayed leaves, and kept clean; and in dry weather they ſhould be occaſionally rolled. New walks may likewiſe be formed now. For the method ſee MARCH.

56 Edgings.

Edgings of boxwood, thrift, &c. may be planted any time this month in open weather. See OCTOBER.

57 Planting, &c. of hedges.

Hedges of hawthorn, barberry, privet, hazel, holm, yew, birch, elm, elder, &c. may be planted during this month. See NOVEMBER. Old hedges which have become open below ſhould be plaſhed. See DECEMBER.

58 Of foreſt trees.

Foreſt trees for ornamental plantations, coppices, or woods, may be planted either now or at any time from the fall of the leaf till the riſe of the ſap in ſpring. See OCTOBER.

SECT. IV. *Nurſery.*

59 Management of ſhrubs and trees.

PRUNE and tranſplant ſhrubs, fruit and foreſt trees. Trim the ſtems of foreſt-trees, and cut off all irregular

January. Green-house and Hot-house.

regular rambling ſhoots of ſhrubs, and reduce them to a regular neat form. This work may be executed any time this month, even during froſt, when little elſe can be done. All kinds of hardy deciduous ſhrubs, fruit, and foreſt trees may be tranſplanted during open weather.

Dig ground in open weather, and wheel out dung in froſt.

Vacant compartments of ground may be dug any time during open weather; and likewiſe after the neceſſary pruning has been given to the trees and ſhrubs, the ground between the rows may be dug, and all weeds carefully buried.

60 Of ſeedlings.

The young plants of many of the tenderer kinds of trees and ſhrubs, ſuch as cedar of Lebanon, and ſome other ſpecies of pine, cypreſs, chineſe arbor vitæ, ſtrawberry-tree, &c. require to be protected during froſt. If they have been raiſed in boxes or pots, they may be placed in garden frames and occaſionally covered with the glaſſes; but care muſt be taken always to remove the glaſſes in mild open weather. If the plants ſtand in beds in the open ground, they may be covered with mats ſupported on hoops, which muſt be removed during favourable weather, or a covering of peaſe ſtraw, or ſomething of that nature may anſwer the purpoſe.

61 Propagate trees, &c. by layers,

Layers of many kinds of trees and ſhrubs may be made any time this month during open weather; many of them which are laid now will be well rooted and fit for removing by October; for the method ſee NOVEMBER.

62 By cuttings.

Put in cuttings of honeyſuckles, gooſberries, currants, &c. indeed moſt kinds of trees and ſhrubs may be propagated by cuttings. For this purpoſe ſelect the ſtraight ſhoots of laſt year's growth; take them off by a clean cut with a ſharp knife, and reduce them to the length of ten, twelve, or fifteen inches, by cutting off part of their ſmaller extremities. Plant them in rows a foot apart, and at the diſtance of four or five inches from one another in the rows, taking care to inſert one third or one half of their length into the ground. Though cuttings will grow when their ſmaller extremities are put into the ground, they never ſucceed ſo well in this inverted poſition, therefore in planting, attention ſhould be paid to place them in their natural poſition. Older and longer branches of ſome trees and ſhrubs, viz. willow, elder, &c. may be employed as cuttings.

63 By ſuckers.

Gooſberries, currants, roſes, lilachs, and many other ſhrubs and trees, may be propagated by ſuckers or offſets from the roots: theſe may be taken off any time this month, and planted in rows. Previous to their being planted it would be proper to trim off part of their extremities.

SECT. V. *Green-Houſe and Hot-Houſe.*

64 The air to be cautiouſly admitted

DURING froſt, keep the glaſſes ſhut, but whenever the weather is mild give the green-houſe air by opening the glaſſes more or leſs according to the ſtate of the weather: even in the brighteſt mild days during this month the glaſſes ſhould not be opened until about ten o'clock in the morning, and ought to be ſhut again about three in the afternoon. In dull foggy days, even though the weather be mild, they ſhould be opened but little, and that for a ſhort time, and in very damp weather, not at all. When very ſevere froſt prevails, fires muſt be put on, and the flues gently warmed; but the temperature of the air ſhould not be raiſed higher than merely to keep off the effects of the external froſt. A little fire ſhould likewiſe be put on during very wet weather to baniſh the damps. Water ſhould be given to ſuch plants as require it, but ſparingly. Succulent plants, ſuch as aloes, &c. require little or no water at this ſeaſon. All dead and decayed leaves ſhould be carefully picked off, and the green-houſe kept clean.

January. Green-houſe.

65 Pine apple plants require attention.

Particular attention muſt be paid to the pine apple plants which are to produce fruit the enſuing ſummer, as many of them in the courſe of this month begin to ſhew flowers. If due attention be not now paid to keep up a proper heat, both in the tanned bed and in the air of the hot-houſe, the plants may receive ſuch a check as will conſiderably affect the ſize of the future fruit. The bark bed muſt be carefully examined; and if the bark be much decayed and the heat found on the decline, a quantity of freſh tanners bark ſhould be prepared to be added as a refreſhment to the old. The pots containing the pine apple plants ſhould then be taken out of the tan pits, and a quantity of the decayed tan removed from the ſurface and ſides of the pits, to make room for the freſh tan which is to be added. The old tan muſt likewiſe be turned up from the bottom, and well mixed with the new, after which the pots muſt be again plunged into the tan. But if, on examination, the heat of the tan pit be found good, and the tan not much decayed, it will be ſufficient to turn the old tan, and to mix it well together without making any addition of new. This operation will revive the heat of the bed, and preſerve it in good condition for ſome time to come. The heat of the air in the houſe muſt likewiſe be attended to, and regulated by the thermometer and by due attention to the fires. Moderate watering muſt be given once a week or ten days, according as the pine-apple plants may ſeem to require it; and care muſt be taken not to pour any of the water into their hearts or among their leaves.

The other plants in the hot-houſe muſt be regularly watered; but thoſe of a ſucculent nature, ſuch as the different ſpecies of aloe, euphorbia, meſembryanthemum, &c. require very little water at a time, and that but ſeldom.

66 Kidney beans.

Kidney beans, ſown in pots or in narrow boxes of about two or three feet long, may be reared in the hot-houſe. Thoſe ſown this month will produce fruit in April or March. When ſown in pots, two or three may be put into each, and covered about an inch deep: When in boxes they may be planted to the depth of an inch along the middle, at the diſtance of two or three inches from one another. The pots or boxes may be placed on the crib of the bark bed, on ſhelves, or any convenient ſituation, within the houſe, where they may not encumber the other plants. After the plants have come up, they ſhould be regularly and frequently watered. The kinds commonly uſed for this purpoſe are the early ſpeckled dwarf, negro dwarf, and dun-coloured dwarf.

67 Cucumbers

Cucumbers may be raiſed with tolerable ſucceſs in the hot-houſe, which will produce fruit early in ſpring. If the plants have been raiſed in ſmall pots, plunged in the tan of the bark bed, or in hot-beds made of horſe dung, they ſhould be tranſplanted into larger pots or boxes, in which they may remain and produce fruit; or

February. Kitchen Garden.

or the ſeeds may be ſown at once in the pots where they are to remain. In this caſe ſix or eight ſeeds may be ſown in each pot, or patches containing that number may be ſown at proper intervals in long narrow boxes. When the plants have come up, only two or three of the ſtrongeſt ſhould be left in each pot or patch. The pots or boxes may be placed in any convenient ſituation in the hot-houſe, but will ſucceed beſt on a ſhelf fixed near the top of the houſe, within a ſhort diſtance of the glaſs. The plants muſt be frequently watered, and have ſome ſmall rods fixed near them, to which the runners may be faſtened.

FEBRUARY.

Sect I. *Kitchen Garden.*

68 Admit air to cauliflowers. plants.

The cauliflower plants, which are under frames, ſhould have plenty of air. Indeed, whenever the weather will permit, the glaſſes ought to be taken off entirely.

About the end of the month, if the weather be mild, ſome of the ſtrongeſt plants may be tranſplanted into the ſituations where they are to remain. They ought to be planted in good well-manured ground, in a warm ſituation, at the diſtance of two feet and a half each way from one another. The ſame attention muſt be paid to cauliflowers under bell or hand-glaſſes. When more than two plants happen to be under one glaſs, the weakeſt of them ſhould be planted out about the end of the month, if the weather be mild, and only one or two ſhould be left under each glaſs: but if the weather is unſettled or ſevere, tranſplanting ought to be deferred till next month.

69 Sow cauliflowers.

Some cauliflower ſeed may be ſown any time this month to produce plants to ſucceed thoſe that have been preſerved during winter under frames or hand-glaſſes, or to ſupply the place of thoſe which may have been cut off by the ſeverity of the weather.

For this purpoſe make a ſlight hot-bed of horſe dung, to the height of 20 inches or two feet; cover it with a light rich earth to the depth of four or five inches, on the ſurface of which ſow the ſeeds, and cover them to the depth of a quarter of an inch with earth of the ſame deſcription. After the ſeed has been ſown, a frame and glaſſes ſhould be put on, if one can be ſpared for this purpoſe; and when the plants begin to appear above ground, they ſhould have plenty of air, whenever the weather will permit, otherwiſe they will be drawn up and become weak. The glaſſes, therefore, (unleſs in very ſevere weather) ſhould be raiſed every day, and in mild ones taken off entirely. When there are no glaſſes to ſpare, the bed may be covered during the night, and in ſevere weather, with mats properly fixed over it. The plants ſhould be ſprinkled with water from time to time, if moderate ſhowers ſhould not render this unneceſſary.

70 Tranſplant cabbages.

Cabbage plants, if tolerably ſtrong, ſhould be tranſplanted in the courſe of this month. See *Planting out Cabbages*, January.

71 Sow cabbages.

About the middle, or towards the end of the month, ſow ſome cabbage and ſavoy ſeed to raiſe plants for late crops in ſummer and autumn. Both the early and late kinds of cabbage may be ſown now, but it is better to ſow them in Auguſt; but if none were ſown in autumn, or if the plants raiſed then have been cut off by the ſeverity of the winter, a quantity of both early and late ſhould be ſown the firſt opportunity this month. That the plants may ſooner acquire ſufficient ſtrength for planting out, it would be proper to ſow them in a ſlight hot-bed.

72 Small ſalad.

Where ſmall ſalad is required, let ſome ſeeds of muſtard, creſs, radiſh, rape, &c. be ſown regularly every eight or ten days during the courſe of the month. See January.

73 Celery.

Earth up celery in open dry weather if the plants have advanced much above ground. Sow ſome upright celery ſeed for an early crop about the middle or towards the end of the month in a ſmall bed of rich light earth in a warm ſituation. There are three ways in which this may be performed. 1ſt, The earth of the bed ſhould be well broken with the ſpade; the ſeed ſown on the rough ſurface and raked in. 2dly, The ſurface of the bed may be made ſmooth; the ſeed ſown and covered to the depth of a quarter of an inch with light rich earth. 3dly, A quantity of earth, to the depth of about half an inch, ſhould be removed with the back of a rake from the ſurface of the bed into the alleys, which, after the ſeed has been ſown, ſhould be gently replaced with the rake. Thoſe who are very anxious to have early celery, ſhould ſow ſome in a ſlight hot-bed. The plants raiſed now will be fit for uſe in June or July; but it would be adviſeable to ſow few at this ſeaſon, as they will be very apt to pipe or run up to ſeed before they acquire ſufficient ſize: there are two kinds of celery, the Italian, and turnip-rooted or celeriac.

74 Radiſhes.

About the beginning of this month ſow ſome ſhort-topped radiſhes to ſucceed thoſe ſown laſt month, and ſome ſalmon and Italian radiſhes at any time during the month. See January.

75 Spinach.

Some round-leaved ſpinach may be ſown any time in the courſe of the month, to ſucceed that which was ſown laſt month. See January.

76 Peas.

Some early peas may be ſown this month. This is likewiſe a proper ſeaſon for ſowing a full crop of late peas, ſuch as marrowfats, rouncivals, Carolina, and ſugar pea, &c. For the diſtances at which they are to be ſown, ſee January.

77 Beans.

This is the proper time to plant beans. For the method and diſtances, ſee January.

78 Earth up peas and beans.

Such peas and beans as are ſufficiently advanced in growth ſhould now be earthed up.

79 Sow and tranſplant lettuces.

In mild open weather ſow ſome ſeeds of green and white cos lettuce, likewiſe ſome Sicilian, imperial, brown Dutch, and common cabbage lettuce. See January.

If young lettuce plants are wanted for tranſplanting early, they ſhould be ſown in a ſlight hot-bed or in ſome warm ſheltered ſituation; and when they have advanced to the height of about two inches, they may be planted out in the open ground. Lettuces that have ſtood the winter in frames, under hand-glaſſes or in warm borders, ſhould be thinned and left ſtanding at the diſtance of one foot from each other, and thoſe that are drawn out ſhould be planted in ſome proper ſituation.

80 Sow carrot and parſnip.

About the middle or end of this month ſow ſome carrots and parſnips. They ſucceed beſt in light deep ſoil, and in an open ſituation. The ground ſhould be dug, at leaſt one ſpade deep or two, if the depth of the ſoil will

February. Kitchen Garden.

will admit, and the clods ought to be well broken. They may be fown either broadcaft, in narrow beds, or in drills. See MARCH.

81 Beet. Sow fome feeds of red, white, and green beet, likewife of mangel wurzel or German beet. The fine red root of the firft is ufed as a pickle, &c.; the leaves of the white and green are made ufe of in foups, &c.; and the large leaves of the mangel wurzel are boiled and ufed as fpinach. The footftalks of its leaves are likewife ufed as afparagus. Each kind fhould be fown feparately, either broadcaft or in drills, an inch deep, and about a foot apart; but the mangel wurzel requires more room than the other kinds, becaufe it is of larger growth. After the plants have come up, they fhould be thinned out, to the diftance of fix or eight inches from each other. The feed may likewife be dibbled in rows, about a foot apart, and at the diftance of fix or eight inches from each other in the rows. Two or more feeds may be put into each hole; and when the plants appear above ground, one of the ftrongeft only fhould be left.

82 Plant carrots, &c. for feed. Some of laft year's carrots, parfnips, and beets, fhould be planted out in rows, two feet apart and one foot diftant from each other in the row, to ftand and produce feed.

83 Sow onions and leeks. Some onions and leeks may be fown in mild dry weather, any time after the middle of this month. The ground fhould be well dug, and the feeds fown when the furface is dry, and then raked in. The beft mode is to divide the ground into beds of about four feet wide, for the convenience of thinning, weeding, &c.; but they may alfo be fown in plots, without being divided into beds, in which cafe, if the foil be light, the feed may be gently trodden in, before the furface is raked. The leeks will be fit for tranfplanting in June and July, and the onions for drawing in Auguft. Sometimes a fmall quantity of leek-feed is fown along with the onion; and when the onions are drawn in Auguft, the leeks are allowed to remain to acquire a proper fize; but it is better to fow each feparately. The principal kinds of onions are the Strafburg, Deptford, Spanifh Portugal, long keeping, and red.

84 Hamburgh parfley, &c. The Hamburgh parfley and fcorzonera are cultivated for their roots; the falfafy for its roots and tops. The roots of all of them, if fown now or any time in fpring, will be fit for ufing in autumn, and continue good all winter. The Hamburgh parfley roots are not only ufed for culinary purpofes, but recommended in medicine. They are faid to be ufeful in the gravel. The feeds may be fown in drills, fix inches apart, and covered with earth to the depth of half an inch. The plants fhould be thinned in May or June, and left ftanding at the diftance of fix inches from each other in the rows.

85 Pot-herbs, &c. About the middle of the month you may fow feeds of burnet, lovage, angelica, marigold, fennel, dill, forrel, chervil, and clary. Each kind fhould be fown feparately, either in the place where they are to remain, or they may be tranfplanted in fummer. See JUNE.

About the middle or end of the month fow marjoram, thyme, favory, and hyffop. The plants may either remain where fown, or be planted out in the beginning of fummer. See JUNE.

86 Plant garlic. &c. Towards the end of the month plant fhalot, garlic, and rokambole. Having procured a quantity of their roots, divide and plant them in rows nine inches apart and fix inches diftant from each other in the row. They may be put in to the depth of two inches with the dibble, or placed in drills, two inches deep, drawn with a hoe.

87 Parfley. This is a proper time to raife a full crop of parfley. See JANUARY.

88 Potatoes. A few potatoes may be planted about the middle or end of this month for an early crop; but if wanted very early, fome early dwarf potatoes fhould be planted in a flight hot-bed. For the method of planting, fee MARCH.

89 Horfe radifh. Horfe radifh is propagated by offsets or cuttings of the roots, about three inches long, which may be planted either with the dibble or fpade, at the diftance of fix or eight inches from each other, in rows two feet apart. When they are planted with the dibble, the holes ought to be made 10 or 12 inches deep; when with the fpade a trench fhould be made a full fpade deep, in the bottom of which the offsets or cuttings fhould be placed erect, and covered with earth from the next trench. As they will not appear above ground till the month of May, a crop of fpinach, radifhes, or fmall falad, may be got from the ground, and cleared off before the horfe radifh appears. After the plants have come above ground, they ought to be kept clear of weeds.

90 Sow turnip. About the middle or towards the end of the month, fow fome feed of the early Dutch turnip in a border of light earth, in a warm fituation. See MARCH.

91 Cucumbers and melons. If no preparations were made laft month for raifing early cucumbers and melons, they may be commenced, any time this month, with better profpect of fuccefs. For the method of forming and managing the feed-bed, fee JANUARY.—If the cucumbers and melons, fown laft month and tranfplanted into fmall pots, be fit for ridging out, a hot-bed for one or more frames fhould be got ready for their reception, which fhould be raifed to the height of three feet and a half, and covered with a frame and glaffes. About a week afterwards, if the hot-bed has fettled unevenly, the frame and glaffes fhould be removed; and after the furface of the bed has been made perfectly level, replaced. As foon as the violent heat has fubfided, the rank fteam efcaped, and all danger of burning apparently over, cover the bed to the depth of two inches with dry light rich earth, and raife a conical heap of the fame earth, to the height of about 10 inches, immediately under the centre of each light. By the following day the earth will have acquired a proper warmth, and the bed will be fit for the reception of the young plants. The earth, laid over the furface of the bed, to the depth of two inches, will prevent the rank fteam of the dung, on the one hand, from rifing up freely, and yet not keep it down altogether: were much of the furface of the dung expofed, and the fteam allowed to efcape freely, the young plants would be deftroyed; and, on the other hand, were it prevented from efcaping altogether, by laying on earth to a fufficient depth at once, the bed would become overheated, and the roots of the plants might be burnt.

92 Management of the former crop. The pots containing the young cucumber and melon plants, which were tranfplanted laft month (fee JANUARY), fhould be well watered the day previous to their being ridged out, to make the ball of earth adhere, and come out of the pot entire. After the tops of the hillocks of earth, which had been raifed to the height

height of 10 inches under each light, have been flatten-ed by reducing their height about two inches, make a hole in the centre of each, capable of containing one of the balls of earth, which is to be turned out of the pots. Select ſome pots containing the ſtrongeſt plants; place your hand on the ſurface of the pot, allowing the plants to paſs between your fingers; invert it, and ſtrike the edge of it gently againſt the frame till the ball of earth comes out, which ſhould be put into one of the holes in the hillock juſt mentioned; cloſe the earth round the ball, and make it riſe about an inch over its ſurface. After they have been thus ridged out, they ſhould re-ceive a gentle watering, and be covered with the glaſ-ſes till the ſteam begin to riſe much, when air ſhould be given by raiſing the glaſſes. Theſe hot-beds, into which the cucumbers and melons have been finally tranſplanted, muſt be managed in the ſame manner as the nurſery beds, mentioned laſt month. A covering of ſtraw, or ſomething of that nature, ſhould be laid all round the dung; linings of freſh dung ſhould be applied to the ſides of the bed when the heat begins to decline, air admitted under the ſame circumſtances and with the ſame precautions as there ſtated. If three cucum-bers or two melons have been planted in the pots, as before directed, one of the weakeſt of either ſhould be removed immediately before, or after they are ridged out. Should any ſymptoms of burning appear ſoon af-ter the plants have been ridged out, part of the earth, cloſe to the bottom of the hillocks, muſt be removed; and as ſoon as the violent heat has ſubſided, be replaced with freſh earth. When the heat of the bed begins to decline a little, eſpecially if any of the roots of the plants ſhew themſelves through the ſides of the hillocks, a quantity of freſh earth ſhould be applied all round them, which ſhould be kept within the frame for one night previouſly, that it may acquire a proper tempera-ture, for ſhould it be applied cold, it might injure the young roots. Two or three days after this an addition-al quantity of freſh earth ſhould be applied to the ſides of the hills; and in two or three more the whole ſur-face of the bed may be earthed over as high as the tops of the hills.

93 Topping.

When the plants have got two rough leaves, and when the ſecond is about an inch broad, the bud, which is ſituated at the axilla (or baſe) of the ſecond rough leaf, muſt be removed either with the finger, a pair of ſciſſars, or a penknife, or, when the bud is very ſmall, with a needle or pin, being careful not to injure the joint. After the plants are thus topped or ſtopped, they ſoon acquire ſtrength; and in about 10 or 12 days, each of them will throw out two or three runners, which will ſhew flowers ſometimes at the ſe-cond or third joint. Were the plants not to be topped, the principal ſhoots would probably advance to the length of about two feet, without ſending off any run-ners to fill up the frame, and without ſhewing a ſingle flower. If none of the runners, which are puſhed out after the firſt topping, ſhew flowers at the third or fourth joint, they ſhould be topped likewiſe, which will cauſe each of them to puſh out two or three runners, all of which may perhaps prove fruitful. As theſe runners advance in growth they ought to be trained regularly along the ſurface of the beds, and all very weak or re-dundant ſhoots removed. The cucumbers, if well ma-naged, will be fit for the table about the end of this or beginning of next month; but the melons will not be ripe before May or June.

94 Impregnation of the flowers.

Cucumbers and melons have male and female flowers on the ſame plant, which are eaſily diſtinguiſhed from one another. The male flowers, in the centre of which the antheræ are ſituated that contain the farina (or fœcundating powder), have ſtalks of an equal thickneſs, without any ſwell immediately under the flowers; whereas a ſwelling is perceptible immediately under the female flowers which contain the female organ of gene-ration, as ſoon as they are puſhed out from the ſtalks of the plant, which is the germen or future fruit. If none of the farina of the male be conveyed into the fe-male flower, the germen decays, becomes yellowiſh, and drops off. It becomes therefore neceſſary, particularly at this early period, to impregnate the female flowers by ſuſpending male flowers over them, and ſhaking ſome of the farina into the piſtillum (or female organ); for after the plants have continued ſome time in flower, the air of the hot-bed in which they grow becomes loaded with the farina, by which means it is wafted into the female flowers. Inſects likewiſe, particularly bees, at a more advanced period of the year, ſerve to convey it from flower to flower. As ſoon as the female flowers have opened, pinch off a newly blown male flower, to-gether with a portion of its foot ſtalk, remove the great-eſt part of its corolla or flower leaf, introduce it into the female flower, and either touch the piſtillum of the female gently with the antheræ of the male ſo as to make ſome of the farina adhere, or ſhake the male flower over the piſtillum of the female in order to make ſome of the farina fall on it. In a day or two after im-pregnation the germen or future fruit begins to ſwell, and in about a fortnight, if the weather be favourable and the heat of the bed good, the young cucumbers may be brought to table. This operation may be em-ployed to produce new varieties, not only of cucumbers and melons, but of many other vegetables. Were the female of one variety of melon to be impregnated with the farina of another, a kind would be produced par-taking ſomewhat of the properties of both; thus a large melon, not poſſeſſed of much flavour, might be improved by intermixture with one ſuperior in flavour but inferior in ſize. In hermaphrodite flowers this operation of im-pregnating, or croſſing, as it is called by cattle breeders, is performed by removing the antheræ from a flower of one ſpecies, and impregnating it with the farina of ano-ther of the ſame natural family. The plants proceeding from ſuch a commixture partake more of the properties of the male than the female parent. We have ſeen a hybrid produced from the *papaver ſomniferum* impreg-nated with the farina of the *papaver orientale*, ſo like the male parent as with difficulty to be diſtinguiſhed from it.

The *papaver orientale* produces only one flower on a ſtalk; ſome of this hybrid however carried more than one, and in this particular alone it reſembled the *papa-ver ſomniferum*, which branches very much. Mr Knight has made ſome curious and intereſting experi-ments on this ſubject, which he has detailed in the fol-lowing letter to Sir Joſeph Banks, publiſhed in the

95 Mr Knight's obſervations on this ſubject.

Tranſactions of the Royal Society. "The reſult of ſome experiments which I have amuſed myſelf with making on plants, appearing to me to be intereſting to the naturaliſt, by proving the exiſtence of ſuperfœtation in

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in the vegetable world, and being likely to conduce to ſome improvements in agriculture, I have taken the liberty to communicate them to you. The breeders of animals have very long entertained an opinion that conſiderable advantages are obtained by breeding from males and females not related to each other. Though this opinion has lately been controverted, the number of its oppoſers has gradually diminiſhed, and I can ſpeak from my own obſervation and experience, that animals degenerate in ſize, at leaſt on the ſame paſture, and in other reſpects under the ſame management, when this proceſs of croſſing the breed is neglected. The cloſe analogy between the animal and vegetable world, and the ſexual ſyſtem equally pervading both, induced me to ſuppoſe that ſimilar means might be productive of ſimilar effects in each; and the event has, I think, fully juſtified this opinion. The principal object I had in view, was to obtain new and improved varieties of the apple, to ſupply the place of thoſe which have become diſeaſed and unproductive by having been cultivated beyond the period which nature appears to have aſſigned to their exiſtence. But as I ſaw that ſeveral years muſt elapſe before the ſucceſs or failure of this proceſs could poſſibly be aſcertained, I wiſhed in the interval to ſee what would be its effects in annual plants. Amongſt theſe none appeared ſo well calculated to anſwer my purpoſe as the common pea, not only becauſe I could obtain many varieties of this plant, of different forms, ſizes, and colours, but alſo becauſe the ſtructure of its bloſſom, by preventing the ingreſs of inſects and adventitious farina, has rendered its varieties remarkably permanent. I had a kind growing in my garden, which, having been long cultivated in the ſame ſoil, had ceaſed to be productive, and did not appear to recover the whole of its former vigour when removed to a ſoil of a ſomewhat different quality: on this my firſt experiment in 1787 was made. Having opened a dozen of its immature bloſſoms, I deſtroyed the male parts, taking great care not to injure the female ones; and a few days, afterwards when the bloſſoms appeared mature, I introduced the farina of a very large and luxuriant gray pea into one half of the bloſſoms, leaving the other half as they were. The pods of each grew equally well, but I ſoon perceived that in theſe into whoſe bloſſoms the farina had not been introduced, the ſeeds remained nearly as they were before the bloſſoms expanded, and in that ſtate they withered. Thoſe in the other pods attained maturity, but were not in any ſenſible degree different from thoſe afforded by other plants of the ſame variety; owing, I imagine, to the external covering of the ſeed (as I have found in other plants) being furniſhed entirely by the female. In the ſucceeding ſpring the difference however became extremely obvious, for the plants from them roſe with exceſſive luxuriance, and the colour of their leaves and ſtems clearly indicated that they had all exchanged their whiteneſs for the colour of the male parent. The ſeeds produced in autumn were dark gray.

"By introducing the farina of another white variety, (or in ſome inſtances by ſimple culture), I found this colour was eaſily diſcharged, and a numerous variety of new kinds produced, many of which were in point of ſize and in every other reſpect much ſuperior to the original white kind, and grew with exceſſive luxuriance, ſome of them attaining the height of more than twelve feet. I had frequent occaſion to obſerve in this plant a ſtronger tendency to produce purple bloſſoms and coloured ſeeds than white ones; for when I introduced the farina of a purple bloſſom into a white one, the whole ſeeds in the ſucceeding year became coloured; but when I endeavoured to diſcharge this colour by reverſing the proceſs, a part only of them afforded plants with white bloſſoms; this part ſometimes occupying one end of the pod, and being at other times irregularly intermixed with theſe which, when ſown, retained their colour. It might perhaps be ſuppoſed that ſomething might depend on the quantity of farina employed; but I never could diſcover, in this or any other experiment in which ſuperfœtation did not take place, that the largeſt or ſmalleſt quantity of farina afforded any difference in the effect produced.

"The diſſimilarity I obſerved in the offspring afforded by different kinds of farina in theſe experiments, pointed out to me an eaſy method of aſcertaining whether ſuperfœtation, (the exiſtence of which has been admitted amongſt animals), could alſo take place in the vegetable world. For as the offspring of a white pea is always white, unleſs the farina of a coloured kind be introduced into the bloſſom; and as the colour of the gray one is always transferred to its offspring though the female be white, it readily occurred to me, that if the farina of both were mingled or applied at the ſame moment, the offspring of each could be eaſily diſtinguiſhed.

"My firſt experiment was not altogether ſucceſsful, for the offspring of five pods (the whole which eſcaped the birds) received their colour from the coloured male. There was, however, a ſtrong reſemblance to the other male in the growth and character of more than one of the plants, and the ſeeds of ſeveral in the autumn very cloſely reſembled it in every thing but colour. In this experiment, I uſed the farina of a white pea, which poſſeſſed the remarkable property of ſhrivelling exceſſively when ripe, and in the ſecond year I obtained white ſeeds from the gray ones above-mentioned, perfectly ſimilar to it. I am ſtrongly diſpoſed to believe, that the ſeeds were here of common parentage; but I do not conceive myſelf to be in poſſeſſion of facts ſufficient to enable me to ſpeak with deciſion on this queſtion.

"If, however, the female afford the firſt organiſed atom, and the farina act only as a ſtimulus, it appears to me by no means impoſſible, that the exploſion of two veſicles of farina at the ſame moment (taken from different plants) may afford ſeeds (as I have ſuppoſed) of common parentage, and as I am unable to diſcover any ſource of inaccuracy in this experiment, I muſt believe this to have happened.

"Another ſpecies of ſuperfœtation, if I have juſtly applied the term to a proceſs in which one ſeed appears to have been the offspring of two males), has occurred to me ſo often as to remove all poſſibility of doubt as to its exiſtence. In 1797, that year after I had ſeen the reſult of the laſt mentioned experiment, having prepared a great many white bloſſoms, I introduced the farina of a white pea, and, that of a gray pea nearly at the ſame moment into each, and as in the laſt year, the character of the coloured male had prevailed, I uſed its farina more ſparingly than that of the white one, and now almoſt every pod afforded plants of different

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ferent colours. The majority however were white, but the characters of the two kinds were not sufficiently distinct to allow me to judge with precision whether any of the seeds produced were of common parentage or not. In the last year I was more fortunate, having prepared blossoms of the little early frame pea, I introduced its own farina, and immediately afterwards, that of a very large and late gray kind; and I sowed the seeds thus obtained in the end of the last summer. Many of them retained the colour and character of the small early pea not in the slightest degree altered, and blossomed before they were 18 inches high, whilst others (taken from the same pods) whose colour was changed, grew to the height of more than four feet, and were killed by the frost before any blossoms appeared.

"It is evident that in those instances, superfetation took place, and it is equally evident that the seeds were not all of common parentage. Should subsequent experience evince that a single plant may be the offspring of two males, the analogy between animal and vegetable nature may induce some curious conjectures relative to the process of generation in the animal world.

"In the course of the preceding experiments, I could never observe that the character either of the male or female in this plant at all preponderated in the offspring, but as this point appeared interesting, I made a few trials to ascertain it. And as the foregoing observations had occurred in experiments made principally to obtain new and improved varieties of the pea for garden culture; I chose for a similar purpose the more hardy varieties usually sown in the fields. By introducing the farina of the largest and most luxuriant kinds into the blossoms of the most diminutive, and by reversing this process, I found that the powers of the male and female in their effects on the offspring are exactly equal. The vigour of the growth, the size of the seeds produced, and the season of maturity, were the same, though the one was a very early, and the other a late variety. I had in this experiment a striking instance of the stimulative effects of crossing the breeds; for the smallest variety whose height rarely exceeded two feet, was increased to six feet, whilst the height of the large and luxuriant kind was very little diminished. By this process, it is evident that any number of new varieties may be obtained; and it is highly probable, that many of these will be found better calculated to correct the defects of different soils and situations, than any we have at present; for I imagine that all we now possess have in a great measure been the produce of accident, and it will rarely happen in this or any other case, that accident has done all that art will be found able to accomplish.

"The success of my endeavours to produce improved varieties of the pea, induced me to try some experiments on wheat, but those did not succeed to my expectations. I readily obtained as many varieties as I wished, by merely sowing the different kinds together, for the structure of the blossoms of this plant, (unlike that of pea), freely admits the ingress of adventitious farina, and is thence very liable to sport in varieties. Some of these I obtained were excellent, others very bad; and none of them permanent. By separating the best varieties, a most abundant crop was produced, but its quality was not quite equal to the quantity, and all the discarded varieties again made their appearance. It appeared to me an extraordinary circumstance, that in the years 1795 and 1796, when almost the whole crop of corn in this island was blighted, the varieties thus obtained, and these only, escaped in this neighbourhood, though sown in several different soils and situations.

"My success in the apple (as far as long experience and attention have enabled me to judge from the cultivated appearance of trees, which have not yet borne fruit) has been fully equal to my hopes. But as the improvement of this fruit was the first object of my attention, no probable means of improvement either from soil or aspect were neglected. The plants, however, which I obtained from my efforts to unite the good qualities of two kinds of apple seem to possess the greatest health and luxuriance of growth, as well as the most promising appearance in other respects. In some of these, the character of the male appears to prevail; in others, that of the female; and in others both appear blended, or neither is distinguishable. These variations which were often observable in the seeds taken from the single apple, evidently arise from the want of permanence in the characters of this fruit when raised from seed.

"The results of similar experiments on another fruit, the grape, were nearly the same as of those on the apple, except that by mingling the farina of a black and a white grape, just as the blossoms of the latter were expanding, I sometimes obtained plants from the same berry so dissimilar that I had good reason to believe them the produce of superfœtation. By taking off the cups and destroying the immature male parts (as in the pea), I perfectly succeeded in combining the characters of different varieties of this fruit, as far as the changes of form and autumnal tints in the leaves of the offspring will allow me to judge.

Many experiments of the same kind were tried on other plants; but it is sufficient to say that all tended to evince, that improved varieties of every fruit and esculent plant may be obtained by this process, and that nature intended that a sexual intercourse should take place between neighbouring plants of the same species. The probability of this will, I think, be apparent, when we take a view of the variety of methods which nature has taken to disperse the farina, even of these plants in which it has placed the male and female parts within the same empalement. It is often scattered by an elastic exertion of the filaments which support it in the first opening of the blossom, and its excessive lightness renders it capable of being carried to a great distance by the wind. Its position within the blossom is generally well adapted to place it on the bodies of insects, and the villous coat of the numerous family of bees is not less well calculated to carry it. I have frequently observed with great pleasure the dispersion of the farina of some of the grasses, when the sun had just risen in a dewy morning. It seemed to be impelled from the plant with considerable force, and being blue was easily visible, and very strongly resembled in appearance the explosion of a grain of gunpowder. An examination of the structure of the blossoms of many plants, will immediately point out that nature has something more in view than that its own proper males should fecundate each blossom, for the means it employs are always best calculated to answer the intended purpose.

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pose. But the farina is often so placed that it can never reach the summit of the pointal, unless by adventitious means; and many trials have convinced me that it has no action on any other part of it. In promoting this sexual intercourse between neighbouring plants of the same species, nature appears to me to have an important purpose in view; for independent of its stimulative power, this intercourse certainly tends to confine within more narrow limits those variations which accidental richness or poverty of soil usually produces. It may be objected by those who admit the existence of vegetable mules, that under this extensive intercourse these must have been more numerous; but my total want of success in many endeavours to produce a single mule plant, makes me much disposed to believe that hybrid plants have been mistaken for mules, and to doubt (with all the deference I feel for the opinions of Linnæus and his illustrious followers) whether nature ever did or ever will permit the production of such a monster. The existence of numerous mules in the animal world between kindred species is allowed, but nature has here guarded against their production, by impelling every animal to seek its proper mate; and amongst the feathered tribe, when from perversion of appetite, sexual intercourse takes place between those of distinct genera (A), it has in some instances at least rendered the death of the female the inevitable consequence. But in the vegetable world there is not any thing to direct the male to its proper female, its farina is carried by winds and insects to plants of every different genus and species, and it therefore appears to me (as vegetable mules certainly are not common) that nature has not permitted them to exist at all.

"I cannot dismiss this subject, without expressing my regret, that those who have made the science of botany their study should have considered the improvement of those vegetables, which in their cultivated state afford the largest portion of subsistence to mankind and other animals, as little connected with the object of their pursuit. Hence it has happened, that whilst much attention has been paid to the improvement of every species of useful animal, the most valuable esculent plants have been almost wholly neglected. But when the extent of the benefit which would arise to the agriculture of the country, from the possession of varieties of plants, which with the same extent of soil and labour would afford even a small increase of produce, is considered, this subject appears of no inconsiderable importance. The improvement of animals is attended with much expence, and the improved kinds necessarily extend themselves slowly; but a single bushel of improved wheat or peas may in ten years be made to afford seed enough to supply the whole island, and a single apple or other fruit tree may within the same time be extended to every garden in it. These considerations have been the cause of my addressing the foregoing observations to you at this time; for it was much my wish to have ascertained before I wrote to you, whether in any instance a single plant can be the offspring of two male parents. The decision of that question must of necessity have occupied two years, and must therefore be left to the test of future experiment."

February. Fruit Garden.

The opinion Mr Knight endeavours to establish towards the end of his letter, is certainly incorrect, if he means to assert that hybrids can only be produced by a commixture of different varieties of the same species, and that none can be produced by the union of plants of different species. The fact already stated relative to the hybrid produced between the *papav. oriental.* and *somnif.* (two species as different, in every respect, from each other as the horse and ass).

Sect. II. *Fruit Garden.*

96 Pruning of fruit-trees.

Where peaches, nectarines, and apricots, have not been pruned before this, that work ought to be done without delay, because the flower buds after they have begun to swell (which they do at this season) are easily rubbed off. Plums, cherries, apples, pears, gooseberries, currants, and raspberries, &c. may likewise be pruned during this month if neglected till now.

97 Figs.

About the end of the month you may prune fig trees, as by that time all danger of the young shoots being killed by the frost will be over. As the young shoots of last season alone produce figs the ensuing, a sufficient supply of them must be left to nail on to the wall; and superfluous, ill-placed, very strong long-jointed shoots, and small weak ones, ought to be cut away close to the branch of the former year's growth. The branches which are retained ought to be laid in and nailed to the wall at full length, at the distance of about half a foot from each other. They ought not to be shortened, because the figs are generally produced from that part of the branch near to the extremity: on this account likewise care must be taken, in choosing those which are to be retained, not only to prefer the shoots of moderately vigorous growth, but likewise those which have had least of their extremities killed by the frost, for it frequently happens that the frost kills the succulent extremities of branches, and sometimes even the whole shoot.

Shortening the branches has another bad effect besides removing the part from which the fruit is to proceed, it makes them throw out a crowd of lateral shoots, which create confusion and shade the fruit. All worn-out old branches which are not furnished with a sufficient number of young lateral shoots, ought to be cut away, either close to the main branch from which they proceed, or close to some shoot placed near their lower end. Young fig trees may be planted also any time this month. See October.

98 Plant, &c. strawberries.

Strawberry beds should now receive a dressing. Last year's runners should be cut away, weeds and decayed leaves removed, the ground between the rows dug or loosened with the hoe, and some earth drawn up about the roots of the plants. Strawberries may be planted towards the end of the month: for the method see June and September.

99 Force early fruit.

Any time this month you may begin to force the trees on hot walls, in vine, peach, and cherry houses, &c.

(A) This is said to be the case with the drake and the hen.

February. Pleasure or Flower Garden.

&c. They ought to be covered with the glasses, some time previous to the application of fire-heat, and if the houses have been constructed with pits for containing hot-beds of tanners bark or horse dung, a quantity of either should be got ready. If tanner's bark is to be used, it ought to be spread out and exposed to the air, that it may dry, for if it be put in too wet it will either not heat at all, or heat violently and soon rot, but if properly dried, the heat will be moderate and last for a long time. When horse dung is to be used, it ought to be forked up into a heap and allowed to remain for a few days, during which time it should be turned two or three times with a fork that it may be thoroughly mixed. Slight fires should be applied for two or three days at first, which may be gradually increased. They ought to be kindled about sunset, and supplied with fuel from time to time till about ten o'clock, which will keep the house in a proper heat until morning, when the fires should again be set a going, if the heat has declined, but it will seldom be necessary at this season to keep the fires burning all day. The fuel employed may be either coal, wood, peat, or turf: of these coal is best, because it makes the strongest, the most durable, and most easily managed fire. The heat of each house should be regulated by a thermometer. The degree of warmth kept up at this season, should not much exceed the 60° of Fahrenheit. When the sun shines bright the heat must be regulated by opening the glasses more or less, and admitting the external air. Besides the trees that may be trained to the wall or front of the house, pots or boxes containing cherry or peach trees may be introduced; likewise pots of kidney beans, strawberries, &c. roses, and a variety of other flowers. The trees and plants within the house must be duly watered, and have plenty of air admitted to them whenever the weather will permit. When the fruit approach to maturity a greater heat should be maintained within the house, which may be effected during the day by the rays of the sun, and sparing admission of the external air, and during the night (if the weather be cold) by fire.

SECT. III. *The Pleasure or Flower Garden.*

100 Sow tender annuals.

TOWARDS the end of the month, you may sow some tender annuals, such as balsams, cockscombs, globe amaranthus, ice plants, egg plants, &c. They must be sown in a hot-bed, which is to be formed and earthed over in the same way as seed beds for cucumbers and melons. See JANUARY. The seeds may either be sown in the earth of the bed, or in pots plunged into the earth. Or a few may be sown in pots, and introduced into a cucumber or melon bed. When the plants have acquired sufficient strength to admit of being transplanted, they should be put into separate pots and transferred to other hot-beds. See APRIL.

101 Hardy annuals.

About the end of the month, you may sow some seed of mignionet, ten weeks stock, larkspur, flos Adonis, convolvulus, lupines, scarlet, sweet-scented, and Tangier pea, candytuft, dwarf lychnis, Venus's looking glass, Lobel's catchfly, Venus's navel-wort, dwarf poppy, annual sunflower, oriental mallow, lavatera, hawkweed, and many others. They must be sown in places where they are to remain, for none of these plants succeed so well when they are transplanted.

Dig small patches with a trowel in the flower borders, break the earth well, remove part of it from the surface with the edge of the trowel, and sow the seeds, which should be covered with the earth which had been moved aside from the surface of the patches. The smaller seeds such as mignionet, ten weeks stock, larkspur, &c. should be covered to the depth of about a quarter of an inch; the larger ones, such as lupines, painted and sweet peas, annual sunflower, &c. may be covered to the depth of an inch. After the plants have advanced a little in growth, they should be thinned out in proportion to their size, viz. one sunflower should be left in a place, two plants of lavatera and oriental mallow, four or five of the larger, and six or eight of the smaller lupines, and so on in proportion.

Most kinds of hardy perennials and biennials may be planted out this month, viz. polyanthuses, primroses, London pride, violets, double daiseys, double chamomile, saxifrage, rose campion, rockets, campanula, catchfly, scarlet lychnis, double feverfew, batchelor's button, carnations, pinks, sweetwilliam, columbines, monkshood, tree primrose, foxglove, goldenrod, perennial asters, perennial sun-flower, holyhocks, French honeysuckles, wallflowers, and many others. 102 Plant hardy perennials.

Where auricula plants are much valued, and where there are many of the finer varieties, they are commonly kept in pots. During mild weather any time this month, it would be proper to give them some fresh earth. Clear away all dead leaves from the plants, remove some of the old earth from the sides of the pot all around, so far as you can do it without injuring the roots, and fill the pots with fresh earth prepared for the purpose. See SEPTEMBER. 103 Dress and sow auriculas, &c.

Auricula and polyanthus seed may be sown any time this month, either in the open ground or in pots. When sown in pots or boxes they are more easily moved to proper situations during different seasons. Sow them in light rich earth, and cover them to the depth of about a quarter of an inch. The pots or boxes should be placed in a situation sheltered from the north, and exposed to the morning and midday sun, from which they ought to be removed in April to a more shady place. They will be fit for transplanting in the month of June. See JUNE.

About the end of the month plant out the carnations which were raised last year by cuttings or layers, into pots or borders where they are to remain to produce flowers the ensuing summer. 104 Transplant carnations.

Any time this month you may transplant evergreen trees, and shrubs; such as pines, firs, evergreen oaks, hollies, yews, cypresses, cedars, phillyreas, arbutuses, laurels, laurustinus, &c. 105 Evergreens.

The finer sorts of tulips, hyacinths, anemones, ranunculuses, &c. should be protected during severe weather, as they begin to appear above ground. For the method of sheltering them see JANUARY. 106 Protect tulips, &c.

Grass walks and lawns ought to be kept clean, poled and rolled at least once a week if the weather permit it. After being rolled with a wooden roller to take off the worm-casts, a heavy stone or iron one should be passed over them to render them firm. Their edges ought likewise to be cut with an edging iron about the end

February. Nurfery. end of the month, which will give them a neat appearance.

107 Walks and edgings. Gravel and grafs walks may be made during this month: for the latter fee JANUARY, and the former MARCH.

Edgings of boxwood, thrift, daifies, thyme, hyffop, &c. may be planted this month. Boxwood forms the neateft, moft durable, and moft eafily kept edging, and if planted now it will fucceed very well. For the method fee OCTOBER. Where any of the old boxwood edgings have become irregular, they ought to be taken up and replanted.

Thrift is frequently employed as an edging, and well kept makes a very neat one. The plants may be either put in with the dibble fo clofe as to touch, or at the diftance of two or three inches from each other, or planted as boxwood, fee OCTOBER. Daifies are fometimes ufed, and form a very pretty edging; they may be planted in the fame manner as the thrift.

108 Early flowers forced. A great variety of flowers, fuch as hyacinths, jonquils, and rofes, &c. may be placed in the hot-houfe, vinery, or peach-houfe; and when they have come into flower they may be placed in a green-houfe, or in apartments of a dwelling houfe.

SECT. IV. *Nurfery.*

MANY things mentioned under the article work to to be done in the *nurfery* for *January* may likewife be done this month; fuch as pruning young trees and fhrubs, digging between the rows, propagating by cuttings, fuckers, and layers, &c. See JANUARY.

109 Layers tranfplanted. Such layers of laft year, as appear well rooted, fhould be removed from the parent plant (or ftool), and planted in rows of from one to two feet afunder, according to the fize of the plant, and at the diftance of a foot or foot and a half from each other in the row.

110 Seeds of fhrubs, &c. fown, If feeds or ftones of apples, pears, cherries, and plums, were not fown laft autumn to raife ftocks for budding and ingrafting, they fhould be fown about the beginning of this month. They fhould be fown in light foil, and covered to about the depth of an inch. The plants raifed from this fowing will be fit for tranfplanting in the beginning of next winter or fpring. The feeds of berries and nuts of fhrubs and foreft trees may likewife be fown any time this month in narrow beds, and covered in proportion to their fize, viz. the fmall feeds to the depth of about half an inch, the larger to the depth of an inch or an inch and a half, and fome of the nuts even to a greater depth.

111 and tranfplanted. Trees and fhrubs may be removed from the feed-bed or from where they ftand too thick, and planted out in rows at proper diftances, or tranfplanted into the places where they are to remain.

112 Stocks headed. Young trees that were budded fuccefsfully laft fummer fhould be cut down to within about four inches of the bud. See JUNE and JULY.

113 Fruit trees engrafted. Pears, plums, and cherries may be ingrafted towards the end of the month, if the weather is mild: apples likewife may be ingrafted at the fame time, or in the courfe of the following month.

Grafting or engrafting, in gardening, is the taking a fhoot from one tree, and inferting it into another, in fuch a manner, that both may unite clofely and become one tree.

By the ancient writers on hufbandry and gardening this operation is called *incifion*, to diftinguifh it from inoculation or budding, which they call *infertion*. Grafting has been practifed from the moft remote antiquity, but its origin and invention are differently related by naturalifts. Theophraftus tells us, that a bird having fwallowed a fruit whole, caft it forth into a cleft or cavity of a rotten tree, where, mixing with fome of the putrefied parts of the tree, and being wafhed with he rains, it germinated, and produced within this tree a tree of a different kind. This led the hufbandman to certain reflections, from which afterwards arofe the art of engrafting. February. Nurfery. 114 Hiftory of engrafting.

Pliny gives a different account of the origin of grafting: he fays, a hufbandman wifhing to make a pallifade in his ground, that it might endure the longer, and with a view to fill up and ftrengthen the bottom of the pallifade, wattled it with the twigs of ivy. The effect of this was, that the ftakes of the pallifades taking root, became engrafted into the twigs, and produced large trees, which fuggefted to the hufbandman the art of engrafting.

The ufe of grafting is to propagate any defirable forts of fruit fo as to be certain of the variety: for as all good varieties of fruit have been accidentally obtained from feeds, fo the feeds of thefe, when fown, will many of them degenerate, and produce fuch fruit as is not worth cultivating; but when grafts are taken from fuch trees as produce good fruit, thefe will never alter from their kind, whatever be the ftock or tree on which they are grafted. Many have fuppofed that fruit undergoes a change, by being engrafted; but this is not the cafe, M. Du Hamel tried it on different trees, and for fear of error repeated every experiment feveral times. He grafted the peach on the almond, the plum on the apricot, the pear upon the apple, the quince on the white thorn, one fpecies of plum on another, and the almond and apricot on the peach. All thefe fucceeded alike; the fruit was never altered; the leaves, the wood, the flowers, were perfectly the fame with thofe of the tree from which the grafts were taken.

Some authors have made mention of engrafting trees of diftinct genera on one another; fuch as the apple on the oak, the elm, the mapple, and the plum. M. Du Hamel tried a number of thefe experiments, none of which proved fuccefsful. Engrafting feems never to fucceed but when trees of the fame natural family are grafted on one another. Some trees are fuppofed to live longer, and grow more vigoroufly when engrafted than when growing in a natural ftate. It is faid, that this is the cafe with the peach, when engrafted on the plum. But it is commonly alledged, that engrafted trees do not live fo long as they would have done in their natural ftate. The reafon why engrafted trees are fhort lived, perhaps proceeds from another caufe than merely from the circumftance of being grafted, viz. the age of the tree from which the fcions were originally taken.

The proper tools and other materials ufed in grafting, are, 1. A ftrong knife for cutting off the heads of the ftocks previous to the infertion of the graft; alfo a fmall hand faw for occafional ufe in cutting off the heads of large ftocks. 2. A common grafting knife or fharp pen knife for cutting and fhaping the grafts ready for infertion; alfo to flope and form the ftocks for the 115 Method of performing it.

February. Nursery. the reception of the grafts. 3. A flat grafting chisel and small mallet for cleaving large stocks, in cleft grafting, for the reception of the graft. 4. A quantity of new bass strings for bandages for tying the grafted parts close together, to secure the grafts, and promote their speedy union with the stock. And 5. A quantity of grafting clay for claying closely round the grafts after their insertion and binding to defend the parts from being dried by the sun and winds, for these parts ought to be closely surrounded with a coat of clay in such a manner as effectually to guard them from all weathers, which would prove injurious to the young grafts, and prevent their junction with the stock.

For this purpose some argillaceous loam or pure clay must be procured, to which should be added one fourth part of fresh horse dung and a small portion of cut hay. The whole must be well moistened with water, and thoroughly beat with a stick after the manner of mortar.

The scions or grafts (which should be shoots of last year) ought to be selected and cut off some time about the beginning or middle of the month. Each kind ought to be put up separately in little bundles, which should be inserted into the earth of a dry border, and should be protected during severe weather by a covering of straw or something of that nature. The reason for taking them off at the time mentioned, is that their growth may be checked, and that they may be preserved in a condition for grafting; for were they to remain on the trees, their buds would begin to swell, and would soon advance so far as to be unfit for using with any prospect of success. The stocks intended to be grafted, must, previous to the insertion of the graft, be cut down; those intended for dwarf trees, to be trained on walls or espaliers, must be cut over five or six inches above the ground; those intended for standards should be cut over at the height of five or six feet.

The stocks must vary according to the kinds of fruit to be grafted on them, and to the size of the tree to be produced. Apples are grafted on apple stocks raised from seed, cuttings, or layers; for dwarfs, paradise pippin or Siberian crab stocks are used; for half dwarfs, codlin stocks raised from suckers, cuttings or layers; and for full standards, stocks raised by sowing the seed of crabs or any common apple. Pears are engrafted upon pear stocks obtained from seed or suckers, on quinces, and on white thorn. When they are engrafted on quince stocks, they become dwarf, and are fit for espaliers, &c.

Cherries are engrafted upon cherry stocks obtained by sowing the stones of red or black cherries, and plums are engrafted upon plum stocks raised from seed or suckers (B).

There are different methods of grafting, termed whip-grafting, cleft-grafting, crown-grafting, cheek-grafting, side-grafting, root-grafting, and grafting by approach or inarching; but whip-grafting and cleft-grafting are the most commonly used, and whip-grafting most of all.

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116 Whip-grafting.

Whip-grafting being the most expeditious and successful method of grafting, is the most commonly practised in all the nurseries; it is always performed upon small stocks, from about the size of a goose-quill to half an inch or a little more or less in diameter, but the nearer the stock and graft approach in size, the better; and is called whip-grafting, because the grafts and stock being nearly of a size, are sloped on one side so as to fit each other, and tied together in the manner of whips or joints of angling rods, &c.; and the method is as follows. Having the scions or grafts, knife, bandages, and clay ready, begin the work by cutting off the head of the stock at some smooth part; this done, cut one side sloping upwards, about an inch and a half or near two inches in length, and making a notch or small slit near the upper part of the slope downwards, about half an inch long, to receive the tongue of the scion; then prepare the scion, cutting it to five or six inches in length, forming the lower end also in a sloping manner, so as exactly to fit the sloped part of the stock, as if cut from the same place, that the bark of both may join evenly in every part, and make a slit so as to form a tongue to fit the slit made in the slope of the stock; then place the graft, inserting the tongue of it into the slit of the stock, applying the parts as evenly and close as possible, and immediately tie the parts close together with a string of bass, passing closely several times round the stock and graft; then clay the whole over near an inch thick all round, from about half an inch or more below the bottom of the graft, to an inch above the top of the stock, finishing the whole coat of clay in a kind of oval form, closing it effectually about the scion, so that neither air nor water may penetrate. The clay must be examined from time to time, for should it crack much, or fall off, a quantity of fresh clay ought to be applied immediately. This sort of grafting may also be performed upon the young shoots of any bearing tree, if you wish to alter the kind of fruit or to have more kinds than one on the same tree. By the middle or latter end of May the graft will be well united with the stock, as will be evident from the shooting of the buds of the graft, when the clay should be removed; but the bass bandage should remain until the united parts seem to swell, and be too much confined, then the bandage should be taken off entirely.

117 Cleft-grafting.

Cleft-grafting is so called because the stock being too large for whip-grafting, is cleft or slit down the middle for the reception of the graft, and is performed in stocks from one to two inches diameter or upwards. First, with a strong knife take off the head of the stock with a sloping cut about an inch and a half long, then cleave the stock with a strong knife or chisel and mallet across the slope to the depth of about two inches, or long enough to admit the graft, leaving the instrument in to keep the cleft open. Prepare the scion by cutting it to such length as to leave four or five eyes, sloping the lower part of it on each side, wedge fashion, to the length of an inch and a half or two inches, making one edge very thin, and leaving the other much thicker with the bark on; then place it in the cleft at the back part

(B) Stocks which are raised from seed, generally grow more freely and vigorously than those raised from cuttings or layers, and on that account are called free stocks.

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If large ſtocks or branches are to be grafted in this way, they muſt be cut horizontally and ſmoothed, and may be cleft quite acroſs, and a graft inſerted on each ſide. More clefts indeed than one may be made, and two grafts put in each. This method of grafting may be performed on the branches or ſtems of old trees, with a view to produce vigorous branches or change the kind of fruit.

Towards the latter end of May or beginning of June the junction of the graft with the ſtock will be effectually formed, when the clay may be removed, and in a fortnight afterwards the baſs bandage may alſo be taken away.

118 Crown-grafting. Crown-grafting is commonly practiſed upon ſuch ſtocks as are too large to cleave, and is often performed upon the large branches of apple and pear trees, &c. that already bear fruit, when it is intended to change the ſorts, or ſupply the tree with a number of new vigorous branches. It is termed crown-grafting, becauſe, after the ſtock or branch has been cut over, ſeveral grafts are inſerted all around betwixt the wood and bark, ſo as to produce a crown-like appearance; this kind of grafting ſhould not be performed until March or early in April, for then the ſap being in motion renders the bark and wood of the ſtock much eaſier to be ſeparated for the admiſſion of the graft. The manner of performing this ſort of grafting is as follows: firſt cut off the head of the ſtock horizontally, and pare the top ſmooth; then having the grafts, cut one ſide of each flat, and ſomewhat ſloping, an inch and a half, forming a ſort of ſhoulder at the top of the ſlope to reſt upon the crown of the ſtock; after the bark of the ſtock has been raiſed by means of a wedge, ſo as to admit the ſcion between the bark and the wood, let the ſcion be thruſt down to the ſhoulder with its cut ſide next the wood of the ſtock: in this manner three, four, or more grafts may be inſerted into one ſtock or branch. After the grafts have been inſerted, let them be tied tight, and let the clay be applied ſo as to riſe an inch above the top of the ſtock, taking care to form it ſo as to prevent the admiſſion of water, which would injure the grafts. Crown-grafting may alſo be performed by making ſeveral clefts in the crown of the ſtock, and inſerting the grafts into the clefts. The grafts will be pretty well united with the ſtock by the end of May or beginning of June, when the clay and bandage may be taken away. The trees grafted by this method will ſucceed very well; but for the firſt two or three years the grafts are liable to be blown out of the ſtock by violent winds, to prevent which, long ſticks muſt be tied to the ſtock or branch, to which they may be fixed.

119 Cheek-grafting. Cheek-grafting is thus executed. Cut the head of the ſtock off horizontally, and pare the top ſmooth: then cut one ſide ſloping an inch and a half or two inches deep, and cut the lower part of the graft ſloping the ſame length, making a ſort of ſhoulder at the top of the ſloped part; it is then to be placed upon the ſloped part of the ſtock, reſting the ſhoulder upon the crown of it; bind it with baſs, and finiſh it with a covering of clay as in whip-grafting.

Side-grafting is done by inſerting grafts into the ſides of the branches without cutting them over, and may be practiſed upon trees to fill up any vacancy, or for the purpoſe of variety, to have ſeveral ſorts of apples, pears, plums, &c upon the ſame tree. It is performed thus. Fix upon ſuch parts of the branches where wood is wanted to furniſh the head or part of the tree; there ſlope off the bark and a little of the wood, and cut the lower end of the grafts to fit the part as near as poſſible, then join them to the branch and tie them with baſs, and clay them over. 120 Side-grafting.

Root-grafting. This is done by whip-grafting ſcions upon pieces of the root of any tree of the ſame genus, and planting the root where it is to remain; it will take root, draw nouriſhment, and feed the graft. 121 Root-grafting.

Grafting by approach, or inarching, is preferred when the ſtocks deſigned to be grafted, and the tree from which the graft is intended to be taken, either grow ſo near, or can be placed ſo near together, that the branch or graft may be made to approach the ſtock, without ſeparating it from the tree till after its union or junction with the ſtock, ſo that the branch or graft being bent to the ſtock they together form a ſort of arch, whence it is called grafting by approach or inarching. It is commonly practiſed upon ſuch trees as are with difficulty made to ſucceed by any of the former ways of grafting. When intended to propagate any kind of tree or ſhrub by this method of grafting; if the tree be hardy enough to grow in the open ground, a proper quantity of young plants for ſtocks muſt be ſet round it, and when grown of a proper height, the work of inarching muſt be performed; if the branches of the tree you intend to take grafts from be too high for the ſtocks, in that caſe the ſtocks planted in pots, muſt be placed on a ſlight ſtage or ſome ſupport of that nature, of ſuch a height as to make them reach the branches. Inarching is ſometimes performed with the head of the ſtock cut off, ſometimes it is allowed to remain; when the head of the ſtock is cut off, the work is more eaſily performed, and is generally more ſucceſsful, becauſe the ſtock having no top of its own to ſupport, will tranſmit all the nouriſhment taken up by its roots into the graft; when the ſtocks are properly placed, make the branches approach to them, and mark on the branches the places where they will moſt eaſily join to the ſtock, and in thoſe parts of each branch, pare away the bark and part of the wood two or three inches in length, and in the ſame manner pare the ſtock at the proper place; then make a ſlit upwards in the branch ſo as to form a ſort of tongue, and make a ſlit downwards in the ſtock to admit it; let the parts be then joined, ſloping the tongue of the graft into the ſlit of the ſtock ſo as to make the whole join in an exact manner; then tie them cloſe together with baſs, and afterwards cover the whole with a proper quantity of clay, as before directed in the other methods. After this, let a ſtout ſtake be fixed for the ſupport of each graft, to which the ſtock and graft may be fixed, to prevent their being disjoined by the wind. If this operation be performed in ſpring, the graft and ſtock will be united in four months, when the branch may be ſeparated from the parent plant; this ſhould be done cautiouſly and with a ſharp knife, leſt the graft ſhould 122 Inarching.

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be shaken and loosened from the stock. If the head of the stock were not removed previous to inarching, it should now be cut off close to the insertion of the graft, and all the old clay and bandages should be taken away and replaced with new, which should be allowed to remain a few weeks longer. If the graft and stock do not seem perfectly united the first autumn after they have been inarched, they should be allowed to stand till next autumn: for were the branch to be cut off from the parent plant before a complete union was formed between it and the stock, the operation would prove abortive.

123 A new method.

An anonymous author has given, in a treatise published at Hamburgh under the title *Amœnitates Hortenses Novæ*, a new method of grafting trees, so as to have very beautiful pyramids of fruit upon them, which will exceed in flavour, beauty, and quantity, all that can otherwise be produced. This he says he had long experienced, and gives the following method of doing it. The trees are to be transplanted in autumn, and all their branches cut off: early in the following summer the young shoots are to be pulled off, and the buds are then to be engrafted into them in an inverted position. This he says, not only adds to the beauty of the pyramids, but also makes the branches more fruitful. These are to be closely connected to the trunk, and are to be fastened with the common ligature; they are to be placed circularly round the tree, three buds in each circle, and these circles at six inches distance from each other. The old trees may be grafted in this manner, the success having been found very good in those of twenty years standing; but the most eligible trees are those which are young, vigorous, and full of juice, and are not above an inch or two thick. When these young trees are transplanted, they must be fenced round with pales to defend them from the violence of the wind. The buds engrafted must be small, that the wounds made in the bark to receive them, not being very large, may heal the sooner; and if the buds do not succeed, which will be perceived in a fortnight, there must be others put in their place. The wound made to receive these buds must be a straight cut, parallel to the horizon, and the piece of bark taken out, must be downwards that the rain may not get in at the wound. In the autumn of the same year this will be a green flourishing pyramid, and the next summer it will flower, and ripen its fruit in autumn.

124 Extreme branch-grafting.

Mr Fairman, of Kent, gives an account of a method of renewing decayed trees, by what he calls extreme branch-grafting, which has been published in the Memoirs of the Society of Arts for 1802. It is addressed to the Secretary.

"Sir,

"From much conversation with Mr Bucknall, on the idea of improving standard fruit trees, we could not but remark that in apple orchards, even in such as are most valuable, some were to be seen that were stinted and barren, which not only occasioned a loss in the production, but made a break in the rows, and spoiled the beauty and uniformity of the plantation.

"To bring these trees into an equal state of bearing, size, and appearance, in a short time, is an object of the greatest importance in the system of orcharding, and also for the recovery of old barren trees, which are fallen into decay, not so much from age as from the sorts of their fruits being of the worn out, and deemed nearly lost, varieties.

"Having long entertained these thoughts, and been by no means inattentive to the accomplishment of the design, I attempted to change their fruits by a new mode of engrafting, and am bold enough to assert that I have most fortunately succeeded in my experiments; working, if I am to be allowed to say it, from the errors of other practitioners, as also from those of my own habits.

"My name having several times appeared in the Transactions of the Society for the encouragement of Arts, &c.; and having the honour of being a member of that Society, I thought no pains or expence would be too much for the completion of so desirable an improvement. Under these impressions, and having many trees of this description, I made an experiment on three of them in March 1798, each being nearly a hundred years old. They were not decayed in their bodies, and but little in their branches. Two of these were golden pippins, and the other was a golden rennet: each had likewise been past a bearing state for several years. I also followed up the practice on many more the succeeding spring, and that of the last year, to the number of forty at least, in my different plantations (c).

"The attempt has gone so far beyond my utmost expectation, that I beg of you, Sir, to introduce the system to the society for their approbation; and I hope it will deserve the honour of a place in their valuable Transactions.

"I directed the process to be conducted as follows: cut out all the spray wood, and make the tree a perfect skeleton, leaving all the healthy limbs; then clean the branches, and cut the top of each branch off, where it would measure from an inch to two inches in diameter. Some of the branches must of course be taken off, where it is a little larger, and some smaller, to preserve a head or canopy of the tree; and it will be necessary to take out the branches which cross others, and observe the arms are left to fork off; so that no considerable opening is to be perceived when you stand under the tree, but that they may represent a uniform head. I must here remark to the practitioner, when he is preparing the tree as I directed, that he should leave the branches sufficiently long to allow of two or three inches to be taken off by the saw, that all the splintered parts may be removed.

"The trees being thus prepared, put in one or two grafts at the extremity of each branch; and from this circumstance I wish to have the method called *extreme branch grafting*. A cement, hereafter described, must be used instead of clay, and the grafts tied with bass or soft string. As there was a considerable quantity of moss on the bodies and branches of the trees, I ordered my gardener to scrape it off, which is effectually done when they are wet, by a stubbed birch broom. I then ordered

(c) The average expence I calculated at 2s. 6d. each tree.

February. Nursery.

ordered him to brush them over with coarse oil, which invigorated the growth of the tree, acted as a manure to the bark, and made it expand very evidently; the old cracks were soon, by this operation, rendered invisible.

"All wounds should be perfectly cleaned out, and the medication applied, as described in the Orchardist, p. 14. By the beginning of July the bandages were cut, and the shoots from the grafts shortened, to prevent them from blowing out. I must here, too, observe, that all the shoots, or suckers from the tree, must enjoy the full liberty of growth till the succeeding spring, when the greater part must be taken out, and few but the grafts suffered to remain, except on a branch where the grafts have not taken; in that case leave one or two of the suckers, which will take a graft the second year, and make good the deficiency. This was the whole of the process (D).

"By observing what is here stated, it will appear that the tree remains nearly as large when the operation is finished, as it was before the business began; and this is a most essential circumstance, as no part of the former vegetation is lost, which is in health fit to continue for forming the new tree. It is worthy of notice, that when the vivifying rays of the sun have caused the sap to flow, these grafts, inducing the fluid through the pores to every part of the tree, will occasion innumerable suckers or scions to start through the bark, which, together with the grafts, give such energy to vegetation, that, in the course of the summer, the tree will be actually covered over by a thick foliage, which enforces and quickens the due circulation of sap. These, when combined, fully compel the roots to work for the general benefit of the tree.

"In these experiments, I judged it proper to make choice of grafts from the sorts of fruits which were the most luxuriant in their growth, or any new variety, as described in the 17th and 18th volumes of the Society's Transactions, by which means a greater vigour was excited; and if this observation is attended to, the practitioner will clearly perceive, from the first year's growth, that the grafts would soon starve the suckers which shoot forth below them, if they were suffered to remain. With a view to accomplish this grand object of improvement, I gave much attention, as I have observed before, to the general practice of invigorating old trees; and I happily discovered the error of the common mode of engrafting but a short distance from the trunk or body. There the circumference of the wounds is as large as to require several grafts, which cannot firmly unite and clasp over the stumps, and consequently these wounds lay a foundation for after decay. If that were not the case, yet it so reduces the size of the tree, that it could not recover its former state in many years, and it is dubious if it ever would; whereas, by the method of extreme grafting, the tree will be larger in three or four years, than before the operation was performed. For all the large branches remaining, the tree has nothing to make but fruit-bearing wood; and from the very beautiful verdure it soon acquires, and the symmetry of the tree, no argument is necessary to enforce the practice. Some of the trees, done in this way, yielded each two bushels of apples from the third year's wood.

February. Green-house and Hot-house.

Cement for Engrafting.

One pound of pitch,
One pound of rosin,
Half a pound of beeswax,
A quarter of a pound of hog's lard,
A quarter of a pound of turpentine;

to be boiled up together, but not to be used till you can bear your finger in it."

SECT. V. *Green-house and Hot-house.*

THE same care of the green-house is required during this month which was recommended in January. If severe frost, or very wet weather prevails, the glasses must be kept close during the day to exclude the frost and damp, or slight fires may be had recourse to for this purpose.

In mild weather the glasses must be opened during the day to admit air, and water must be given to the plants regularly, though sparingly. Towards the end of the month it will be proper to remove a little of the earth from the surface and sides of the boxes or pots, and to replace it with some fresh compost. If any of the orange trees, myrtles, or plants of that nature, have irregular heads, they may be cut so as to cause them to throw out a number of new branches to fill up any vacant places, or form an entirely new head. If they require to be much pruned, or to be cut over altogether, it would be proper to shift them at the same time, i. e. to remove them from the box or pot in which they have stood with the ball of earth about their roots, part of which, together with any matted roots, should be pared off from the sides and bottom, and replaced in the boxes and pots, with a proper addition of fresh earth. Any of the plants which are to undergo this operation, that are very sickly, should have almost the whole of the earth removed from their roots, and ought, for some time after shifting, to stand in a bark-bed. 125 Air to be admitted.

If the bark-bed in the pine stove received no fresh tan or turning last month, it should be examined as early as convenient; and if the heat should have at all declined, it ought immediately to be turned or have an addition of fresh tan, as directed last month. See JANUARY. 126 Pine stove.

If a lively heat be not kept up in the bark bed now, when the plants shew flower, the size of the future fruit will be considerably affected. A proper degree of warmth, applied to the roots of the plants, will make them grow vigorously and produce large fruit. The heat of the air of the house must be kept at a proper temperature, by due attention to the fires every night and morning, and even during the day in frosty weather, or when cold winds prevail. The bark bed, in which the succession pine-apple plants grow, should be examined; and if the heat in it begins to decline, it ought

(D) The system succeeds equally well on pear, as also on cherry trees, provided the medication is used to prevent the cherry tree from gumming.

March. Kitchen Garden.

ought to be turned or receive an addition of fresh tan. When the sun shines bright, and the weather is moderate, air must be given by opening some of the glasses. Water should be given regularly both to the pine apple and other plants in the hot-house, but much should not be given at a time.

127 Kidney beans to be watered. The kidney beans that were sown last month should receive water frequently. If none were sown last month, some of the early dwarf kinds may be sown now.

128 Cucumbers sown. If no cucumbers were sown last month in the hot-house, some may be sown now; or, plants raised in hot-beds may be introduced, and placed in any convenient situation near the glass.

MARCH.

Sect. I. *Kitchen Garden.*

We need not here give a detailed account of the methods of performing many of the things mentioned under this head, in the two preceding months, though most of them might be performed now with better prospect of success, as this is the principal month in the year for

129 Sow full crops. sowing and planting full crops of the greater part of kitchen-garden vegetables. We shall, therefore, merely enumerate them. Make hot-beds. Sow cucumbers and melons. Transplant and sow cauliflower. Transplant and sow cabbage. Transplant and sow lettuce. Sow spinach, onions, leeks, radishes, carrots, parsnips, beets, beans, peas, turnips, celery, small salad, parsley, salsafy, and Hamburgh parsley. Plant shallot, garlic, scorzonera, and rockambole.

130 Brocoli. Some seed of the early purple and cauliflower brocoli should be sown, both about the beginning and towards the end of the month, in a bed of rich earth, in an open situation, to raise plants to be fit for the table the following autumn. For the subsequent management, see April, May, June, and July.

131 Sea cabbage. The seeds of the sea cabbage (*crambe maritima*) may be sown any time this month, in narrow beds of light earth, about four feet wide, for the convenience of weeding. They may either be sown all over the surface of the bed, tolerably thick, when they are to be transplanted, or in drills a foot and a half or two feet apart, where they are to remain. Those plants are perennial, and every year push up thick succulent shoots. They should be covered, some time during the course of the winter, with dry earth, to the depth of a few inches, by which the young shoots, as they come up in spring, are blanched and become fit for use. They should be cut as soon as they appear above ground, or very soon after, in the manner of asparagus.

132 Coleworts. Sow brown and green cole, or bore cole.

Any time in the course of the month some seeds of brown and green cole (kale) may be sown in an open situation, for when they are shaded they are apt to grow up tall and weak. The plants raised now will be fit for planting out in summer, and may be cut for use any time from autumn to spring.

133 Asparagus. About the beginning of this month asparagus seed may be sown in narrow beds of good earth in an open situation. The seed may be scattered regularly all over the surface of the bed, raked in, and then receive a slight covering of earth from the alleys, or in drills, about an inch deep, at the distance of six inches from one another. The plants will appear above ground in four or five weeks, when they ought to be kept clear of weeds, and watered occasionally during dry weather. The plants raised now will be fit for transplanting next spring into beds, where they are to remain and produce crops, or into plots, to remain for a year or two till they be fit for forcing.

This is a proper season for making plantations of asparagus, for which purpose young plants of one or two years old are commonly used. They succeed best in a deep light soil, and in an exposed situation. The ground should be well manured, dug to the depth of 12 or 15 inches, and divided into beds of the breadth of four feet and a half, in which the asparagus may be planted in rows, 10 or 12 inches apart, and about the same distance from each other in the rows. The usual mode of planting them is to stretch a garden line along the bed, and to form a drill with a spade, to the depth of about six inches, in which the asparagus roots are placed with their crowns or buds uppermost. 134 Asparagus to be planted

A crop of onions may be sown in beds when it is an object to make the most of the ground.

The surface of asparagus beds should be loosened or turned over with a fork, in the course of this month. 135 dressed. The instrument commonly made use of for this purpose, is a fork with three flat blunt prongs. Care must be taken not to dig too deep, lest the tops of the asparagus roots should receive injury. Immediately after the surfaces of the beds have been loosened, they should be raked over; for if the raking were to be deferred for some time till the buds of the asparagus approach the surface of the ground, they might be broken by the teeth of the rake. Asparagus beds will continue to produce good crops for 10 or 12 years, if properly managed. They ought not to be cut till the third or fourth year after they have been planted in rich soils; however, a few of the strongest shoots may be cut even in the second, but it should be done sparingly. When asparagus has advanced to the height of three or four inches above ground, it should be collected for the table; but as the shoots are commonly cut about three inches under the surface of the ground, care must be taken not to injure the rising buds (for several buds rise in succession from the same root), for this reason, it is commonly cut with an instrument made on purpose, called an *asparagus knife*, which should be introduced close by the shoot to the requisite depth, and directed so as to cut it off obliquely.

Artichoke plants, that were earthed up during winter to protect them from frost, should now be examined; and if their stems appear to push up vigorously, the earth ought to be removed and levelled. 136 Artichokes dressed, and The soil should likewise be loosened from the plants, and if many shoots proceed from the same root, they should all be taken away except three of the strongest. The redundant shoots, if carefully detached from the main roots, may be employed to form new plantations; the earth, therefore, should be so far removed as to allow the hand to be introduced to slip them close to their insertion.

Plantations of young artichokes are made towards the end of this or in the course of next month, as soon, indeed, as the offsets (the only way in which this plant is propagated) can be procured. 137 planted. For this purpose choose a plot of good ground, dig in a good quantity of of rotten dung, and plant the offſets with a dibble after their tops and roots have been trimmed a little (if it appear neceſſary), in rows about four feet and a half aſunder, and at the diſtance of from two to three feet in the rows. A crop of ſpinach, lettuce, radiſhes, &c. may be got from the ground the firſt year, without injuring the artichokes. This plantation will produce heads in September and October, and will continue to produce plentiful crops for ſix or ſeven years. Whenever artichokes are required late in the ſeaſon, young plantations ought to be formed every year, as it is from them alone that heads may be expected late in autumn; for the old plantations generally produce them in June, July, and Auguſt. There are two ſorts, the large globe, and the French or green oval artichoke; the former is commonly preferred, on account of the ſize of the head and the quantity of eatable matter they afford.

138 Pot-herbs propagated. Slips or cuttings of ſage, rue, roſemary, hyſſop, thyme, and ſavory, may be planted any time this month. They ſhould be planted about ſix inches apart, and to the depth of nearly two-thirds of their length. By next autumn they will be fit for tranſplanting.

139 Sow ſkirrets, Some ſeeds of ſkirrets may be ſown in narrow beds, in an open ſituation, either in drills ſix inches aſunder, or regularly over the ſurface of the bed. After the plants have come above ground, they ſhould be thinned out to the diſtance of about ſix inches from one another, and allowed to remain in the place where ſown. This plant is frequently propagated by offſets taken from old roots, which ſhould be planted at the diſtance of ſix or eight inches from one another.

140 kidney beans, About the end of the month, if the weather be mild and dry, a few early kidney-beans may be ſown in a well ſheltered ſituation, at the foot of a wall, having a ſouth expoſure. See April. But as theſe plants are tender, they are liable to be injured by cold weather, therefore a ſmall quantity only ſhould be ſown now.

141 and cardoons. About the middle or latter end of the month ſome cardoons may be ſown for tranſplanting. For this purpoſe a piece of light ground ſhould be well dug, the ſeed ſown thinly, and raked in evenly; a few weeks after the plants have come up, they ſhould be thinned out to the diſtance of about ſix inches from one another, to allow them room to grow till they are ſtrong enough to be planted out, which will be in June. See June. They may be ſown likewiſe in rows five feet aſunder, and at the diſtance of four feet from each other in the row, and allowed to remain where ſown. They are biennial, grow to the height of three or four feet, and are cultivated for the ſake of the footſtalks of their leaves, which are blanched by being earthed up ſomewhat in the manner of celery, on which account they require a good deal of room.

142 Plant chives, This is a proper time to plant chives, a ſmall ſpecies of onion, which is uſed in ſpring as a ſubſtitute for young onions. They grow in large tufts, and are propagated by parting the roots into ſmall tufts containing eight or ten bulbs, which may be planted with the dibble in beds or rows at the diſtance of ſix or eight inches from one another.

143 Jeruſalem artichokes, You may now plant Jeruſalem artichokes, a ſpecies of ſunflower (*helianthus tuberoſa*) the roots of which ſomewhat reſemble the potato, and are to be planted much in the ſame manner to the depth of about four inches, in rows three feet apart, and about half that diſtance from each other in the row. They are fit for the table in October, and continue good all winter and ſpring.

A full crop of potatoes may be planted any time towards the end of this or in the courſe of next month. 144 potatoes, Cuttings of moderate-ſized potatoes (of the variety intended to be planted), each containing one or two eyes at leaſt, may be put in with a blunt dibble, to the depth of about four inches, in rows two feet apart, and at the diſtance of about a foot from each other in the row, or in trenches or holes made with the ſpade. In the fields they are planted either with the dibble or in furrows made by the plough. See Agriculture. They ſucceed beſt in light ſoil, which ſhould be well manured. After they have come above ground, they ought to be kept clear of weeds, and have a quantity of earth drawn up about their ſtems. There are many varieties of this vegetable, which are obtained from ſeed; the principal are, early dwarf, champion, large round white, oblong red and white kidney, common kidney, ſmall white kidney, round red, large round dark red, &c.

Any time in the courſe of this month new plantations of mint may be formed. 145 and mint. This plant is propagated by parting the roots or by cuttings of the young ſtalks; the former is practiſed this month, the latter in next and following month. Procure a quantity of the roots from an old plantation of mint; part and plant them in rows ſix inches aſunder, and about the ſame diſtance from each other in the row, either with the dibble, or in drills about an inch deep, drawn by the hoe. Theſe plants ſucceed very well in any ſoil, but prefer a moiſt one. The kinds commonly cultivated are ſpearmint, peppermint, orangemint, &c.

The leaves and flowers of Indian creſſes are frequently uſed in ſalads, and their ſeeds for pickling. 146 Sow Indian creſſes, The ſeeds may be ſown about the beginning of the month, at the diſtance of two or three inches from each other, in drills, about an inch deep. If they are not ſown along ſide of a hedge or other ſupport, they may have ſticks placed beſide them like peas after they have come above ground. There are two kinds, the large, and dwarf; the former is generally preferred.

Seeds of baſil, love apple (or *tomatoes*), and capſicum, 147 baſil, &c. may be ſown any time this month. They are tender annuals, and muſt be ſown in a hot-bed, to be afterwards planted out in the open ground in May; they muſt be managed like other tender annuals. See *Flower Garden*. Baſil is uſed in ſoups and ſalads, and muſt be ſown in very dry earth, otherwiſe the ſeeds will rot. Love apples are uſed in ſoups and for pickling. The capſicum, of which there is great variety, is uſed as a pickle, and for ſeaſoning. The principal kinds are the long-podded, heart-ſhaped, bell-ſhaped, angular-podded, round ſhort-podded, cherry-ſhaped, &c.

Sow cucumbers and melons, to be planted out under 148 cucumbers and melons. hand or bell-glaſſes.

Some cucumber and melon ſeed may be ſown towards the end of this month, in any of the beds already employed; or one may be formed on purpoſe to raiſe plants to be reared under bell or hand-glaſſes. Thoſe ſown now will be fit for ridging out in the beginning of May. See May.

March. Fruit Garden, &c.

Sect. II. *Fruit Garden.*

149 Trees pruned, All kinds of fruit trees mentioned under this head last month may be pruned now, though it ought to be performed as near the beginning of the month as possible; for if the weather has been mild during the preceding month, many of the trees will have advanced too far to be in a state proper for pruning. Figs, however, on account of the late period at which they begin to push, may be safely pruned; indeed this is the best season for pruning them.

150 planted, Fruit trees may still be planted, though the earlier in the month the better; for if mild weather prevails, the buds of the trees will have advanced so far before the end of the month, as to render transplanting less safe. For the method, see October. The duration of the planting season depends more on the mildness and severity of the weather than the time of the year.

151 protected in flower, When apricot, nectarine, and peach trees are in flower, they should be protected during frost with large garden-mats fixed to the top of the walls by hooks, and fastened at the bottom to prevent them from being agitated by the wind so as to dash off the blossoms. These mats must be removed during the mildest part of the day, unless when the weather is very severe, and without sunshine. Instead of mats, old fish-nets doubled may be used for this purpose, and need not be removed during the day; a number of small branches of evergreens (well clad with leaves) fixed among the branches of the trees in flower, will also afford shelter to the blossom and setting fruit.

Dress strawberry beds, if not done last month. See February.

152 and forced. Fruit trees on hot walls, in peach, cherry, and vine-houses, must be duly attended to, must receive air and water regularly, and have the fires put on every evening and cold morning.

Sect. III. *Flower Garden and Pleasure Ground.*

153 Transplant early annuals. If any early annuals, such as balsams, cockscombs, &c. were sown last month, they will be fit for planting out into small pots or a hot-bed prepared for the purpose. This hot-bed should be raised to the height of two feet; and when the violent heat has subsided, covered over to the depth of six inches with rich dry earth. The plants may be put in at the distance of three or four inches from one another, or rather in small pots, because from these they can be more easily removed into larger ones at a subsequent period. Due attention must be paid to give them water and air when requisite; and linings of fresh dung must be applied to the bed whenever the heat begins to decline. If properly taken care of, they will be fit for final transplantation in May or June.

If no tender annuals were sown in February, some may be sown any time this month.

Sow less tender or half-hardy annuals, such as China aster, Indian pink, capsicum, French and African marigold, chrysanthemum, tree and purple amaranthus, and Chinese hollyhocks.

154 Sow tender and hardy annuals. Form a slight hot-bed any time this month, which need not be raised higher than two feet, and earth it over to the depth of about six inches. The seed may be sown in narrow drills, at the distance of two or three inches from one another, and each kind, separately or in pots, plunged in the earth of the bed. After the plants have come up, they will require plenty of free air and moderate watering; and when they have acquired the height of two or three inches, they must be gradually hardened to bear the open air, by taking the lights entirely off in mild warm days. Instead of hot-bed frames and lights, oil-paper frames, or hand-glasses, may be made use of. The plants raised now will be fit for transplanting into the flower border in May. If hardy annuals were not sown last month, they may be sown any time during the present.

155 Management of chrysanthemums and auriculas. Cuttings of double chrysanthemums which were planted last autumn in pots or boxes, should be planted out into pots or flower borders if mild weather prevails. Auricula plants in pots should be protected from rain and frost, and should still be kept covered with hooped arches, over which mats may be occasionally thrown, for should they be exposed to much rain or severe weather now when their flower-stalks begin to advance, the future bloom might be injured. Keep the pots clear of weeds, and give them a little water in dry weather, or expose them to a gentle shower. If the pots received no fresh earth last month, let them receive some now.

156 hyacinths, &c. Let the hoops mentioned the two preceding months still continue over the beds of tulips, hyacinths, ranunculus, &c. for if severe weather occurs, the beds must be protected by a covering of mats, as already mentioned. See January. When the stalks of hyacinths, particularly double ones, have advanced almost to their full height, they are apt to be borne down by the weight of their own flowers, therefore a neat small stick ought to be fixed in the ground close to every plant, to which the flowerstalks should be fastened by a piece of bass or other soft ligature.

157 ranunculus, and anemones. Ranunculuses and anemones may still be planted; they will succeed the early ones, and flower in June and July.

158 Sow biennials, &c. Towards the end of the month, seeds of biennial and perennial flowers may be sown, such as carnations, pinks, sweetwilliams, wallflowers, and stock julyflowers of all sorts, also rose campion, catchfly, scarlet lychnis, columbines, Greek valerian, polyanthus, auriculas, scabiouses, and Canterbury bells; likewise hollyhocks, French honeysuckles, rockets, honesty or satin flower, tree primrose, shrubby mallow, broad-leaved campanula, foxglove, snapdragon or frogsmouth, &c.

Biennial and perennial plants may likewise be transplanted at this season.

159 Plant trees and shrubs. Trees and shrubs, both deciduous and evergreen, may still be planted; but that work should be finished before the end of the month.

March. Nursery.

Sect. IV. *Nursery.*

160 Ingrafting and treatment of trees budded last year. Fruit trees, elms, &c. may be engrafted; and the shoots of trees engrafted last year should be so shortened about the time their buds begin to swell, as to leave four or five buds, which will push out branches to form a head. The shoots of last year's growth of trees budded the preceding summer should likewise be shortened, and the heads of trees budded last summer should be cut off about four inches above the bud, which will cause

March. Nursery.

161 Sow feeds of trees, &c.

cause it to push out vigorously. The part of the stock which is left will serve as a support, to which the young branch may be fixed in the course of the summer to prevent it from being blown out by the wind.

Seeds of hardy trees and shrubs may be sown any time this month, in beds three or four feet wide, which should be well dug, and thoroughly pulverised. The seed may be sown either regularly over the surface of the bed or in drills, and covered in proportion to their size; the acorns and other large seeds to the depth of from an inch and a half to two inches, and the smaller ones from about half an inch to an inch. Some of the more delicate shrubs, such as the arbutus, &c. may be sown in pots or boxes, by which means they will be more easily protected from the severity of the weather in winter.

162 Propagate by cuttings.

Most kind of trees and shrubs may be propagated by cuttings this month, particularly vines.

The vine cuttings must be shoots of last year's growth, about ten or twelve inches long, and each furnished with three buds. If cut from the vines during the winter, before the sap begins to rise, and preserved in dry earth, they will succeed the better. Some leave about an inch of the former year's wood attached to each cutting, but this is unnecessary. They may be planted in rows a foot and a half asunder, and at the distance of eight or ten inches from each other in rows, and so deep as to leave only their uppermost bud above ground; they should afterwards be occasionally watered, and kept clear of weeds. Though cuttings of vines may be raised in the open air, much better plants may be obtained by striking them in a hot-bed or tan-pit in a hot-house. At pruning season select some well-ripened shoots, cut them into pieces of a convenient length, and insert them a little way into pots filled with dry earth, where they may remain till wanted for planting. Protect them in severe, but in mild weather, expose them to the free air. About the beginning of this month, if there is no room in the hot-beds already made, prepare one on purpose, which may be formed and earthed over exactly like a seed-bed for melons. See JANUARY. Fill a number of pots, about four inches deep, corresponding to the cuttings you mean to plant, with light rich earth. Take the cuttings you have preserved during the winter; select the roundest and fullest buds; cut the branch about a quarter of an inch above, and about three inches below the bud, with a sharp knife, so as to make a smooth cut, and insert each close by the side of the pot, so deep, that the bud may be covered about a quarter of an inch by the earth of the pot; for it is alleged, that a cutting strikes with greater freedom when placed close to the side than in the middle of the pot. When plants are raised in this manner from a single bud, they seem as if reared from seed. As soon as the cuttings are planted, plunge the pots into the earth of the bed, give them a gentle watering, and put on the glasses. Attention must be paid to the bed, to see that the heat be not too strong, for a moderate bottom heat is all that is necessary. Air should be freely admitted during the day, and even during the night, in mild weather; but when the weather is cold, the beds should be covered with mats during the night, to protect them from frost. The cuttings should likewise be shaded when the sun shines very bright, with mats, and should receive occasional watering. When the plants are about six or eight inches high, they will require to be shifted into larger pots, which must be done cautiously for fear of injuring their roots. Take pots of about six inches deep, and about the same width; put a little good earth into the bottom of each, and turn the cutting out of the small pot into it with the ball of earth as entire as possible, and fill it up with earth. The frames of the beds should be raised in proportion as the plants increase in height, and the heat of the bed renewed by linings of fresh dung when on the decline. Support the shoots when they are about ten or twelve inches high, and pinch off the tendrils and lateral shoots as soon as they appear. They will be fit for planting out in the end of June or beginning of July.

April. Kitchen Garden.

163 Water feedlings.

When dry weather prevails, give gentle waterings to seedling trees and shrubs, and keep them free from weeds.

SECT. V. *Green-house and Hot-house.*

164 Air to be freely admitted.

THE plants in the green-house should receive air freely, unless during wet or frosty weather, and more frequent and plentiful waterings than in the two former months. Dead branches or decayed leaves should be removed, and any of the larger leaved plants that appear foul should have their leaves cleaned with a wet sponge. Those also which require shifting or pruning may be managed as directed last month. Sow seeds and plant cuttings of green-house plants; for which purpose a hot-bed or tan-pit of a hot-house will be necessary at this season.

165 Treatment of pine apples.

Pine apple plants will require a good deal of warmth, particularly in the tan-pit; as their fruit will now be considerably advanced, they must therefore be kept in a vigorous state of growth, to secure large fruit. If the heat of the tan-bed be not very great, at least one-third of new tan ought to be added. After the tan has been procured, it ought to be spread out and dried a little, and then laid up in a heap, in some shade adjacent to the hot-house, till it begin to ferment. The plants should then be taken from the tan-bed, and a quantity of the decayed tan removed from its surface and sides, to make room for the new, which must be thoroughly mixed with the old; and, as this operation ought to be completed in the course of one day, a sufficient number of hands should be employed to effect it. Both pine apples and other plants in the hot-house should be regularly watered, and have fresh air admitted in bright calm days, from about two hours before till two or three after noon.

APRIL.

SECT. I. *Kitchen Garden.*

166 Management of cucumbers and melons.

IF the heat begin to decline in the cucumber and melon beds, they should receive linings as directed in the former months; for these plants will not yield fine fruit, or a plentiful crop, if the beds are destitute of a proper heat. Air must be admitted every day, and a moderate watering given every four or five days, particularly to cucumbers; but melons should receive it sparingly, especially when their fruits are setting, as much water at that time would prove injurious, and make the fruit drop off. Keep the plants clear of all decayed leaves

April. Fruit Garden.

leaves and decayed male flowers. When the ſun ſhines ſo bright as to cauſe the leaves of cucumbers and melons to flag, it will be proper to ſhade them for two or three hours, during its greateſt heat, with a thin mat or a little looſe hay, ſtrewed thinly over the glaſſes.

Make hot-beds on which to ridge out cucumbers or melons under hand glaſſes or oiled paper frames. See MAY.

167 Plant lettuce,

Sow ſome cabbage, Cilicia, imperial, and large admirable cabbage lettuces any time this month; indeed, ſome ought to be ſown about the beginning, middle, and towards the end of the month, to ſecure a regular ſucceſſion. Should the lettuces that were ſown laſt month or in February ſtand too thick, they may be thinned out and tranſplanted at the diſtance of about ten inches from each other, and watered occaſionally till they take root.

168 kidney beans.

Some early kidney beans, viz. the Batterſea, ſpeckled, dun-coloured, and Canterbury dwarfs, may be planted towards the end of the month, in a well-ſheltered ſituation, expoſed to the ſouth, in drills two feet or two feet and a half aſunder, and about two inches from each other in the drills. The tall running kinds ſhould not be planted till next month.

169 Tranſplant cabbages, &c.

Some of the cabbage and ſavoy plants, which were ſown in February and March, ſhould be thinned and tranſplanted, when their leaves are about two inches broad, into beds, to gain ſtrength before their final tranſplantation; and thoſe which have ſtood the winter may be planted out for good.

170 cauliflowers,

Cauliflower plants under bell or hand glaſſes ſhould have ſome earth drawn up about their ſtems, and ſhould be expoſed to the open air during the day in good weather. Thoſe ſown laſt month ſhould be planted out into beds in the open air, or into ſlight hot-beds, to forward their growth. Some of the ſtrongeſt of the plants raiſed in the early part of ſpring may be planted out at the end of the month, at the diſtance of two or two feet and a half each way from one another, and ſhould be occaſionally watered till they are well rooted.

171 brocoli,

Young plants of brocoli, which were ſown laſt month, may be planted out at the diſtance of two or three inches from one another, to acquire ſtrength for final tranſplantation; and ſome ſeed of the early purple, late purple, and cauliflower brocoli, may be ſown to raiſe plants for tranſplanting in June. Some plants of laſt year's ſowing, which produced heads this ſpring, ſhould be allowed to remain for ſeed, which will ripen in Auguſt.

SECT. II. *Fruit Garden.*

172 Tranſplant and prune,

IN late ſeaſons, pear, plum, and cherry trees may ſtill be planted, and even apricot, peach, and nectarine; but it ſhould be done as early in the month as poſſible, for if any of theſe have advanced much in growth before they are tranſplanted, they will not puſh freely in the courſe of the ſummer, and will be liable to be injured by drought. Where pruning has been neglected, it may ſtill be done, but the ſooner the better, for many fruit trees will now be in flower.

173 and protect fruit trees.

Fruit trees in flower ſhould ſtill be protected in cold weather. See MARCH. All ill-placed ſhoots ſhould be rubbed off, and the young fruit on apricot trees where ſet too thick ſhould be thinned.

April. Fruit Garden.

174 Dreſs vines.

Look over the vines trained on walls about the end of the month, and rub off the young ſhoots which proceed from the old wood, unleſs they happen to be ſituated where a ſupply of young wood is wanted; likewiſe where two ſhoots proceed from the ſame eye on branches of of laſt year's growth, let the weakeſt be rubbed off. Stakes ſhould be placed beſide the vines in the vineyard, to which they ſhould be tied, and the ground between the rows ſhould be kept perfectly free from weeds.

175 Hiſtory of the vine.

The vine was introduced by the Romans into Britain, and appears formerly to have been very common. From the name of vineyard yet adhering to the ruinous ſites of our caſtles and monaſteries there ſeem to have been few in the country but what had a vineyard. The county of Glouceſter is particularly commended by Malmſbury in the twelfth century, as excelling all the reſt of the kingdom in the number and goodneſs of its vineyards. In the earlier periods of our hiſtory the iſle of Ely was expreſsly denominated the *Iſle of Vines* by the Normans. Vineyards are frequently noticed in the deſcriptive accounts of Doomſday; and thoſe of England are even mentioned by Bede as early as the commencement of the eighth century.

Doomſday book exhibits to us a particular proof that wine was made in England during the period preceding the conqueſt. And after the conqueſt, the biſhop of Ely appears to have received at leaſt three or four tuns annually, as tythes from the produce of the vineyards in his dioceſe, and to have made frequent reſervations in his leaſes of a certain quantity of wine for rent. Dr Thomas, the late dean of Ely, gives the following extracts from the archives of that church.

	£.	s.	d.
Exitus vineti - -	2	15	3¼
Ditto vineæ - -	10	12	2½
Ten buſhels of grapes from the vineyard	0	7	6
Seven dolia muſti from the vineyard, 12th Edward II. - -	15	1	0
Wine ſold for - - -	1	12	0
Verjuice - - -	1	7	
One dolium and one pipe filled with new wine, and ſuppoſed at Ely. For wine out of this vineyard -	1	2	2
For verjuice from thence. -	0	16	0
No wine but verjuice made, 9th Edward IV.			

From theſe extracts it appears that Ely grapes would ſometimes ripen, and the convent made wine of them; and ſometimes not, and then they converted them into verjuice. Maddocks in his hiſtory of the Exchequer, i. 364, ſays that the ſheriffs of Northamptonſhire and Leiceſterſhire, were allowed their account, for the livery of the king's vinedreſſer at Rockingham, and for neceſſaries for the vineyard. A piece of land in London, now forming Eaſt Smithfield and ſome adjoining ſtreets, was withheld from the religious houſe within Aldgate by four ſucceſſive conſtables of the Tower, in the reigns of Rufus, Henry, and Stephen, and made by them into a vineyard, to their great emolument. In the old accounts of rectorial and vicarial revenues, and in the old regiſters of eccleſiaſtical ſuits concerning them, the

April. Fruit Garden.

the tithe of wine is an article that frequently occurs in Kent, Surry, and other counties. And the wines of Gloucestershire within a century after the conquest were little inferior to the French in sweetness. It is alleged that a black grape very similar to the black muscadine was introduced from Gaul into Britain, about the middle of the third century. To these proofs of the antiquity of vineyards in Britain, we shall add the following account of the vineyard at Pains-hill, Surry, (the most extensive one at present in England), given by the original proprietor, the honourable Charles Hamilton, to Sir Edward Barry, and published in his treatise on wines, p. 468.

"The vineyard at Pains-hill is situated on the south side of a gentle hill, the soil a gravelly sand: it is planted entirely with two kinds of Burgundy grapes, the Auvernat, which is the most delicate, but the tenderest; and the Miller grape, commonly called the black cluster, which is more hardy. The first year I attempted to make red wine in the usual way, by treading the grapes, then letting them ferment in a vat, till all the husks and impurities formed a thick crust at the top: the boiling ceased, and clear wine was drawn off from the bottom. This essay did not answer; the wine was so very harsh and austere, that I despaired of ever making red wine fit to drink; but through that harshness I perceived a flavour something like that of some small French white wines, which made me hope I should succeed better with white wine. That experiment succeeded far beyond my most sanguine expectation; for the very first year I made white wine, it nearly resembled the flavour of Champagne; and in two or three years more, as the vines grew stronger, to my great amazement my wine had a finer flavour than the best Champagne I ever tasted. The first running was as clear as spirits; the second was œil de perdrix; and both of them sparkled and creamed in the glass like Champagne. It would be endless to mention how many great judges of wine were deceived by my wine, and thought it superior to any Champagne they ever drank; but such is the prejudice of most people against any thing of English growth, I generally found it most prudent not to declare where it grew, till after they had passed their verdict upon it. The surest proof I can give of its excellence is, that I have sold it to wine merchants for fifty guineas a hogshead; and one wine merchant to whom I sold five hundred pounds worth at one time assured me, he sold some of the best of it from 7s. 6d. to 10s. 6d. per bottle. After many years experience, the best method I found of making and managing it was this: I let the grapes hang till they had got all the maturity the season would give them; then they were carefully cut off with scissars, and brought home to the wine barn, in small quantities, to prevent their heating, or pressing one another; then they were all picked off the stalks, and all the mouldy or green ones were discarded, before they were put upon the press; where they were all pressed in a few hours after they were gathered: much would run from them, before the press squeezed them, from their own weight one upon another. This running was as clear as water, and sweet as syrup; and all this of the first pressing, and part of the second continued white; the other pressings grew reddish, and were not mixed with the best. As fast as the wine run from the press into a large receiver, it was put into the hogsheads, and closely bunged up. In a few hours one would hear the fermentation begin, which would soon burst the casks, if not guarded against, by hooping them strongly with iron, and securing them in strong wooden frames, and the heads with wedges. In the height of fermentation, I have frequently seen the wine oozing through the pores of the staves. The hogsheads were left all the depth of winter in the cold barn, to reap the benefit of the frosts. When the fermentation was over, which was easily discovered by the cessation of noise and oozing, but to be more certain, by pegging the cask, when it would be quite clear, then it was racked off into clean hogsheads, and carried to the vaults, before any warmth of weather could raise a second fermentation. In March, the hogsheads were examined: if any were not quite fine, they were fined down with common fish glue in the usual manner; those that were fine of themselves were not fined down, and all were bottled about the end of March; and in about six weeks more would be in perfect order for drinking, and would be in their prime for above one year; but the second year the flavour and sweetness would abate, and would gradually decline, till at last it lost all flavour and sweetness; and some that I kept sixteen years became so like old hock, that it might pass for such to one who was not a perfect connoisseur. The only art I ever used to it, was putting three pounds of white sugarcandy to some of the hogsheads, when the wine was first tunned from the press, in order to conform to a rage that prevailed, to drink none but very sweet Champagne. I am convinced much good wine might be made in many parts of the south of England. Many parts are south of Pains-hill; many soils may be yet fitter for it; and many situations must be so: for mine was much exposed to the south west wind (the worst of all for vines), and the declivity was rather too steep; yet with these disadvantages it succeeded many years. Indeed the uncertainty of our climate is against it, and many fine crops have been spoiled by May frosts and wet summers; but one good year balances many disappointments."

In a dissertation on the growth of wine in England by F. X. Visper, printed at Bath 1786, there is a method of training vines along the surface of the ground proposed, which seems well adapted to the northerly climate of Britain, for which the Rev. M. L. Broeg obtained a patent. Mr Visper acknowledges, that he took the first hint from the following passage, from Lord Chancellor Bacon: "The lowness of the fruit boughs makes the fruit greater, and causes it to ripen better; for we always see in apricots, peaches, and mello-cottens upon a wall, the largest fruit is towards the bottom; and in France, the grapes that make the wine grow upon low vines bound to small stakes, while the raised vines in arbours make verjuice." He adds "It is reported, that in some places vines are suffered to grow like herbs, spreading upon the ground, and the grapes of these vines are very large; it were proper to try whether plants usually sustained by props, will not bear large leaves and fruit if laid along the ground."

SECT.

April. Flower Garden, or Pleasure Ground, &c.

Sect. III. *The Flower Garden, or Pleasure Ground.*

176 Sow and transplant annuals. Sow and transplant tender annuals. See February and March. Protect hyacinths, ranunculuses, and anemones, planted in beds, from heavy rain and frost, as directed in January and February; likewise, when they are in flower, from very bright sunshine, from about two hours before till two or three after noon; but in this case the covering should be raised a considerable height, to admit air, and allow them to be viewed.

Plant tuberoses in a hot-bed or hot-house, and give them but little water till they have come above ground.

177 Plant evergreens. Evergreen shrubs and trees may still be planted, but the earlier in the month the better.

178 Walks dressed. Grass walks and lawns should be poled, rolled, and mown. Gravel walks may be broken up and turned.

Sect. IV. *Nursery.*

179 Examine newly ingrafted trees. Look over newly engrafted trees, and see if the clay keeps close about the grafts, as it is apt to crack and fall off; when you find it any way defective so as admit the air and rain to the graft, then remove it and apply fresh clay in its stead. All shoots which rise from the stalk below the graft must be taken off whenever they are produced; for if permitted to remain, they would rob the graft of nourishment, and prevent it shooting freely.

180 Those budded last year. Trees that were budded last year, will now begin to push out their first shoots. Should they be infested with insects, so as to cause any of their leaves to curl, these should be picked off, and pains taken to destroy the vermin. Shoots that proceed from the stock under the bud must be rubbed off as soon as they appear.

181 And transplant young ones. The sowing and transplanting of young trees and shrubs from the seed bed, or where they stand too thick, should be finished early in the month, and if very dry weather prevail, water should be given to seed-beds, cuttings, and lately transplanted trees and shrubs.

Sect. V. *Green-house and Hot-house.*

Air may be admitted, and water given more freely than in the former months, because the plants will begin now to advance in growth; but in general the management must be nearly the same as recommended last month.

182 Requisite heat for pine apples. A proper degree of warmth, both in the bark bed and in the air of the hot-house, is requsite for fruiting pine apple plants. Water may be more frequently given, and air admitted more freely, because the weather will be milder; and in other respects they must be managed as directed in March. The succession pine apple plants, or such as are to fruit next year should be shifted into larger pots, (viz. 24s.) the size commonly made use of. When the plants are healthy, they should be turned out of the pots with the ball of earth about their roots as entire as possible, and put them into larger ones with an additional quantity of fresh earth; but should the plants be sickly, infested with insects, or appear to have bad roots, the whole of the earth should be shaken off, and the roots trimmed, a few of the under leaves stripped off the stem, and the plants then put into pots filled entirely with fresh earth.

After the plants have been thus shifted, they should have a moderate quantity of water given them frequently, which will promote their growth. The young pine apple plants which were raised from suckers or crowns last season should likewise be shifted into larger pots, if their roots appear to have filled those in which they have stood during the winter: if healthy, they should be turned out of the pots with the ball of earth entire; if otherwise, they must be treated like the succession plants as above.

This is a proper season for propagating hot-house plants by cuttings, layers, &c. or for sowing their seeds. Cuttings of green-house plants may likewise be struck in the bark bed of the hot-house, and kept there till fit for transplanting. 183 Propagate hot-house plants.

MAY.

May. Kitchen Garden.

Sect. I. *Kitchen Garden.*

Melons require attention, particularly when their fruit are setting. The heat of the hot-beds must be kept up by proper linings; water must be given moderately, and air admitted regularly. In warm weather when the sun shines bright, the plants should be shaded from its rays for an hour or two about mid-day, by a covering of mats or something of that nature. A piece of tile or slate should be placed under each fruit after it is set, to prevent it from coming into contact with the moist earth of the bed, which would injure it, and cause it to drop off. Ridges may be formed for the reception of the melon and cucumber plants, which were sown last or preceding month, to be raised under hand or bell glasses. These ridges should be about four feet wide, and are to be constructed in the same manner as hot-beds. See January. The dung should be raised to the height of two feet and half, and covered with six or eight inches of rich light earth, and may be made either in trenches about a foot deep or on the surface of the ground. When more than one ridge is to be constructed, they should be placed parallel to one another at the distance of about four feet, which interval should afterwards be filled up with fresh horse dung when the heat in the ridges begins to decline; this will both revive the heat, and when earthed over, will afford room to extend the advancing runners of the plants. As soon as the ridges are earthed over, the hand or bell glasses may be put on along the middle of the bed, at the distance of four feet, when intended for melons, and three feet when for cucumbers; and the following day, or as soon after as the earth under the glasses has become warm, a hole should be made under each, into which two melon or three cucumber plants are to be put with the ball of earth about their roots; the earth should then be well closed about the ball and stem of the plant, a little water given, and the glasses put on. Shade them for a day or two, and give air during the day by raising the glasses. When the plants have filled the glasses, the runners must be trained out from under them, but this should not take place till the end of the month, or some time in June. Oil paper frames are sometimes used for covering the ridges. These frames 184 Treatment of melons, &c.

May. Fruit Garden.

frames are made of thin ſlips of wood covered with paper, rendered tranſparent and water proof by means of oil. Melons reared in this way will produce plentifully in Auguſt and September, and cucumbers from the middle of June, till the cold weather in autumn ſet in. If no cucumber plants were raiſed in March or April for this purpoſe, ſome ſeeds may be ſown in the ridges. Some may likewiſe be ſown about the end of the month in the open ground, to produce a crop for pickling; but ſhould cold weather prevail at that time, it ſhould be deferred till June. Gourds and pumpkins may be ſown in the open ground in a warm ſituation, or in a hot-bed, to be afterwards tranſplanted.

185 Plant kidney beans. A full crop of kidney beans may be planted both of the dwarf and tall running ſorts: the former, viz. black ſpeckled, Batterſea and Canterbury white, ſhould be planted in drills about an inch deep, and two feet and a half aſunder, at the diſtance of two or three inches from each other; the latter, viz. the ſcarlet and large Dutch white, ſhould be ſown in drills, about an inch and a half deep, and three feet and a half or four aſunder. Theſe running kinds muſt have tall ſticks, or ſome ſupport of that nature.

186 Capſicum, &c. planted out. The capſicum and love apples which were raiſed laſt or the preceding month in hot-beds, may be planted out into well ſheltered ſituations expoſed to the ſouth.

187 Sow ſpinach. Some ſpinach plants, both of the ſmooth and prickly ſeeded, ſhould be allowed to run up for ſeed; and ſome of the different kinds of radiſhes ſhould be tranſplanted for the ſame purpoſe.

188 Weed and thin crops. The different crops ſhould be kept clear of weeds, and thinned with the hoe. Turnips may be left at the diſtance of ſeven or eight inches from each other; carrots, ſix or eight; parſnips, eight to ten or twelve; onions, four or five; Hamburgh parſley, ſcorzonera, and ſalſafy, ſix or ſeven; and cardoons, five or ſix; that they may acquire ſtrength for final tranſplantation.

189 Plant out cabbages, &c. Plant out cabbages, ſavoys, cauliflower, brocoli, and bore cole.

Sect. II. *Fruit Garden.*

190 Wall-trees trained. As wall trees will now have made vigorous ſhoots, a ſufficient quantity of the beſt placed lateral, and all the terminal ones, ſhould be trained to the wall, and all foreright, ill placed, ſuperfluous, and very luxuriant ſhoots, ſhould be removed. None of the young branches ſhould be ſhortened, unleſs where a ſupply of new wood is wanted to fill up ſome vacant ſpace. When the fruit ſtands too thick on wall trees, they ſhould be thinned. When wall trees are infeſted with inſects, means ſhould be made uſe of to deſtroy them; the curled leaves ſhould be picked off with a view to check their propagation: tobacco duſt may be ſometimes employed with advantage; but water ſprinkled plentifully over the branches with an engine conſtructed on purpoſe, is the moſt efficacious remedy.

191 Examine vines. Let vines both on walls and in vineyards be looked over; and let all ſuperfluous branches, which proceed from the old wood or lateral ſhoots, which are puſhed out by the young branches, be rubbed off; indeed this muſt be done conſtantly during the ſummer.

Sect. III. *The Flower Garden*, or *Pleaſure Ground.*

Tender annuals ſhould be tranſplanted into newly formed hot-beds, when they are wiſhed to flower early and in full perfection, particularly balſams and cockſcombs. 192 Tranſplant tender annuals into hot-beds.

Let the auricula plants in pots, which are paſt flower, be placed in ſome ſituation where they may enjoy the free air and the ſun till about ten o'clock in the morning. 193 Treatment of auriculas.

Some wallflower and ſtock gilliflower ſeed may be ſown about the beginning of the month; cuttings alſo of double wall-flowers and ſtocks may be planted under bell and hand glaſſes, or in a ſhady border. 194 Sow wallflower, &c.

Perennial and biennial plants that were ſown laſt March, will be fit for tranſplanting about the end of the month into beds, where they may remain to acquire ſtrength. 195 Tranſplant biennials, &c.

Sect. IV. *Nurſery.*

Towards the end of the month, the clay ſhould be removed from newly grafted trees, and the bandages looſened, becauſe they might check the growth of the grafts which will now ſhoot freely, and all buds under the graft ſhould be carefully removed. 196 Newly grafted trees.

Sect. V. *Green-houſe and Hot-houſe.*

About the end of the month, if the weather ſhould be favourable, the greater part of the plants may be removed from the green-houſe, and placed in ſome well-ſheltered ſituation in the open air. The plants in the hot-houſe ſhould receive water and air freely, particularly in bright weather. 197 Plants to be removed into open air.

JUNE.

Sect. I. *Kitchen Garden.*

June. Kitchen Garden.

The ſame care of cucumbers and melons which was recommended for laſt month, is neceſſary now; the cucumbers ſown in the open ground laſt month ſhould be thinned, when they begin to puſh out their firſt rough leaves, and a few more ſeeds may be ſown for the ſame purpoſe, but the earlier in the month the better. Tranſplant celery for blanching. For this purpoſe, form trenches, about a ſpade deep and three feet apart; lay the earth which comes out of the trenches regularly along each ſide; lay into each trench ſome well rotten dung, and dig it in: put the plants in a row along the middle of the trench at the diſtance of four or five inches from one another. About a month or ſix weeks after they have been planted, when they have acquired the height of ſix or eight inches, a quantity of earth ſhould be laid about their ſtems, to blanch them and prepare them for the table; this ſhould be done during dry weather, and repeated once a fortnight, or according as the plants advance in growth, till they are blanched to the height of a foot or fifteen inches. The earlier ſown celery will be fit for tranſplanting about the beginning of the month; the later ſown, about the end. 198 Melons, &c.

About the latter end of the month tranſplant endive for

for blanching; which ſhould be planted out in rows, a foot apart, and at the ſame diſtance from one another in the row. Some endive ſeed ſhould be ſown for a principal crop; the green curled is commonly ſown for 199 Endive blanched. this purpoſe, becauſe it is leaſt apt to be injured by rain or cold.

200 Cauliflowers, &c. planted out. The cauliflower, brocoli, and bore-cole plants which were ſown laſt month, ſhould be planted out at the diſtance of about three inches from one another, into beds where they may remain, to acquire ſtrength to fit them for final tranſplantation in July. Some of the early cauliflower plants, which have formed good heads, ſhould be allowed to ſtand for ſeed, which will ripen in September.

201 Sow turnips. About the middle of this month is the beſt ſeaſon for ſowing a principal crop of turnips; the different kinds commonly ſown, are the yellow, white Dutch, round white, ſtone-turnip, Swediſh, black Ruſſian, ſmall French round. The large white Norfolk, green topped, and red-topped, are chiefly uſed for field culture.

202 Plant out leeks, Plant out leeks in rows nine inches aſunder, and about ſix inches from one another in the row; it is an uſual practice to trim off the extremities of their leaves and of their roots before they are planted.

203 and pot-herbs. Plant out pot-herbs, ſuch as thyme, ſavory, ſweet-marjoram and hyſſop; likewiſe angelica, marygolds, clary, &c. A rainy or dull day ſhould be choſen, and the plants put in at the diſtance of ſix inches from one another; occaſional watering will be neceſſary, till they have taken root. Cuttings or ſlips of ſage, hyſſop, rue, roſemary, lavender, &c. may be planted in a ſhady ſituation, and occaſionally watered.

Sect. II. *Fruit Garden.*

Wall trees, and vines in the vineyard, require the ſame attention this month that was recommended laſt. 204 Strawberry plants prepared. When plantations of ſtrawberries are wanted, the young plants that are produced at the joints of the runners, that are furniſhed with good roots, ſhould be taken up about the end of this month, and planted in a ſhady border at the diſtance of about ſix inches from one another; by September they will be fit to be planted out at the diſtance of a foot or fifteen inches from each other.

Sect. III. *Flower Garden, or Pleaſure Ground.*

205 Bulbous roots, &c. taken up. The roots of hyacinths, jonquils, ranunculuſes, &c. ſhould be taken up after their ſtalks begin to decay, dried and preſerved till planting ſeaſon; the roots of narciſſus, crocus, ſnow-drop, &c. may likewiſe be taken up and ſeparated, and either planted again immediately or kept till autumn.

Take up alſo autumnal flowering bulbs, ſuch as colchicum, autumnal crocuſes and narciſſus, Guernſey and belladona lilies, cyclamens, &c.; take off the off-ſets, and plant them again immediately, or keep them till next month.

206 Propagate perennial plants. Perennial plants, ſuch as double ſcarlet lychnis, double rocket, &c. may be propagated by cuttings of their ſtalks; each cutting ſhould conſiſt of three or four joints, two of which, (or more than one half the length of the cutting), ſhould be inſerted into the ground; they may be either planted into a ſhady border, three or four inches apart, or more cloſely together, and covered with bell or hand glaſſes.

207 Carnations, &c. Propagate carnations, pinks, and double ſweet-williams, by layers. Select young ſhoots about five or ſix inches long for this purpoſe; ſtrip off the leaves from the lower part of the ſtalks, and trim off the tops of thoſe placed at its extremity; make a ſlanting cut with a ſharp knife on the under part of the ſtalk, which ſhould commence at a joint near the middle of the ſhoot, and extend upwards almoſt half way to the next; make a hole in the earth about an inch or an inch and a half deep, immediately under the ſhoot, for its reception; fix it down with a ſmall hooked ſtick, and cover it with earth, except an inch or two at its extremity. A little water ſhould be given in dry weather, which will make the layers ſtrike root more readily. Pinks and carnations may likewiſe be propagated by cuttings or pipings. Theſe pipings are formed of the extremities of the young ſhoots, taken off immediately under the third joint, which ſhould be inſerted into light earth almoſt to their tops, (the extremities of their leaves being previouſly trimmed off.) They ſhould receive a little water to make the earth ſettle cloſely about them, and ſhould be covered with a bell or hand glaſs. The earth is ſometimes rendered quite wet, and reduced to a ſtate reſembling mortar, before the pipings are introduced.

About the end of the month hedges ſhould receive their firſt clipping.

Sect. IV. *Nurſery.*

208 Fruit-trees inoculated. About the end of the month you may inoculate peaches, nectarines, apricots, and roſes: for the method, ſee July.

If any of the trees that were budded laſt ſummer, or engrafted laſt ſpring, have made very vigorous ſhoots, ſtakes ſhould be fixed into the ground cloſe to the ſtocks, to which both the ſtocks and ſhoots muſt be fixed.

Propagate both deciduous and evergreen ſhrubs by layers, particularly ſuch as do not puſh out roots freely except from the new wood.

Sect. V. *Green-houſe and Hot-houſe.*

209 Exotics propagated. If the green-houſe plants were not placed in the open air laſt month, on account of the coldneſs of the weather, they may be ſafely truſted out now. Theſe plants may be propagated this month by cuttings, layers, inarching, &c.

Hot-houſe plants may likewiſe be propagated now, and ſhould receive a plentiful allowance of air and water; pine apple plants which are approaching to maturity ſhould be ſparingly watered, becauſe too much water would injure the flavour of the fruit.

JULY.

Sect. I. *Kitchen Garden.*

210 Cabbages, &c. planted out. Plant out cabbages, ſavoys, brocoli, bore-cole, endive and celery; for the methods ſee the former months. Sow ſome brocoli ſeed about the beginning of the month. Sow ſome endive ſeed for a winter crop; the green curled endive is the beſt for this purpoſe, but ſome

July. Fruit Garden, &c. some white and Batavian may likewise be sown. Some kidney-beans, of the dwarf kind, should be sown for a late crop. Some turnip-rooted or Spanish radish may be sown, and managed exactly like turnip: there are two kinds, the black and the white; both of which are very hardy, and stand the winter well.

211 Late crops of peas. Some peas and beans may be sown when a late crop is wanted.

As artichokes now advance to maturity, those who prefer one large head to two or three smaller ones, ought to cut off all the lateral heads from the stalks, before they exceed the size of a hen's egg; which will promote the growth of the principal head. It is a common practice to break down the stalks of artichokes near the ground, as soon as their heads have been cut for the table, to make them push more vigorously from the root.

If the stalks of onions, garlick, and shallot, begin to decay, which is sometimes the case about the end of this month, they should be pulled up and dried. See August.

Sect. II. *Fruit Garden.*

212 Fruit protected. As fruits advance to maturity, wall trees should be protected from birds by nets; and means should be taken to destroy snails, wasps, and other insects.

Sect. III. *Flower Garden, or Pleasure Ground.*

213 Plant out annuals. Some tender annuals may be planted out into the flower borders in the open air.

214 And auriculas, &c. Seedling auriculas and polyanthuses may be planted out, into a border not exposed to the midday sun, at the distance of two inches from one another, and watered occasionally.

Sect. IV. *Nursery.*

Inoculate apricots, peaches, nectarines, plums, and pears; the first four are commonly inoculated on plum stocks, the last on pear or quince stocks. Inoculating or budding, as it is termed, may be performed on many other trees, and shrubs; the method of performing it is as follows.

215 Method of inoculation. With a budding knife, which resembles a penknife with a flat handle, make a horizontal cut at some smooth part quite through the bark of the stock, from the middle of which make a perpendicular cut downwards, about two inches in length, so as to form a figure resembling the letter T. Take a young shoot of the tree, with which you intend to inoculate, cut off the leaves from its lower extremity, leaving a small part of the footstalk of each, then, about an inch under the lowest bud, make a cross cut in the shoot almost halfway through, with the knife slanting upwards, and with a clean cut, bring it out about half an inch above the bud, detaching part both of the wood and bark containing the bud. Separate the small piece of the wood which was taken off along with the bud, from the bark, which is readily done with your knife, placing the point of it between the bark and wood at one end; then examine the inside of the bark, to see if the internal eye of the bud be left; for if there appears a small hole, the eye is gone with the wood, and the bud becomes useless; but if no hole appears, the bud is good, and may be inserted into the stock, by raising the bark with the handle of the budding knife on each side of the perpendicular cut, immediately under the cross cut. If the piece of bark which contains the bud be too long for the incision made in the stock, it should be reduced to a proper length with the knife, and introduced between the bark and wood of the stock, and placed so as to make the bud project through the perpendicular cut. Having fixed the bud, and placed the bark of the stock closely about it, put a bandage of mat, which should be previously steeped in water to increase its tenacity, round the stock, which should extend from a little below to a little above the incision; taking care that none of the folds of the bandage cover the bud.

In three weeks or a month after the inoculation has been performed, the buds will have united with the stock, which is discoverable by the bud appearing plump; the bandages should then be removed: were they to remain, they would cramp the buds and injure them. The incisions should be made in the stocks, about six inches above ground, when dwarf trees are wanted; and at the height of six feet, when standards are to be inoculated: the buds remain dormant, and require no further attention till next spring; when they begin to push out, the heads of the stalks should be cut off.

Seedling pines, where they stand too thick in the seed-bed, may be transplanted; but great care must be taken to water them and shade them from the sun. 216 Seedling pines transplanted.

Sect. V. *Green-house and Hot-house.*

July. Green-House and Hot-house.

Green-house plants require a plentiful supply of water at this season. If the fruit have set too thick on orange or lemon trees, they should be thinned, otherwise they will not acquire a proper size. 217 Thin the fruit of oranges.

As many of the pines will ripen their fruit in the course of this month, it is a proper time to begin to propagate these plants, which is done by planting the crowns that are produced at the top of the fruit, and the suckers which proceed from the root of the plants, about the time the fruit is ripe, or soon after they are cut. 218 Propagate pine apples.

These suckers or crowns, if properly managed, will produce fruit in two years, and then decay. Each fruit is surmounted by at least one crown, which frequently has a number of offsets at its base; and each plant, after it has produced fruit, throws out from its root one or more suckers before it decays. The crowns, when they are separated from the fruit, must lie five or six days in some dry place, till the part which was attached to the fruit is completely dried, before they are fit for planting. The suckers which proceed from the root of the plant should be taken off, when they have acquired the length of five or six inches, and when their lower extremity has become brown; they must likewise lie in some dry situation for a few days, till the part by which they were connected with the root of the parent plant be thoroughly dried. Put each crown or sucker into a small pot, filled with light rich earth, and plunge them in the bark-bed of a hot-house, or in a hot-bed made on purpose.

A method of raising pine apples in water is given by William Bastard, Esq. of Devonshire, in the 67th volume 219 Method of raising pines in water.

July. Green-house and Hot-house.

lume of the Philosophical Transactions. His account of this method is as follows:

"In the front part of the house, and indeed anywhere in the lowest parts of it, the pine-apple plants will not thrive well in water. The way in which I treat them is as follows:—I place a shelf near the highest part of the back wall, so that the pine apples may stand without absolutely touching, but as near it as can be; on this shelf I place pans full of water, about seven or eight inches deep; and in these pans I put the pine-apple plants, growing in the same pots of earth as they are generally planted in, to be plunged into the bark-bed in the common way; that is, I put the pot of earth, with the pine plant in it, in the pan full of water, and as the water decreases I constantly fill up the pan. I place either plants in fruit, or young plants, as soon as they are well rooted, in these pans of water, and find they thrive equally well: the fruit reared this way is always much larger, as well as better flavoured, than when ripened in the bark-bed. I have more than once put only the plants themselves without any earth, I mean after they had roots, into these pans of water, with only water sufficient to keep the roots always covered, and found them flourish beyond expectation. In my house the shelf I mention is supported by irons from the top; and there is an intervening space of about 10 inches between the back wall and the shelf. A neighbour of mine has placed a leaden cistern upon the top of the back flue, in which, as it is in contact with the flue, the water is always warm when there is fire in the house, and finds his fruit excellent and large. My shelf does not touch the back flue, but is about a foot above it; and, consequently, the water is only warmed by the air in the house. Both these methods do well. The way I account for this success is, that the warm air, always ascending to the part where the shelf is placed, as being the highest part of the house, keeps it much hotter than in any other part. The temperature at that place is, I believe, seldom less than what is indicated by the 73° of Fahrenheit's thermometer, and when the sun shines it is often above 100°: the water the plants grow in seems to enable them to bear the greatest heat, if sufficient air be allowed; and I often see the roots of plants growing out of the holes in the bottom of the pot of earth, and shooting vigorously in the water.

"My hot-house, the dimensions of which it may be proper to know, is 60 feet long, and 11 feet wide, the flues included; six feet high in the front, and 11 feet at the back of the inside of the house. It is warmed by two fires. A leaden trough or cistern on the top of the back flue is preferable to my shelf; as in it the pine plants grow much faster in the winter, the water being always warmed by the flue. Of this I have seen great benefits these last two months in my neighbourhood.

"It is not foreign to this purpose to mention, that as a person was moving a large pine plant from the hot-bed in my house last summer, which plant was just shewing fruit, by some accident he broke off the plant just above the earth in which it grew, and there was no root whatever left to it. By way of experiment, I took the plant, and fixed it upright in a pan of water, without any earth whatever, in the shelf; it there soon threw out roots, and bore a pine apple that weighed upwards of two pounds."

August. Kitchen Garden.

220 Varieties of the pine apple.

1. The *bromelia ananas*, of which there are six varieties: 1. *Ovatus*, or oval-shaped pine apple. 2. *Pyramidalis* (pyramidal), or sugar-loaf pine. 3. *Glaber*, with smooth leaves. 4. *Lucidus*, with shining green leaves. 5. *Serotinus*, with a yellowish-coloured flesh. 6. *Viridis*, or green pine apple.

The first sort of ananas is the most common in Europe; but the second sort is much preferable to it, the fruit of this being larger and much better flavoured: the juice of this sort is not so astringent as that of the first; so that this fruit may be eaten in greater quantity, with less danger. This sort frequently produces suckers immediately under the fruit, whereby it may be increased much better than the common sort; so that in a few years it may be the best common sort in Britain.

The third sort is preserved for curiosity by way of variety; but the fruit is not worth any thing.

The sort with very smooth green leaves, was raised from seeds taken out of a rotten fruit, which came from the West Indies to the late Henry Heathcote, Esq. from whom Mr Millar received one plant, which produced large fruit: this is what the people of America call the *king pine*.

AUGUST.

Sect. I. *Kitchen Garden.*

221 Sow winter crops of spinach.

Sow some prickly-seeded, or triangular-leaved spinach, for a winter and spring crop; for though the round-seeded produces larger and more succulent leaves, the prickly-seeded is to be preferred now, because it is by much the hardier of the two. After the plants have got their first leaves about an inch broad, they should be thinned to the distance of four inches from one another, and kept free from weeds.

222 Cabbage.

Sow some cabbage seed both of the early and late kinds, to produce plants for next year.

223 Onions.

Sow some onions, to be used when young in winter or spring, or to produce a crop of early onions this summer. The Strasburg or any other kind may be sown now, but the Welsh onion is very hardy, and stands the winter well; for though their tops should be destroyed by the severity of the weather, they will push up again from the root in the spring: this onion, however, does not produce bulbs.

224 Cauliflower

Towards the end of the month sow some cauliflower seed to produce plants for an early crop next summer, which may be protected during the winter, either under hot-bed frames, bell or hand-glasses, or in a well-sheltered border exposed to the south. Between the 18th and 24th of this month is, perhaps, the best time to sow these seeds. The London gardeners, who sow great quantities, are accustomed to sow them on a particular day, viz. the 21st of this month. If they be sown too early, they are apt to button, as the gardeners term it, i. e. run up to seed without producing heads of a proper size; and if they be sown too late, the plants do not acquire sufficient strength, before winter, to enable them to support the severity of the weather.

225 Lettuce.

Sow some lettuce seed about the middle of the month, both to supply the table late in the autumn, or beginning of winter, and to plant out into well-sheltered borders, or under hot-bed frames, to stand during winter.

August. Fruit Garden.

226 Plant out brocoli, &c.

Plant out brocoli, ſavoys, bore-cole, and celery, for the uſe of winter and ſpring.

The cardoons which were planted in June ſhould have ſome earth laid up to their ſtems, to blanch them and render them fit for the table. That this may be accompliſhed the more eaſily, tie up the leaves of each plant, with a piece of baſs mat or ſmall ſtraw rope, and apply ſome earth cloſe round the ſtem, which earthing muſt be repeated at intervals, till it riſe to the height of two feet.

227 Time of taking up onions.

The principal crops of onions will be fit for taking up in the courſe of this month. Chooſe a dry day for taking them up; take off the ſtalks within two or three inches of the bulb; ſpread them in ſome dry place, expoſed to the ſunſhine, for 10 or 12 days, that they may be thoroughly dried.

Sect. II. *Fruit Garden.*

228 Dreſs the vines, &c.

Look over vines, figs, and other wall trees; remove all foreright and ſuperfluous branches, and nail the others cloſe into the wall, that the rays of the ſun may have free acceſs to the fruit.

Vines in the vineyard likewiſe ſhould be fixed to the ſtakes, and cleared of all ſuperfluous ſhoots.

Sect. III. *Flower Garden* or *Pleaſure Ground.*

229 Propagate fibrous-rooted perennials.

About the end of the month, you may propagate by ſlips, fibrous-rooted perennial plants, ſuch as double roſe campion, catchfly, double ſcarlet lychnis, double rocket, double ragged robin, bachelors button, gentianella, polyanthuſes, auriculas, double daiſies, &c. As theſe plants frequently grow in tufts, they may be taken up and divided, taking care that every ſlip be provided with ſome roots.

230 Treatment of auriculas,

Auricula plants in pots ſhould receive freſh earth.

Auricula and polyanthus ſeed may be ſown any time this month, but will not come up till ſpring.

231 and carnations.

Layers of carnations, double ſweetwilliams, and pinks, that are properly rooted, may be ſeparated from the parent plant, and planted into borders or pots. Cuttings and pipings of pinks and carnations, may be planted out into beds or borders.

232 Sow bulbous rooted plants.

Towards the end of the month the ſeeds of bulbous-rooted flowers, ſuch as tulips, hyacinths, narciſſus, iris, crocus, fritillaria, crown imperial, lilies, and ſnowdrops; likewiſe, the ſeeds of anemone, ranunculus, and cyclamen, may be ſown in beds or boxes, to obtain new varieties. They muſt be protected during winter from the froſt; and when they appear above ground in ſpring, they muſt be kept clear of weeds.

Plant out ſeedling biennials and perennials.

233 Clip hedges.

About the end of this month hedges ſhould receive their ſecond clipping.

Sect. IV. *Nurſery.*

234 Examine the budded trees.

Budding may ſtill be performed about the beginning of the month, and thoſe trees which were budded three weeks or a month ago, ſhould be examined. If the buds remain plump and freſh, there is reaſon to believe that they have ſucceeded; in that caſe the bandages muſt be looſened.

Sect. V. *Green-houſe and Hot-houſe.*

Green-house plants, in the open air, muſt be managed as already directed.

The plants in the hot-houſe muſt receive a plentiful allowance of air and water.

Succeſſion pine-apple plants, that are to produce fruit next year, ſhould be ſhifted into larger pots, viz twenty-fours or ſixteens, about the beginning of the month. The plants ſhould be turned out of the old pots and placed in the new ones, a quantity of light rich earth being previouſly put into the bottom of each. Each pot ſhould then be filled with ſome of the ſame earth, watered, and plunged into the tan, which, at the ſame time, ſhould be turned over and receive an addition of about one-third of freſh tan.

SEPTEMBER.

September. Kitchen Garden.

Sect. I. *Kitchen Garden.*

Plant ſome brown Dutch, cos, and common cabbage lettuce, in a well-ſheltered ſituation, expoſed to the mid-day ſun, to be covered with hot-bed frames and glaſſes, which ſhould not be put over them till ſome time next month. 235 Plant out lettuce.

Plant out from the ſeed-bed the cauliflowers that were ſown laſt month, into well-ſheltered borders, at the diſtance of three or four inches from one another, taking care not to plant them ſo deep as to cover their hearts with earth. Theſe plants may be either planted out again next month under garden frames, bell or hand-glaſſes, to ſtand during the winter, or may remain where planted. 236 Cauliflowers.

Plant brocoli, ſavoys, bore-cole, celery, and endive. 237 Brocoli, &c.

Earth up celery and cardoons.

Tie up the leaves of endive with a piece of baſs mat, or ſomething of that nature, to blanch them, and prepare them for the table.

Muſhroom beds may be formed any time this month, as ſpawn will very eaſily be procured during Auguſt, September, or October. The ſpawn has the appearance of a white mould ſhooting out in ſtrings, which, when bruiſed, ſmells like muſhrooms. It may be obtained either from old muſhroom beds, old hot-beds, or dung hills that are principally compoſed of horſe dung, and from paſture fields, indeed in any place where horſe or ſheep's dung has lain for ſome time undiſturbed and not expoſed to much moiſture; and may be preſerved for a conſiderable length of time, in a proper ſtate for uſing. If ſpawn is not otherwiſe to be procured, ſome may be produced by laying a quantity of horſe dung and rich earth in alternate layers, and covered with ſtraw to exclude the rain and air; for the more theſe are excluded, the ſooner the ſpawn will appear, which commonly happens in about two months after the dung and earth have been laid together. Muſhroom beds ſhould be formed of dung that has been ſpread out for ſome time, without having been fermented, and may be made two or three feet broad, and of any length. A ſtratum of dung about a foot thick, ſhould be laid firſt, which ſhould be covered with rich earth to the depth of about four inches, then another 238 Preparation of muſhroom beds.

September. Fruit Garden.

ther ſtratum of dung about ten inches thick, which ſhould be covered like the former; a third ſtratum of dung may be laid and covered with earth like the two former. The whole ſhould be made to grow narrower as it advances in height, and formed into a ridge reſembling the roof of a houſe. When the bed is finiſhed it ſhould be covered with ſtraw, to exclude the rain, and to prevent the bed from being dried by the ſun or wind, in which ſituation it ſhould remain eight or ten days, when the bed will be in a proper temperature of warmth to receive the ſpawn. The ſpawn ſhould be placed in lumps four or five inches aſunder, in the ſloping ſides of the bed, and covered with a little rich earth; the whole muſt then be covered with a thick coat of ſtraw. When theſe beds are made in ſpring or autumn, as the weather in thoſe months is temperate, the ſpawn will take ſoon, and the muſhrooms will appear in about a month after the bed has been made; but when theſe are made in winter, when the weather is cold, or even in ſummer when the weather is very hot, a much longer time will elapſe. The principal thing to be attended to, in the management of theſe beds, is to preſerve them in a proper degree of moiſture and warmth. Therefore, when the weather is very cold or very wet, care muſt be taken to apply a thick covering of dry ſtraw, and when the bed appears dry, a gentle watering muſt be given.

Sect. II. *Fruit Garden.*

239 Fruit to be expoſed to the ſun.

Where any fruit, particularly grapes, are ſhaded with leaves, pains ſhould be taken to expoſe them to the rays of the ſun, that they may acquire proper flavour, likewiſe when the cluſters are entangled, they ſhould be diſengaged, that each may have the benefit of the ſun and air.

240 Plant ſtrawberries.

Strawberries may be planted any time this month when the weather is ſhowery. If rain ſhould not fall towards the beginning of the month, the tranſplanting ſhould be deferred, otherwiſe they muſt be watered occaſionally, for ſome time after they are planted. If any were planted into beds in June, they will be in excellent condition for planting out now; but if none were planted out then, the beſt rooted plants produced at the joints of the runners, or offsets from the old plants, ſhould be choſen, and planted at the diſtance of a foot or 15 inches from one another, either in beds, about four feet wide, or in rows along the borders. Moſt kinds of ſtrawberries ſucceed beſt in an open ſituation, but the wood ſtrawberry may be planted under the ſhade of trees or buſhes.

241 Different kinds of ſtrawberries.

The principal kinds of ſtrawberries, are, the ſcarlet or Virginian, white wood, green wood, red wood, large white wood, hautboy ſtrawberry, large globe hautboy, oblong hautboy, royal hautboy, green hautboy, Chili ſtrawberry, globe Chili, ſugar-loaf Chili, pine-apple Chili, Bath Chili, Carolina Chili, white Carolina Chili, Devonſhire Chili, Royal Chili, Dutch Chili, Alpine or prolific, which produces fruit from June to November, red Alpine, white Alpine, ſcarlet Alpine, pine-apple ſtrawberry, red, white, and green.

About the end of the month, moſt of the late pears and apples will be fit for taking down, to be laid up for keeping. See October.

Sect. III. *Flower Garden or Pleaſure Ground.*

October. Kitchen Garden.

Transplant and propagate fibrous-rooted perennial plants by ſlips.

Towards the end of the month, hyacinths, tulips, and other bulbs, may be planted. See October. 242 Tulips, &c. planted.

Sect. IV. *Nurſery.*

Transplant evergreens towards the end of the month, ſuch as Portugal laurels, lauruſtinus, arbutus, &c. 243 Tranſplant and propagate evergreens, &c.

Both evergreen and deciduous trees and ſhrubs may be propagated by layers or cuttings about the end of the month.

Sect. V. *Green-houſe and Hot-houſe.*

About the end of the month, if the weather be cold, orange and lemon trees, and many of the tenderer kinds of green-houſe plants, ſhould be removed into the houſe. 244 Tender plants taken into the houſe.

About the end of this month or beginning of next, the tan-bed in the hot-houſe ſhould be refreſhed with a quantity of new tan, one half or two thirds according as the old tan may be more or leſs decayed. 245 Tan-bed renewed.

OCTOBER.

Sect. I. *Kitchen Garden.*

Plant out ſome of the lettuces that were raiſed in Auguſt, into a well ſheltered border or into a hot-bed frame to ſupply the table during winter and ſpring. 246 Plant out lettuces.

Cauliflowers that were planted out laſt month from the ſeed-bed, may now be planted under hot-bed frames, at the diſtance of about four inches from one another, or under bell or hand glaſſes. Four or five plants may be put under each hand glaſs, all of which (ſhould they ſurvive the winter) may again be planted out in the ſpring, except one, or at moſt two, of the ſtrongeſt, which ſhould be allowed to remain and produce heads. See February. 247 Cauliflowers under frames.

Propagate aromatic vegetables by ſlips, ſuch as thyme, mint, balm, ſage, &c.

Aſparagus beds ſhould receive their winter dreſſing, i. e. their ſtalks ſhould be cut down, and the alleys between the beds ſhould be dug, and a little of the earth from the alleys ſpread over the ſurface of each bed. Aſparagus beds require ſome dung once every two years, which ſhould be applied at this ſeaſon. Before the alleys are dug, a little well rotten dung ſhould be ſpread over the ſurface of the beds, dug in with a fork, and covered with a little of the earth from the alleys. Where forced aſparagus is required early in winter, a hot-bed may be made any time this month. See January. 248 Dreſs aſparagus.

Plant ſome early Mazagan beans, and hotſpur peas about the end of the month, to ſtand the winter, and produce a crop early in ſummer.

Sect. II. *Fruit Garden.*

Winter pears and apples ſhould in general be gathered this month. Some will be fit to take down the 249 Gather winter apples.

beginning

October. Fruit Garden. beginning of the month, others will not be ready before the middle, or towards the end. To know when the fruits have had their full growth, some of them should be tried in different parts of the tree, by turning them gently upwards; if they quit the tree easily, it is a sign of maturity, and time to gather them. But none of the more delicate eating pears should be permitted to hang longer on the trees than the middle of the month, especially if the nights prove frosty; for if they are once touched with the frost, it will occasion many of them to rot before they are fit for the table; and therefore, in general, let neither apples nor pears remain longer on the trees than the middle or the end of this month, for they will not improve by hanging on the trees after that time. The best apples and pears which are intended for long keeping, should be taken down one by one, on a dry day, and carefully put into baskets, to be carried to the fruitery, or place where they are to be stored up. The fruit themselves should be dry when taken down from the trees, therefore should not be gathered too early in the morning, before the dew on their surface has evaporated. They should be laid in a heap for ten days or a fortnight, that their watery juices may transpire; each should then be thoroughly dried with a cloth, and laid on the shelves of the fruitery, or in boxes or hampers well covered with dry straw or hay.

250 Prune and plant fruit trees. About the end of the month, apricots, peaches, and nectarines may be pruned. See January.

All sorts of fruit trees may be planted, such as apricots, peaches, nectarines, plums, cherries, apples, pears, quinces, vines, figs, mulberries, medlars, services, filberts, &c. The ground for this purpose should be trenched to the depth of one or two spades, and should be well manured. If the borders on which the fruit trees are to be planted have not a sufficient depth of soil, a quantity of good earth may be added. Peaches, nectarines, apricots, plums, and cherries, are commonly planted at the distance of about fifteen feet from one another. Pears and apples when engrafted on dwarf stocks may be planted about the same distance, but those which are on free stocks, about eighteen or twenty feet. Cherries and plums for standards should be planted at the distance of twenty or twenty-five feet from one another. Apples and pears, on free stocks, should be planted in rows, thirty or forty feet asunder, and at the distance of twenty-five or thirty feet from one another in the row. Dwarf apples and pears, however, may be planted at less than half that distance.

The principal kinds of apricots are, the early muscadine, Turkey, Brussels, Roman, Breda, orange, Algiers, royal, Moor-park, alberget, transparent, Dunmore, or apricot peach, and Portugal.

The principal sorts of peaches are, the red magdalen, white magdalen, red nutmeg, white nutmeg, nobless, early Newington, old Newington, great French mignone, small mignone, admirable chancellor, Millet's mignone, incomparable, violet native, purple native, Royal George, Montauban, teton de Venus, round transparent, Catharine, and bloody peach.

The principal kinds of nectarines are, early nutmeg, Newington, red, Roman, violet, violet, musk, golden, scarlet, Elruge, Temple, Murray, Brugnion, white Italian.

The principal sorts of plums are, the Primordan or early white, Precoce or early black, early Morocco, Orleans, green gage, la royale, damas de Tour, damas violette, white bonum magnum or egg plum, red bonum magnum or Imperial, Perdrigron white, Perdrigron violet, Monsieur plum, drap d'or, royal dauphin, Fotheringham, azure native, or early blue gage, queen mother, myrobalan, apricot plum, red, white, diaprée, Monsieur native, Roche carbon, Jaune native, grosse queen Claude, petite queen Claude, imperiale violette or blue imperial, petite mirabille, damas musque, diaprée noire, diaprée violette, imperitrice blanche or white empress, imperitrice noire or late black, Spanish damas, damas of September, St Catharine, common damson, Bullace.

The principal kinds of cherries are, the early May, May-duke, arch-duke, Harrison's duke, white heart, black heart, bleeding heart, Adams's crown heart, Hertfordshire heart, ox heart, Turkey, carnation, amber, Kentish or Flemish, Portugal, morella, white crossian, black coroun, small black guigne or geen, small red guigne, smallest wild black of the woods and hedges, ditto red.

The principal kinds of apples are, the common codlin, Kentish codlin, Dutch codlin, Margaret, golden pippin, gold rennet, Holland pippin, Kentish pippin, nonpareil, royal russet, Wheeler's russet, golden russet, gray russet, winter pearmain, scarlet pearmain, Loan's pearmain, aromatic russet, pomme d'Appis, Newton pippin, English rennet, autumn rennet, winter queening, margille, nonesuch, gray Leadington, Marget, tender rennet, kitchen rennet, large white, Italian, Spanish rennet, Canada rennet, grosse rennet de Normandie, Fearns pippin, white French rennet, cluster pearmain, lemon pippin, French pippin, winter greening, winter pippin, Flanders pippin, white costin, Kirton pippin, stone pippin, courpendu, or hanging body, courpendu red, rambour summer, rambour winter, rennet grise, French rennet, cat's head, leathercoat, russet of winter, pomme de gelée, Siberian crab, American cherry crab, two years apple hanging on the trees, if permitted, till the second year. 251 Apples.

The principal kinds of pears are, the green missal, catharine, jargonelle, cuisse madame, Windsor chamontelle, cressane, echasserie, grasse blanquette, beuré de roi, white beuré, winter beuré, colmar, St Germain, lent St Germain, Martinsee, grasse muscat, autumn muscat, orange bergamot, Hambden's bergamot, red beuré, golden beuré, brown beuré, great rousselet, petit rousselet, Holland bergamot, verte longue, winter bonchretien, summer ditto, Spanish ditto, Messieur Jean, Green sugar, la marquis, swan egg, virgleuse, Portugal, gray goodwife, citron de carmes, ambrette, royal d'hiver, St Michael, Louise bonne, summer orange, winter orange, Swiss bergamot, devionett. 252 Pears.

Baking pears. Large black pear of Worcester, Parkinson's warden, Uvedale St Germain, cadillac. The principal kinds of quinces are the Portugal, apple quince, pear quince. The principal kinds of mulberries are the common black, white, red, medlars, Dutch, Nottingham or English. Services. Common wild service, bervey, sweet service or serb, apple-shaped, pear-shaped, berry-shaped.

The principal sorts of figs are, the common blue, early long blue, early white, large white, large Genoa, Brunswick, Marseilles, Cyprian, brown Ischia, brown Malta. 253 Figs.

November. Kitchen Garden. Malta. Filberts. Large red ſkinned filbert, white ſkinned, common hazel nut, Barcelona nut, cob nut, cluſter nut, Byzantine nut.

Gooſeberries, currants, and raſpberries, may likewiſe be planted about the end of this month. See JANUARY.

SECT. III. *Flower Garden*, or *Pleaſure Ground.*

254 Bulbous roots planted. BULBOUS-rooted plants, ſuch as tulips, hyacinths, narciſſus, jonquils, crocus, dens-canis, crown imperial, ſword lily, ixia, Perſian and Engliſh iris, ranunculus, and anemone, may be planted any time this month, either in beds by themſelves, or in flower borders, together with other flowers; but the finer ſorts of tulip, hyacinths, ranunculus, and anemone, are commonly planted in beds, ſix or eight inches diſtant, and two or three deep.

Plant out deciduous and evergreen trees and ſhrubs. The method of planting all theſe is to open a circular hole, wide enough to receive the roots, and about a ſpade deep, more or leſs, according to the length of the roots.

Thorn and other hedges may be planted towards the end of this month, or any time in the courſe of the next.

SECT. IV. *Nurſery.*

255 Sow ſtone fruit, &c. Sow haws, holly berries, hips, barberries, yew-berries, acorns, beech-maſts, maple and aſh-ſeed, cherry and plum ſtones, in a bed about four feet wide. It is a common practice to keep haws and hips, in heaps covered over with earth for twelve months; for thoſe which are ſown without this preparation frequently lie a whole year in the ſeed-bed, without coming above ground. Plant cuttings of laurels and evergreens.

SECT. V. *Green-houſe and Hot-houſe.*

THE hardier kinds of green-houſe plants ſhould be all removed into the green-houſe, when they ſhould have plenty of air, except in very cold or wet weather.

The ſucceſſion pine-apple plants ſhould be removed into the fruiting houſe, which ſhould previouſly receive a quantity of new tan, as directed laſt month. The younger ſucceſſion plants likewiſe ſhould be moved into the place of thoſe that have been transferred into the fruiting houſe, air ſhould be given freely in mild weather, and water very moderately.

NOVEMBER.

SECT. I. *Kitchen Garden.*

256 Blanch endive, &c. TIE up endive for blanching, continue to earth-up cardoons, and dreſs the plantations of artichokes, i. e. cut down their larger leaves, and lay ſome earth about the plants, to protect them during winter.

Carrots and parſneps may be taken up, and preſerved in ſand during the winter.

Some more peas and beans may be ſown to ſucceed thoſe that were ſown laſt month, or to ſupply their place if they ſhould be cut off by the ſeverity of the weather.

SECT. II. *Fruit Garden.*

November. Fruit Garden.

THE beſt time for pruning vines is immediately after the fall of the leaf, becauſe the greateſt poſſible time in that way is allowed for healing the wounds. Vines that are cut about the time of the riſe of the ſap in the ſpring, are apt to bleed profuſely; this happens ſometimes even to thoſe that are pruned in the courſe of the winter. It is a common error, in pruning vines, to allow the branches to grow too cloſe together, particularly in thoſe varieties which grow vigorouſly, and have very large leaves; for, in ſummer, when the leaves are fully expanded, they are ſo much crowded together as to exclude the rays of the ſun from the fruit. When pruning is properly performed, the young branches ſhould be left at the diſtance of from one foot or two feet, and even upwards from one another; but this in a great meaſure muſt be regulated by the ſize of their leaves. The Syrian grape has leaves about a foot and a half broad, with foot-ſtalks ſix inches long. The black Hamburgh has leaves twelve or thirteen inches broad, with footſtalks ſeven inches long. The black cluſter on the contrary has leaves five inches broad, with foot-ſtalks three inches long. Blue frontignac and claret grape have leaves ſix inches broad, with foot-ſtalks about four inches long. When vines are weakly, each ſhoot ſhould be ſhortened ſo as to leave only three or four eyes; when they are moderately vigorous, each ſhould be left about a foot long. When very vigorous, ſome of the ſhoots may be left three or four feet long or more; the ſhoots of vines, however, that are trained to the rafters of a vinery or pine-ſtove may be left eighteen or twenty feet long. It has been obſerved, that both the largeſt grapes and fineſt cluſters are produced on ſhoots of a conſiderable length. When vines have been allowed to run into confuſion, much time and pains are requiſite to reduce them to regularity; but when they have been trained regularly from the beginning, pruning is eaſily and expeditiouſly performed. 257 Prune vines

If the following directions for training vines in a vinery be obſerved, they will eaſily be kept in order, and plentiful crops of good fruit may be expected. 258 Directions for training vines.

Vines may be planted both on the back wall and front of a vinery; thoſe on the back wall ſhould be planted fron ſix to twelve feet aſunder, according to the vigour of growth of the particular ſort, and in ſuch a poſition that the two uppermoſt buds may point eaſt and weſt; theſe on the front ſhould be planted ſo as one may be trained to each rafter. When the vines begin to grow, all the buds except the two uppermoſt muſt be rubbed off from thoſe on the back wall, and all except the uppermoſt from thoſe on the front wall. If any of the plants ſhew fruit the firſt year, the cluſters ſhould be rubbed off, as well as the tendrils and lateral ſhoots and the principal ſhoots ſhould be trained regularly to the trellis as they advance in growth. Fires ſhould be put in the vinery during the ſpring, to encourage an early growth in the vines, that they may have full time to ripen their wood. In the month of June the glaſſes may be taken off altogether, but ſhould be put on again in September, and continued till the fall of the leaf, when the vines ſhould be pruned. The two ſhoots which each vine on the back-wall was permitted to puſh, ſhould be cut down to their third or fourth bud, according

November. Fruit Garden.

according as either of them appears fulleſt and ſtrongeſt, and then bent down as near as poſſible to a horizontal poſition, forming a figure reſembling the letter T. Plants in front that are trained to the rafters, ſhould be cut down almoſt to the bottom, and no more left than is merely ſufficient to train them to the rafter. Only two ſhoots ſhould again be permitted to grow on each plant on the back wall, and one on thoſe of the front, and theſe may be allowed to run the whole height of the houſe before they are ſtopped. After the vine ſhoots are ſtopped (which is done by pinching off their tops), they will in general puſh out laterals at three or four eyes, on the upper part of the ſhoot. Theſe laterals ſhould not entirely be taken off, as it would cauſe more eyes lower upon the ſhoots to puſh out. It would therefore be prudent to permit the firſt laterals to grow twelve or fourteen inches, and then to pinch off their tops. Theſe laterals, in their turn, will puſh out ſecondary laterals, which ſhould be pinched off at the ſecond or third joint, and in that way the ſap may be diverted till the end of the ſeaſon.

The ſhoots of the plants on the back wall muſt be brought down to a horizontal poſition, and cut ſo that the branches of each plant may reach within a foot of the other. If all the vines on the rafters have puſhed vigorouſly, it will be proper to prune every other plant down to three or four eyes, and the reſt to from twenty to twenty-five eyes each, the latter being intended to produce fruit, and the former to make bearing wood againſt another year. When the vines begin to puſh in the ſpring of the third year, the ſhoots of thoſe on the back wall ſhould not be allowed to ſtand nearer one another than a foot or fifteen inches, all the intermediate buds being carefully rubbed off. The ſhoots ought to be trained up perpendicularly, and however vigorous they may be, no more than one cluſter ſhould be allowed to remain on any of them: all of them may run up to the height of five or ſix feet before they are ſtopped. The ſhoots on the rafters, that were pruned to twenty or twenty-five eyes each, will probably puſh at all of them; but not more than five or ſeven ſhoots ſhould be permitted to remain, even on the ſtrongeſt; viz. a leading ſhoot, and two or three on each ſide. Care being taken to leave one ſhoot as near the bottom as poſſible, as the whole branch will require to be pruned down to this ſhoot next winter. Only one ſhoot ſhould be left upon thoſe vines that were pruned down to three or four eyes, at every other rafter; and this muſt be trained up the rafter as in the preceding year. At next pruning ſeaſon all the ſhoots proceeding from the horizontal branches of the vines in the back wall ſhould be pruned down to three or four eyes. The vines on the front which produced fruit ſhould be pruned to their loweſt ſhoot, which ſhould be ſhortened, ſo as to leave four or five eyes. Thoſe at every other rafter which were ſhortened the preceding year, and which were allowed to puſh one ſhoot, ſhould now be pruned like the bearers of the former year; i. e. twenty or twenty-five eyes ſhould be left on each. In the following and all ſucceeding ſeaſons, theſe vines on the front will require a ſimilar management, with this difference, that, as they acquire more ſtrength, they may be permitted to puſh more ſhoots, and more cluſters may be allowed to remain on each ſhoot; for, as the vines advance in age, they will certainly be enabled to produce every year for a certain period, a larger crop of fruit. The ſpurs of the vines on the back-wall, i. e. the ſhoots that were ſhortened to three or four eyes, ſhould be allowed to puſh up one ſhoot: theſe ſhoots at next pruning ſeaſon muſt be cut ſo as to leave a long one, viz. about four feet, and a ſhort one, alternately. The long ones ſhould be allowed to puſh five ſhoots (all the other buds being rubbed off), the four lateral of which ſhould be cut down to two or three eyes each, at next pruning ſeaſon, and the terminal one ſhould be left about a foot and a half long. The ſhort ſhoots between the long ones muſt conſtantly be pruned down to two or three eyes each, in order to keep up a proper ſucceſſion of bottom wood. The pruning following ſeaſon muſt be the ſame, with this difference, that the upright ſhoots, as they have acquired a foot and a half additional length, may be allowed to puſh ſeven ſhoots inſtead of five.

November. Flower Garden or Pleaſure Ground.

259 Different kinds of grapes.

The principal kinds of vines (E) are, * the white muſcat of Alexandria, * black damaſcus, * golden gallician, *† white frontinac, *† griſly frontinac, *† black or purple frontinac, †‡ blue or violet frontinac, †‡ red frontinac, *† white ſweet water, *† black Hamburgh, *† red Hamburgh, or Gibraltar grape, * white Hamburgh, *† malvoiſe or blue tokay, *† genuine tokay, *† flame-coloured tokay, †‡ brick grape, *† white muſcadine or chaſſelas, *† royal muſcadine or d'arboyce, *† Malmſey grape, *† claret grape, * Syrian, †‡ Burgundy or Munier grape, †‡ ſmall black cluſter, † large black cluſter, †‡ early black July grape or morillon, noir natif, † white parſley-leaved.

260 Prune gooſberries and currants.

Gooſberries and currants may be pruned any time from the fall of the leaf, till their buds begin to grow in the ſpring. If theſe buſhes be not well pruned, the fruit will neither be large nor well-flavoured. The principal thing to be attended to is, to keep them open; for they are very apt to become over-crowded with branches: all ſuckers therefore which ariſe from the root, or ſhoots which proceed from the main ſtem, ſhould be removed, becauſe they would only create confuſion, by growing up into the heart of the buſh. When laſt ſummer's ſhoots ſtand too thick, on the main branches, which is frequently the caſe, particularly with gooſberries, they ſhould be thinned, and few either of them or of the main branches ſhould be ſhortened, becauſe the more they are ſhortened the more liable they are to run to wood. They who make uſe of garden-ſhears, for ſake of expedition, which is too frequently the caſe, may ſave time, and make neat-looking buſhes, but will be diſappointed with reſpect to the quantity and quality of their fruit.

Sect. III. *Flower Garden or Pleaſure Ground.*

Fibrous-rooted perennial plants may ſtill be planted; likewiſe bulbous-rooted plants, ſuch as tulips, hyacinths, &c.

Shrubs and ornamental or foreſt trees may be tranſplanted

(E) Thoſe marked * are for a hot-houſe; thoſe marked † are for a vinery; and thoſe marked ‡ are for a common wall.

December. Kitchen Garden.

planted now or any time during the winter when the weather is open.

Sect. IV. *The Nurſery.*

Transplant young trees and ſhrubs, and protect tender ſeedlings during ſevere weather.

Sect. V. *Green-Houſe and Hot-Houſe.*

The plants in the green-houſe ſhould have air during the day, whenever the weather will permit, and ſhould receive but little water. The plants in the hot-houſe ſhould likewiſe receive air during the day in favourable weather, and fires muſt be put on every evening, but ſeldom need to be continued during the day, except the weather is very ſevere.

DECEMBER.

Sect. I. *Kitchen Garden.*

The cauliflower plants and lettuces planted under hot-bed frames, or under bell or hand-glaſſes, ſhould be expoſed to the air during the mild days, and protected during ſevere weather with a covering of mats or ſtraw. In dry weather celery and cardoons ſhould be earthed up, and endive tied up for blanching.

In this month there is nothing to be done either in the fruit garden, nurſery, green-houſe, or hot-houſe, that has not already been taken notice of in the preceding months.

261 Conſtruction of green-houſes.

Here we ſhall add ſome obſervations on the conſtruction of green-houſes and hot-houſes.

A green-houſe conſtructed for the protection of ſuch vegetables as cannot ſtand in the open air during winter, may vary in form and dimenſions according to the fancy of the proprietor, and the number of plants it is intended to contain. When the front only is of glaſs, which formerly was the only, and even ſtill is the prevalent, mode of conſtructing green-houſes, the pillars between the ſaſhes ought to be as narrow as the weight they have to ſupport will admit of, and formed ſo as to give the leaſt poſſible obſtruction to the light; they may be either of ſtone, brick, wood, or caſt iron. The height of the ſaſhes ſhould equal if not exceed the width of the houſe, that a ſufficient quantity of light may be thrown on the plants which ſtand near the back wall, otherwiſe they will loſe colour, become unhealthy and deformed; for not only the colour, but the vigour, and even the form of vegetables, depends on the light. When one half or the whole of the roof is of glaſs, which ought to be the caſe, there is no neceſſity for attending to the proportion the height ought to bear to the width of the houſe. The ends of the houſe ſhould alſo be of glaſs, unleſs when it is connected with a ſeries of other buildings. The pots containing the plants are commonly ſet on benches, which gradually increaſe in height as they recede from the front; however, when the roof is of glaſs, the arrangement may be different. Every green-houſe ought to be furniſhed with flues; for though many winters may occur in which the application of fire-heat may not be neceſſary, yet ſuch intenſe froſts at times prevail as would infallibly kill a great many of the plants: external coverings, it is true, are frequently made uſe of as a protection againſt the ſeverity of the weather, but they do not anſwer the purpoſe equally well, for when the froſt continues long they cannot be applied day and night without doing injury, by excluding air and light; the application of fire-heat is likewiſe neceſſary for baniſhing the damp, which very much injures and frequently deſtroys the plants, during long-continued, dull, rainy weather. The flues in green-houſes are frequently confined to the back wall, but they ought to paſs in front of the houſe likewiſe, becauſe the plants ſituated are moſt liable to be injured by the ſeverity of the weather.

Conſtruction of Green-houſes, &c.

As fires are ſeldom required, and thoſe but very ſlight ones, merely to baniſh froſt and damp, it will not be neceſſary from economical motives to conſtruct the flues, ſo as to throw off the greateſt poſſible quantity of heat, they may therefore be concealed that they may not affect the appearance of the houſe.

Hot-houſes for rearing plants which grow in warmer climates, or for forcing at an early period ſuch vegetables as grow in the open air, vary conſiderably according to the different purpoſes for which they are intended. 1ſt, Conſervatories, or dry ſtoves, ſo called becauſe they are conſtructed without pits for containing tanners bark, oak leaves, or other fermentable ſubſtances, and in which the plants grow in the earth which forms the floor of the houſe, and not in pots. Thoſe are commonly of a conſiderable width and height, and are either covered entirely, or at leaſt on the front, roof, and ends, with glaſs. 2dly, Hot-houſes for rearing exotic plants, furniſhed with a pit containing tanners bark, oak leaves, heated ſand, &c. in which pots containing the plants are plunged: theſe likewiſe are of conſiderable breadth and height, and have their front, roof, and ends, covered with glaſs. 3dly, Pine-houſes which are furniſhed with a pit, as above: theſe are low, the roof being within a few feet of the ſurface of the pit, that the pine plants may be as near the light as poſſible, and the roof and part of the front only need be of glaſs.

Vine-houſes are commonly conſtructed without pits, and are generally about 12 or 14 feet high, ſometimes very narrow, at other times of conſiderable breadth; the former anſwer beſt for forcing at a very early period, and in both houſes the vines are commonly trained both to the back and front.

Peach-houſes are almoſt always conſtructed without pits, are of a moderate height, and vary in breadth. The peaches are trained either to the front or back, or to both; and ſometimes they are planted in the middle of the houſe, and allowed to grow like ſtandard fruit trees, in which caſe the houſe ſhould be capacious.

Cherry and fig-houſes are conſtructed nearly in the ſame way as peach-houſes. The flues for warming all theſe ought to paſs round the front as well as the back of the houſe, and ought to have as much of their ſurface expoſed as poſſible; for the more of the ſurface of the flue comes in contact with the air of the houſe, the more readily the houſe will be warmed: therefore they ought not to be built in contact with the front or back walls when that can be avoided, but ought to be ſupported on pillars of brick, to keep them from reſting on the ground.

The furnaces for containing the fuel are placed ſometimes

Construction of Green-houses, &c.

times in front, sometimes at the end, but most frequently behind the house. They ought to be situated so far below the level of the flue, as is necessary to cause a sufficient draught; if this be not attended to, the smoke will not pass through the flues to warm the houses, but escape some other way. When the furnaces are about 18 inches high (a common size), they ought to be placed about two feet below the level of the flue, that the heated air may have an ascent of about six or eight inches, which will be sufficient to give the requisite draught.

When the hot-house is of considerable extent, it is better to employ several moderate, than a smaller number of strong fires, for violent fires are apt to crack the flues, in which case the smoke escapes into the house, and injures the plants. Some are partial to large fires, from an idea that they consume less fuel in proportion; but this is a mistake, for two moderate fires are found to heat the same extent of hot-house to an equal degree, and more equably, with a less expenditure of fuel than one large one. One moderate fire will be sufficient for an extent of 500 or 600 square feet of glass, but if the house is protected with coverings during the night, it will be sufficient for 700 or 800: thus the number of square feet of glass being known, the requisite number of fires may be easily ascertained. The fires employed for warming hot-houses may at the same time be converted to other useful purposes. At Billing in Northamptonshire, the seat of Lord John Cavendish, the furnaces are constructed to burn lime at the same time that they heat the hot-house. One furnace can burn four bushels of lime, and consume about three-fourths of a hundred weight of coal, when lighted only at night and in the morning.

Hot-houses are sometimes protected during the winter nights by external coverings of wood or canvass, &c. This renders less fire necessary; but the saving in point of fuel is more than overbalanced by the original expence of the covering, by the trouble of taking it off and putting it on morning and evening, and by the quantity of glass broken, particularly when the covering is made of canvass, which is apt to be dashed against the glass by the wind. When light coverings of cloth are applied internally they are not liable to the last-mentioned objection, but there are few hot-houses where they can be so applied.

INDEX to PART III.

GARDINER, Stephen, bishop of Winchester, and lord chancellor of England, born at Bury St Edmunds in Suffolk, natural son to Richard Woodville, brother to Queen Elizabeth wife to Edward IV. was learned in the canon and civil laws, and in divinity. He signed the divorce of Henry VIII. from Katharine of Spain; abjured the pope's supremacy; and writ *De vera et falsa obedientia*, in behalf of the king; yet in Edward's reign he opposed the reformation, and was punished with imprisonment; but Queen Mary coming to the throne, she enlarged him. He drew up the articles of marriage between the queen and Philip of Spain, which were very advantageous to England. He was violent against the reformers; but on his death-bed was dissatisfied with his life, and often repeated these words: *Erravi cum Petro, sed non flevi cum Petro.* He died in 1555.

GARGARISM (from γαργαριζω, "to wash the mouth;") a gargle. Its use is for washing the mouth and throat with, when inflammations, ulcerations, &c. are there. A small quantity may be taken into the mouth, and moved briskly about, and then spit out; or if the patient cannot do this to any advantage, the liquor may be injected by a syringe. When gargles are required, their use should be more frequently repeated than is done in common practice.

GARGET, a disease of cattle, consisting in a swelling of the throat and the neighbouring parts; to prevent which bleeding in the spring is recommended.

GARGIL, a distemper in geese, which by stopping the head frequently proves mortal. Three or four cloves of garlic, beaten in a mortar with sweet butter, and made into little balls, and given the creature fasting, are the ordinary cure.

GARIDELLA, a genus of plants belonging to the decandria class, and in the natural method ranking under the 26th order, *Multisiliquæ*. See Botany *Index*.

GARIZIM, Gerizim, or *Gerisim*, in *Ancient Geography*, a mountain of Samaria, at the foot of which stood Sichem; so near, that Jotham could be heard by the Sichemites from its top, (Judges, ix. 7.) Famous for the temple built on it by Sanballet, in favour of his son-in-law Manasseh, by the permission of Alexander the Great, and 200 years after destroyed by John Hyrcanus, son of Simon, the fourth in succession of the Asmoneans (Josephus).

GARLAND, a sort of chaplet made of flowers, feathers, and sometimes precious stones, worn on the head in manner of a crown.—The word is formed of the French *guirlande*, and that of the barbarous Latin *garlanda*, or Italian *ghirlanda*. Menage traces its origin from *gyrus* through *gyrulus*, to *gyrulare*, *gyrlandum*, *ghirlandum*; and at length *ghirlanda* and *guirlande*; so that *guirlande* and *garland* are descended in the sixth or seventh degree from *gyrus*.—Hicks rejects this derivation, and brings the word from *gardel handa*, which in the northern languages signify a *nosegay artfully wrought with the hand*.

Garland also denotes ornaments of flowers, fruits, and leaves, intermixed; anciently much used at the gates of temples, where feasts and solemn rejoicings were held; or at any other place where marks of public joy or gaiety were required, as at triumphal arches, tournaments, &c.

GARLIC. See Allium, Botany *Index*.

GARMENT, that wherewith any person is clothed. See Dress and Habit.

GARNET, in *Natural History*, a very beautiful gem, of a red colour, with an admixture of blue. See Mineralogy *Index*.

When pure and free from blemishes, it is little inferior in appearance to the oriental ruby, though only of a middle degree of hardness between the sapphire and common crystal. It is found of various sizes, from that of a pin's head to an inch in diameter.

Among lapidaries and jewellers, genuine garnets are known by different names according to their different degrees of colour. 1. The garnet, simply so called, is the finest and most valuable kind, being of a very deep blood-red with a faint admixture of blue. 2. The rock-ruby; a name very improperly given to the garnet when it is of a very strong but not deep red, and has a fairer cast of the blue; this is a very beautiful gem. 3. The sorane or serain garnet; that of a yet brighter red, approaching to the colour of native cinnabar,

cinnabar, with a faint blue tinge. 4. The almandine, a garnet only a little paler than that called the *rock-ruby*.

Garnet-Colour. See *Colouring of Glass*.

To imitate Garnets. The making the counterfeit garnet in paste is done as follows.—Take prepared crystal two ounces, common red-lead six ounces, manganese 16 grains, zaffre three grains; mix all well, put them into a crucible, cover it with lute, and set it in a potter's kiln for 24 hours. Or take crystal two ounces, minium five ounces and a half, manganese 15 grains, zaffre four grains: mix them well together; and let all be baked, in a pot well luted, in a potter's kiln 24 hours.

GARONNE, a large river of France, which taking its rise in the Pyrenean mountains, runs north-west by the city of Tholouse, divides the provinces of Guienne and Gascony, and, visiting the city of Bourdeaux, falls into the bay of Biscay, about 60 miles below that city. It has also a communication with the Mediterranean, by means of the royal canal of Louis XIV. The tide flows up this river 20 miles above Bourdeaux.

GARRICK, David, Esq. the great Roscius of his age and country, who for near 40 years shone the brightest luminary in the hemisphere of the stage, was born at the Angel Inn at Hereford, in the year 1716. His father, Captain Peter Garrick, was a French refugee, and had a troop of horse which were then quartered in that city. This rank he maintained in the army for several years, and had a majority at the time of his death; that event, however, prevented him from ever enjoying it. Mr Garrick received the first rudiments of his education at the free-school at Litchfield; which he afterwards completed at Rochester, under the celebrated Mr Colson, since mathematical professor at Cambridge. Dr Johnson and he were fellow-students at the same school; and it is a curious fact, that these two celebrated geniuses came up to London, with the intention of pushing themselves into active life, in the same coach. On the 9th of March 1736, he was entered at the honourable society of Lincoln's Inn. The study of the law, however, he soon quitted; and followed for some time the employment of a wine merchant: but that too disgusting him, he gave way at last to the irresistible bias of his mind, and joined a travelling company of comedians at Ipswich in Suffolk, where he went by the name of *Lyddle*. Having in this poor school of Apollo got some acquaintance with the theatric art, he burst at once upon the world, in the year 1740-1, in all the lustre of perfection, at the little theatre in Goodman's Fields, then under the direction of Henry Giffard.

The character he first performed was Richard III. in which, like the sun bursting from behind a cloud, he displayed in the earliest dawn even more than meridian brightness. His excellence dazzled and astonished every one; and the seeing a young man, in no more than his 24th year, and a novice in reality to the stage, reaching at one single step to that height of perfection which maturity of years and long practical experience had not been able to bestow on the then capital performers of the English stage, was a phenomenon that could not but become the object of universal speculation and of as universal admiration. The theatres at the west end of the town were deserted; Goodman's Fields, from being the rendezvous of citizens and citizens wives alone, became the resort of all ranks of men; and Mr Garrick continued to act till the close of the season.

Having very advantageous terms offered him for the performing in Dublin during some part of the summer (1741), he went over thither, where he found the same just homage paid to his merit which he had received from his own countrymen. To the service of the latter, however, he esteemed himself more immediately bound; and therefore in the ensuing winter, engaged himself to Mr Fleetwood, then manager of Drury Lane; in which theatre he continued till the year 1745, when he again went over to Ireland, and continued there the whole season, joint manager with Mr Sheridan in the direction and profits of the theatre royal in Smock Alley. From thence he returned to England, and was engaged for the season of 1746 with Mr Rich at Covent Garden. This was his last performance as a hired actor: for in the close of that season, Mr Fleetwood's patent for the management of Drury Lane being expired, and that gentleman having no inclination further to pursue a design by which, from his want of acquaintance with the proper conduct of it, or some other cause, he had considerably impaired his fortune; Mr Garrick, in conjunction with Mr Lacy, purchased the property of that theatre, together with the renovation of the patent; and in the winter of 1747, opened it with the greatest part of Mr Fleetwood's company, and with the great additional strength of Mr Barry, Mrs Pritchard, and Mrs Cibber, from Covent Garden.

Were we to trace Mr Garrick through the several occurrences of his life,—a life so active, so busy, and so full of occurrences as his, we should swell this account to many pages. Suffice it to say, he continued in the unmolested enjoyment of his fame and unrivalled excellence to the moment of his retirement. His universality of excellence was never once attacked by competition. Tragedy, comedy, and farce, the lover and the hero, the jealous husband who suspects his wife without cause, and the thoughtless lively rake who attacks her without design, were all alike his own. Rage and ridicule, doubt and despair, transport and tenderness, compassion and contempt; love, jealousy, fear, fury, and simplicity; all took in turn possession of his features, while each of them in turn appeared to be the sole possessor of his heart. In the several characters of Lear and Hamlet, Richard, Dorilas, Romeo, and Lusignane; in his Ranger, Bayes, Drugger, Kitely, Brute, and Benedict, you saw the muscular conformations that your ideas attached to them all. In short, Nature, the mistress from whom alone this great performer borrowed all his lessons, being in herself inexhaustible, this her darling son, marked out for her truest representative, found an unlimited scope for change and diversity in his manner of copying from her various productions. There is one part of theatrical conduct which ought unquestionably to be recorded to Mr Garrick's honour, since the cause of virtue and morality, and the formation of public manners, are considerably dependent upon it; and that is, the zeal with which he aimed to banish from the stage all those plays which carry with them an immoral tendency, and

and to prune from thoſe which do not abſolutely, on the whole, promote the intereſts of vice, ſuch ſcenes of licentiouſneſs and liberty, as a redundancy of wit and too great livelineſs of imagination have induced ſome of our comic writers to indulge themſelves in, and to which the ſympathetic diſpoſition of our age of gallantry and intrigue has given ſanction. The purity of the Engliſh ſtage has certainly been much more fully eſtabliſhed during the adminiſtration of this theatrical miniſter, than it had ever been during preceding managements. He ſeems to have carried his modeſt, moral, chaſte, and pious principles with him into the very management of the theatre itſelf, and reſcued performers from that obloquy which ſtuck on the profeſſion. Of thoſe who were accounted blackguards, unworthy the aſſociation of the world, he made gentlemen, united them with ſociety, and introduced them to all the domeſtic comforts of life. The theatre was no longer eſteemed the receptacle of all vice; and the moral, the ſerious, the religious part of mankind, did not heſitate to partake of the rational entertainment of a play, and paſs a cheerful evening undiſguſted with the licentiouſneſs, and uncorrupted by the immorality, of the exhibition.

Notwithſtanding the numberleſs and laborious avocations attendant on his profeſſion as an actor, and his ſtation as a manager; yet ſtill his active genius was perpetually burſting forth in various little productions in the dramatic and poetical way, whoſe merit cannot but make us regret his want of time for the purſuance of more extenſive and important works. It is certain that his merit as an author is not of the firſt magnitude: but his great knowledge of men and manners, of ſtage effect, and his happy turn for lively and ſtriking ſatire, made him generally ſucceſsful; and his prologues and epilogues in particular, which are almoſt innumerable, poſſeſs ſuch a degree of happineſs, both in the conception and execution, as to ſtand unequalled. His Ode on the death of Mr Pelham ran through four editions in leſs than ſix weeks. His Ode on Shakeſpeare is a maſterly piece of poetry; and when delivered by himſelf, was a moſt capital exhibition. His alterations of Shakeſpeare and other authors have been at times ſucceſsful, and at times exploded. The cutting out the gravediggers ſcene from Hamlet will never be forgotten to him by the inhabitants of the gallery at Drury. Though neceſſary to the chaſteneſs of the ſcene, they cannot bear to loſe ſo much true ſterling wit and humour; and it muſt be owned, that exuberances of that kind, though they hurt the uniformity, yet increaſe the luxuriance of the tree. Among his alterations the following are part: Every Man in his Humour, altered from Ben Johnſon; Romeo and Juliet, Winter's Tale, Catherine and Petruchio, Cymbeline, Hamlet, &c. altered and made up from Shakeſpeare; Gameſters, a comedy, from Shirley; Iſabella, from Southerne. To theſe we add, as original productions, The Farmer's Return, and Linco's Travels, interludes; Guardian, Lethe, Lying Valet, Miſs in her Teens, Male Coquet, Iriſh Widow, and other comedies in two acts; Enchanter, a muſical entertainment; Lilliput: the Chriſtmas Tale is aſcribed to him, and many others.

We now bring him to the period of his retirement in the ſpring of 1776; when, full of fame, with the acquirement of a ſplendid fortune, and growing into years, he thought proper to ſeek the vale of life, to enjoy that dignified and honourable eaſe which was compatible with his public ſituation, and which he had ſo well earned by the activity and the merits of his dramatic reign. But very ſhort indeed was the period allotted to him for this precious enjoyment: for on the 20th of January 1779, he departed this life; leaving no one rival in excellence upon earth to compenſate for his loſs, or a hope of our ever meeting with his like again.

GARRISON, in the art of war, a body of forces, diſpoſed in a fortreſs, to defend it againſt the enemy, or to keep the inhabitants in ſubjection; or even to be ſubſiſted during the winter ſeaſon: hence *garriſon* and *winter quarters* are ſometimes uſed indifferently for the ſame thing; and ſometimes they denote different things. In the latter caſe, a garriſon is a place wherein forces are maintained to ſecure it, and where they keep regular guard, as a frontier town, a citadel, caſtle, tower, &c. The garriſon ſhould be always ſtronger than the townſmen.

Du Cange derives the word from the corrupt Latin *garniſio*, which the latter writers uſe to ſignify all manner of munition, arms, victuals, &c. neceſſary for the defence of a place, and ſuſtaining of a ſiege.

Winter quarters ſignify a place where a number of forces are laid up in the winter ſeaſon, without keeping the regular guard.

GARSTANG, a town in Lancaſhire, 223 miles from London. It is a large populous place, near a mile in length, but built in a very irregular manner, with dirty ſtreets, and very indifferent houſes. The church is a ſtately Gothic ſtructure. By the late inland navigation, it has communication with the rivers Merſey, Dee, Ribble, Ouſe, Trent, Darwent, Severn, Humber, Thames, Avon, &c. which navigation, including its windings, extends above 500 miles, in the counties of Lincoln, Nottingham, York, Weſtmorland, Cheſter, Stafford, Warwick, Leiceſter, Oxford, Worceſter, &c.

GARTER, a ligature for tying up the ſtocking; but particularly uſed for the badge of a noble order of knights, hence denominated the

Order of the GARTER, a military order of knighthood, the moſt noble and ancient of any lay order in the world, inſtituted by Edward III. The knights companions are generally princes and peers; and the king of England is the ſovereign or chief of the order. The number of knights was originally 26; but ſix were added in 1786, on account of the increaſe of the royal family. They are a college or corporation, having a great and little ſeal.

Their officers are a prelate, chancellor, regiſter, king at arms, and uſher of the black rod. They have alſo a dean, with 12 canons and petty canons, vergers, and 26 penſioners or poor knights. The prelate is the head. This office is veſted in the biſhop of Wincheſter, and has ever been ſo. Next to the prelate is the chancellor; which office is veſted in the biſhop of Saliſbury, who keeps the ſeals, &c. The next is the regiſter, who by his oath is to enter upon the regiſtry, the ſcrutinies, elections, penalties, and other acts of the order, with all fidelity: The dean of Windſor is always regiſter *ex officio*. The fourth officer is Garter and king-at-arms, being two diſtinct offices united in one perſon.

Garter

Garter.

Garter carries the rod and ſceptre at the feaſt of St George, the protector of this order, when the ſovereign is preſent. He notifies the elections of new knights, attends the ſolemnity of their inſtallations, carries the garter to foreign princes, &c. He is the principal officer within the college of arms, and chief of the heralds. See *King-at-Arms*.

All theſe officers except the prelate have fees and penſions. The college of the order is ſeated in the caſtle of Windſor, within the chapel of St George, and the charter houſe, erected by the founder for that purpoſe. The habit and enſign of the order are, a garter, mantle, cape, george, and collar. The three firſt were aſſigned the knights companions by the founder; and, the george and collar by Henry VIII.

The garter challenges pre-eminence over all the other parts of the dreſs, by reaſon that from it the noble order is denominated; that it is the firſt part of the habit preſented to foreign princes and abſent knights, who, and all other knights-elect, are therewith firſt adorned; and it is of ſo great honour and grandeur, that by the bare inveſtiture with this noble enſign, the knights are eſteemed companions of the greateſt military order in the world. It is worn on the left leg between the knee and calf, and is enamelled with this motto, Honi soit qui mal y pense; i. e. *Shame to him that thinks evil hereof:* The meaning of which is, that King Edward having laid claim to the kingdom of France, retorted ſhame and defiance upon him that ſhould dare to think amiſs of the juſt enterpriſe he had undertaken, for recovering his lawful right to that crown; and that the bravery of thoſe knights whom he had elected into this order, was ſuch as would enable him to maintain the quarrel againſt thoſe that thought ill of it.

The mantle is the chief of theſe veſtments made uſe of upon all ſolemn occaſions. The colour of the mantle is by the ſtatutes appointed to be blue. The length of the train of the mantle only diſtinguiſhes the ſovereign from the knights companions. To the collar of the mantle is fixed a pair of long ſtrings, anciently woven with blue ſilk only, but now twiſted round, and made of Venice gold and ſilk, of the colour of the robes, with knobs or buttons, and taſſels at the end. The left ſhoulder of the mantle has from the inſtitution been adorned with a large garter, with the device, Honi soit, &c. Within this is the croſs of the order, which was ordained to be worn at all times by King Charles I. At length the ſtar was introduced, being a ſort of croſs irradiated with beams of ſilver.

The collar is appointed to be compoſed of pieces of gold in faſhion of garters, the ground enamelled blue, and the motto gold.

When the knights wear not their robes, they are to have a ſilver ſtar on the left ſide; and they commonly bear the picture of St George, enamelled on gold, and beſet with diamonds, at the end of a blue ribbon, croſſing the body from the left ſhoulder. They are not to appear abroad without the garter, on penalty of 6s. 8d. paid to the regiſter.

The manner of electing a knight companion into this moſt noble order, and the ceremonies of inveſtiture, are as follow. When the ſovereign deſigns to elect a companion of the garter, the chancellor belonging to this order draws up the letters, which, paſſing both under the ſovereign's ſign manual and ſignet of the order, are ſent to the perſon by Garter principal king at arms; and are in this manner, or to the ſame effect: "We, with the companions of our moſt noble order of the garter, aſſembled in chapter, holden this preſent day at our caſtle at Windſor, conſidering the virtuous fidelity you have ſhown, and the honourable exploits you have done in our ſervice, by vindicating and maintaining our right, &c. have elected and choſen you one of the companions of our order. Therefore, we require you to make your ſpeedy repair unto us, to receive the enſigns thereof, and be ready for your inſtallation upon the — day of this preſent month, &c."

The garter, which is of blue velvet bordered with fine gold wire, having commonly the letters of the motto of the ſame, is, at the time of election, buckled upon the left leg, by two of the ſenior companions, who receive it from the ſovereign, to whom it was preſented upon a velvet cuſhion, by Garter king at arms, with the uſual reverence, whilſt the chancellor reads the following admonition, enjoined by the ſtatutes: "To the honour of God omnipotent, and in memorial of the bleſſed martyr St George, tie about thy leg, for thy renown, this noble garter; wear it as the ſymbol of the moſt illuſtrious order, never to be forgotten or laid aſide; that thereby thou mayeſt be admoniſhed to be courageous; and having undertaken a juſt war, in which thou ſhalt be engaged, thou mayeſt ſtand firm, valiantly fight, and ſucceſsfully conquer." The princely garter being then buckled on, and the word of its ſignification pronounced, the knight elect is brought before the ſovereign, who puts about his neck, kneeling, a dark blue ribbon, whereunto is appendant, wrought in gold within the garter, the image of St George on horſeback, with his ſword drawn, encountering with the dragon. In the mean time, the chancellor reads the following admonition: "Wear this ribbon about thy neck, adorned with the image of the bleſſed martyr and ſoldier of Chriſt, St George, by whoſe imitation provoked, thou mayeſt ſo overpaſs both proſperous and adverſe adventures, that having ſtoutly vanquiſhed thy enemies both of body and ſoul, thou mayeſt not only receive the praiſe of this tranſient combat, but be crowned with the palm of eternal victory." Then the knight elected kiſſes the ſovereign's hand; thanks his majeſty for the great honour done him; riſes up, and ſalutes all the companions ſeverally, who return their congratulations. See a repreſentation of the above inſignia, among others, on the plate belonging to *Orders of Knighthood*.

Since the inſtitution of this order, there have been eight emperors and twenty-eight kings, beſides numerous ſovereign princes enrolled as companions thereof. Its origin is ſomewhat differently related. The common account is, that the counteſs of Saliſbury at a ball happening to drop her garter, the king took it up and preſented it to her with theſe words, "*Honi ſoit qui mal y penſe*; i. e. Evil to him that evil thinks. This accident, it is ſaid, gave riſe to the order and the motto; it being the ſpirit of the times to mix love and war together: but as in the original ſtatutes of this order there is not the leaſt conjecture to countenance ſuch a feminine inſtitution, credit cannot be given to this tradition. Camden, Fern, &c. take it to to have been instituted on occasion of the victory obtained by Edward over the French at the battle of Cressy; that prince, say some historians, ordered his garter to be displayed, as a signal of battle: in commemoration whereof, he made a garter the principal ornament of the order, erected in memory of this signal victory, and a symbol of the indissoluble union of the knights.

It appears from Rastel's Chronicle, lib. vi. quoted by Granger in the supplement to his Biographical History, that this order was devised by Richard I. at the siege of the city of Acre, when he caused twenty-six knights, who firmly stood by him, to wear thongs of blue leather about their legs, and that it was perfected in the nineteenth year of Edward III.

In 1551, Edward VI. made some alterations in the ritual of this order: that prince composed it in Latin, the original whereof is still extant in his own hand writing. He there ordained, that the order should no longer be called the order of St George, but that of the Garter; and, instead of the george, hung at the collar, he substituted a cavalier, bearing a book on the point of his sword, with the word *protectio* graven on the sword, and *verbum Dei* on the book: with a buckle in the left hand, and the word *fides* thereon. Larrey.

GARTER, *principal King at Arms*. This office was instituted by Henry V.

Garter, and principal king at arms, are two distinct offices united in one person: Garter's employment is to attend the service of the order of the garter; for which he is allowed a mantle and badge, a house in Windsor castle, and pensions both from the sovereign and knights, and lastly, fees. He also carries the rod and sceptre at every feast of St George, when the sovereign is present, and notifies the election of such as are new chosen; attends the solemnity of their installations, takes care of placing their arms over their seats; and carries the garter to foreign kings and princes, for which service it has been usual to join him in commission with some peer, or other person of distinction.

Garter's oath relates only to services being performed within the order, and is taken in chapter before the sovereign and knights. His oath, as king at arms, is taken before the earl marshal.

GARTER is also a term in heraldry, signifying the moiety or half of a bend.

GARTH is used in some parts of England for a little backside or close. It is an ancient British word. Gardd, in that language, signifies *garden*, and is pronounced and written *garth*. This word is also used for a dam or wear, &c.

GARTH *Men* is used in our statutes for those who catch fish by means of fish garths, or wears. By statute it is ordained, that no fisher, nor garth man, shall use any nets or engines to destroy the fry of fish, &c. 17 Ric. II. cap. 9. The word is supposed by some to be derived from the Scotch word *gart*, which signifies *forced* or *compelled*; because fish are forced by the wear to pass in a loop, where they are taken.

GARTH, *Sir Samuel*, an excellent English poet and physician, was descended from a good family in Yorkshire. He was admitted into the college of physicians at London in 1693. He at that time zealously promoted and encouraged the erecting of the dispensary for the relief of the sick poor, by giving them advice gratis, and medicines at low rates. This work of charity having exposed him and many other physicians to the envy and resentment of several persons of the same faculty as well as apothecaries, he ridiculed them, with a peculiar spirit and vivacity, in a poem called the *Dispensary*, in six cantos, highly esteemed. He was one of the most eminent members of the famous society called the *Kit Kat Club*, which consisted of noblemen and gentlemen distinguished by their excellent parts and affection to the house of Hanover. Upon the accession of George I. he was knighted, and made physician in ordinary to his majesty, and physician general to the army. Nor were these more than just rewards even of his physical merit. He had gone through the office of censor of the college in 1702; and had practised always with great reputation, and a strict regard to the honour and interest of the faculty, never stooping to prostitute the dignity of his profession, through mean and sordid views of self-interest, to any, even the most popular and wealthy apothecaries. In a steady adherence to this noble principle, he concurred with the much celebrated Dr Radcliffe, with whom he was also often joined in physical consultations. He had a very extensive practice, but was very moderate in his views of advancing his own fortune; his humanity and good nature inclining him more to make use of the great interest he had with persons in power, for the support and encouragement of other men of letters. He chose to live with the great in that degree of independency and freedom which became a man possessed of a superior genius, whereof he was daily giving fresh proofs to the public. One of his last performances in polite letters, was his translation of the whole fourteenth book, and the story of Cinnus in the fifteenth book, of Ovid's Metamorphoses. These, together with an English version of the rest, were published in 1717; and he has prefixed an excellent preface to the whole, wherein he not only gives an idea of the work, and points out its principal beauties, but shows the uses of the poem, and how it may be read to most profit. The distemper which seized him the ensuing year, and ended not but with his life, caused a general concern; which was particularly testified by Lord Lansdowne, a brother poet, though of a different party, in some admirable verses written on the occasion. He died, after a short illness, which he bore with great patience, in January 1719.

GARUMNA, a noble and navigable river of Gaul, which rising from the Pyrenees, formerly bounded Aquitain on the north (Cæsar); but by the new regulation of Augustus divided it in the middle, emptying itself to the north of Burdegala, in the Aquitanic ocean. Now the *Garonne*. Mela observes concerning it, that unless it is swelled by winter rains, or the melting of the snow, it is for a great part of the year shoaly and scarce navigable; but when increased by the meeting tide, whereby its waters are impelled, it is somewhat fuller; and the farther the river advances, it is broader, till at length it resembles a large frith or arm of the sea, not only bearing large vessels, but alfo fwelling like a raging fea, toffes them extremely, efpecially if the direction of the wind be one way and that of the current another.

GAS, in *Chemiftry*, a general name for all permanently elaftic fluids, which are obtained by chemical proceffes, as *azotic gas*, *muriatic acid gas*, *nitrous gas*. See Chemistry *Index*. It is derived from the German *gafcht* or *gaft*, fignifying an eruption of wind, or the ebullition attending the expulfion of elaftic fluids from fubftances in a ftate of fermentation or effervefcence. It was firft employed by Van Helmont.

GASCOIGNE, Sir William, chief juftice of the court of king's bench under Henry IV. A moft learned and upright judge: who being infulted on the bench by the then prince of Wales, afterwards Henry V. with equal intrepidity and coolnefs committed the prince to prifon; and by this feafonable fortitude laid the foundation of the future glory of that great monarch, who from this event dated his reformation from the licentioufnefs of his youth. It is not well authenticated that the prince ftruck Sir William, as recorded by Shakefpeare; but all authors agree, that he interrupted the courfe of juftice to fcreen a lewd fervant. Sir William died in 1413.

Gascoigne, *George*, an Englifh poet of fome fame in the early part of the reign of Queen Elizabeth, was born at Walthamftow in Effex, of an ancient family, and educated at both univerfities, but principally at Cambridge. From thence he removed to Gray's Inn, and commenced ftudent of the law; but having a genius too volatile for that ftudy, he travelled abroad, and for fome time ferved in the army in the Low Countries. He afterwards went to France; where he became enamoured of a Scottifh lady, and married her. Being at length, fays Wood, *weary of thofe vanities*, he returned to England; and fettled once more in Gray's Inn, where he wrote moft of his dramatic and other poems. The latter part of his life he fpent in his native village of Walthamftow, where he died in the year 1578. He had the character of a polite gentleman, an eloquent and witty companion, *et vir inter poetas fui feculi præftantiffimus*. His plays, firft printed feparately, were afterwards, with feveral other poems, &c. reprinted in two volumes 4to; the firft volume in 1577, the fecond in 1587.

GASCOIN, or Gascoign, denotes the hinder thigh of a horfe, which begins at the ftifle, and reaches to the ply or bending of the ham.

GASCONADE, a boaft or vaunt of fomething very improbable. The term has its rife from the Gafcons, or people of Gafcony in France, who it feems have been diftinguifhed for bragging and rhodomontade.

GASCONY, the moft fouth-weft province of France, is bounded by Guienne on the north, by Languedoc on the eaft, by the Pyrenees which feparate it from Spain on the fouth, and by the bay of Bifcay on the weft. It had its name from the ancient inhabitants, called *Gafcones*, or *Vafcones*; by the moderns *Bafques*, or *Vafques*. After thefe were fubdued by the Franks, they had for fome time dukes of their own, who were fubject to the dukes of Aquitaine; but both were at laft difpoffeffed by the kings of France. The country produces corn, wine, fruits, tobacco, hemp, brandy, prunes, &c. The inhabitants are noted for a corrupt and vicious pronunciation of the French tongue, as well as their vain-glorious boafting.

GASSENDI, Peter, one of the moft celebrated philofophers France has produced, was born at Chanterfier, about three miles from Digne in Provence, in 1592. When a child, he took particular delight in gazing at the moon and ftars as often as they appeared in clear unclouded weather. This pleafure frequently drew him into bye places, in order to feaft his eye freely and undifturbed; by which means his parents had him often to feek, not without many anxious fears and apprehenfions. They therefore put him to fchool at Digne; where, in a fhort time, he made fuch an extraordinary progrefs in learning, that fome perfons, who had feen fpecimens of his genius, refolved to have him removed to Aix, in order to ftudy philofophy under Fefay, a learned minor friar. This propofal was fo difagreeable to his father, who intended to breed him up in his own way to country bufinefs, as being more profitable than that of a fcholar, that he would confent to it only upon condition that he fhould return home in two years at fartheft. Accordingly young Gaffendi, at the end of the appointed time, repaired to Chanterfier; but he had not been long there when he was invited to be profeffor of rhetoric at Digne, before he was quite 16 years of age; and he had been engaged in that office but three years, when his mafter Fefay dying, he was made profeffor in his room at Aix. When he had been there a few years, he compofed his Paradoxical Exercitations; which, coming to the hands of Nicholas Peirefc, that great patron of learning joined with Jofeph Walter prior of Valette in promoting him; and he having entered into holy orders, was firft made canon of the church of Digne and doctor of divinity, and then obtained the wardenfhip or rectorfhip of that church. Gaffendi's fondnefs for aftronomy grew up with his years; and his reputation daily increafing, he was in 1645 appointed royal profeffor of mathematics at Paris. This inftitution being chiefly defigned for aftronomy, our author read lectures on that fcience to a crowded audience. However, he did not hold this place long; for a dangerous cough and inflammation of the lungs obliged him, in 1647, to return to Digne for the benefit of his native air.—Gaffendi wrote againft the metaphyfical meditations of Defcartes; and divided with that great man the philofophers of his time, almoft all of whom were Cartefians or Gaffendians. He joined to his knowledge of philofophy and the mathematics an acquaintance with the languages and a profound erudition. He wrote, 1. Three volumes on Epicurus's Philofophy; and fix others, which contain his own philofophy. 2. Aftronomical Works. 3. The Lives of Nicholas de Peirefc, Epicurus, Copernicus, Tycho Brahe, Puerbachius, and Regiomontanus. 4. Epiftles, and other treatifes. All his works were collected together, and printed at Lyons in 1658, in fix volumes folio. He died at Paris in 1658, aged 63.

GASTEROSTEUS, the stickleback, a genus of fifhes belonging to the order of thoracici. See Ichthyology *Index*.

GAST-hound. See *Gaze Hound*.

GASTRIC, in general, fomething belonging to the ftomach.

Gastric *Juice*, a thin pellucid liquor, which diftils from

from certain glands in the ſtomach, for the dilution, &c. of the food. See ANATOMY.

GASTROCNEMIUS, in *Anatomy*. See ANATOMY, *Table of the Muſcles*.

GASTROMANCY, or GASTROMANTIA, a kind of divination practiſed among the ancients by means of words coming or ſeeming to come out of the belly.

The word is Greek, γαςρομαντεια, compoſed of γαςηρ, *belly*, and μαντεια, *divination*.

There is another kind of divination called by the ſame name *gaſtromancy*, which is performed by means of glaſſes or other round tranſparent veſſels, within which certain figures appear by magic art. It is thus called, becauſe the figures appear as in the belly of the veſſels.

GASTRORAPHY, in *Surgery*, the operation of ſewing up wounds of the abdomen. See SURGERY.

GASTROTOMY (of γαςηρ, and τεμνω, *I cut*), the operation of cutting open the belly; otherwiſe called the *Cæſarean ſection*. See MIDWIFERY.

GATAKER, THOMAS, a learned critic and divine, was born at London in 1574, and ſtudied at St John's college, Cambridge. He was afterwards choſen preacher at Lincoln's Inn; which he quitted in 1611, for the rectory of Rotherhithe in Surry. In 1620, he made a tour through the Low Countries; and in 1624, publiſhed at London a book, entitled, Tranſubſtantiation declared by the confeſſion of the Popiſh Writers to have no neceſſary foundation in God's Word: he wrote likewiſe a defence of this diſcourſe. In 1642, he was appointed one of the aſſembly of divines, and was engaged with them in writing annotations upon the Bible. He died in July 1654, in the 80th year of his age. Beſides the above works, he publiſhed, 1. A Diſſertation upon the Style of the New Teſtament. 2. *De Nomine Tetragrammata*. 3. *De Diphthongis, ſive Bivocalibus*. 4. An Edition and Tranſlation of the Emperor Marcus Antoninus's Meditations. 5. A Collection of Sermons, in folio; and many other works. His piety and charity were very exemplary; and his modeſty ſo great, that he declined all eccleſiaſtical dignity and court preferments. His extenſive learning was admired by Salmaſius and other great men abroad; his houſe was a private ſeminary for young gentlemen of this nation, and many foreigners reſorted to him to receive advice in their ſtudies.

GATE, in *Architecture*, a large door, leading or giving entrance into a city, town, caſtle, palace, or other conſiderable building. See ARCHITECTURE.

Thebes, in Egypt, was anciently known by the appellation *with a hundred gates*. In ancient Rome there was a triumphal gate, *porta triumphalis*. In modern Rome there is the *jubilee gate*, which is only opened in the year of a grand jubilee.

The gates of London were many of them converted into gaols or priſons, as Ludgate, Newgate, &c. but they are now removed. The leſſer or by-gates are called *poſterns*. Gates, through which coaches, &c. are to paſs, ſhould not be leſs than 7 feet broad, nor more than 12; the height to be $1\frac{1}{2}$ the breadth.

GATE, or GAIT, in the manege, called in French *train*, is uſed for the going or pace of a horſe.

GATE, in a military ſenſe, is made of ſtrong planks, with iron bars, to oppoſe an enemy. They are generally made in the middle of the curtain, from whence they are ſeen, and defended by the two flanks of the baſtions. They ſhould be covered with a good ravelin, that they may not be ſeen or enfiladed by the enemy. Theſe gates, belonging to a fortified place, are paſſages through the rampart, which may be ſhut and opened by means of doors and a portcullis. They are either private or public.

Private gates are thoſe paſſages by which the troops can go out of the town unſeen by the enemy, when they paſs to and from the relief of the duty in the outworks, or from any other occaſion which is to be concealed from the beſiegers.

Public gates are thoſe paſſages through the middle of ſuch curtains, to which the great roads of public ways lead. The dimenſions of theſe are uſually about 13 or 14 feet high, and 9 or 10 feet wide, continued through the rampart, with proper receſſes for foot paſſengers to ſtand in out of the way of wheel carriages.

GATES of Hell. This expreſſion is uſed in Scripture, to denote figuratively either the *grave* or the *powers of darkneſs*, i. e. the devil and his angels.

The Mahometans uſe the expreſſion literally, and ſuppoſe that hell has ſeven gates. The firſt is that where Muſſulmans, who incur the guilt of ſin, will be tormented. The ſecond is for the Chriſtians. The third is for the Jews. The fourth is for the Sabians. The fifth for the Magians or worſhippers of fire. The ſixth for Pagans and idolaters. And the ſeventh for hypocrites, who make an outward ſhow of religion, but have none.

GATESHEAD, in the county of Durham, is as it were the ſuburbs of Newcaſtle, though it lies in another county, being divided by the river Tyne; over which there is a fine ſtone bridge, with an iron gate in the middle, having the arms of Durham on one ſide, and thoſe of Newcaſtle on the other, which is the boundary between the biſhopric and Northumberland. The church is a fine building, with a very high tower, ſeen at a great diſtance; and in the churchyard are ſeveral ancient monuments. There are few traces left of its ancient monaſtery, except a ſtone gateway, or rather a modern erection. The houſe covered two acres and a half of land.

GATH, or GETH, in *Ancient Geography*, a celebrated city of the Philiſtines, and one of their five principalities. It is famous for having given birth to Goliath. David made a conqueſt of it in the beginning of his reign over all Iſrael; and it continued ſubject to the kings his ſucceſſors till the declenſion and decay of the kingdom of Judah. Rehoboam rebuilt or fortified it; King Uzziah retook it, and Hezekiah once more reduced it under his ſubjection.

Gath ſtood about five or ſix miles from Jamnia, about 14 ſouth of Joppa, and 32 weſt of Jeruſalem. Hence ſome authors (among whom is F. Calmet) have committed an egregious miſtake in making Gath the moſt ſouthern, and Ekron the moſt northern, of the Philiſtine cities; as if theſe two had been the two boundaries of their dominions, whereas theſe two cities are not above five miles aſunder; and Gaza is the laſt of the five ſatrapies ſouth. And Joſephus (in the place already quoted) expreſſes himſelf plainly enough, when he ſays, that Hezekiah took all the Philiſtine cities

cities from Gaza to Gath; there being many more cities of that name, which signifies in the Hebrew a *wine press*. Several more of the name of Geth or Gath are mentioned in Eusebius and St Jerome, whose situation, according to them, plainly shows them to have been different places from this, and from each other; besides those which had an adjunct to distinguish them.

This city recovered its liberty and lustre in the time of the prophets Amos and Micah; but was afterwards demolished by Hazael king of Syria, after which it became of but little consideration till the time of the holy war, when Fulk king of Jerusalem built a castle on its ruins.

Gath Opher, *Gath Epher*, or *Gath*, in the canton of Opher, in Galilee, was the birth-place of the prophet Jonah. Joshua makes this city to be part of the tribe of Zebulun; and St Jerome, in his preface upon Jonah, says, that it was two miles from Sephoris, otherwise called *Diocæsarea*.

Gath Rimmon, a city belonging to the tribe of Dan. St Jerome places it ten miles from Diospolis on the way from Eleutheropolis. It was given to the Levites of Kohath's family.

Gath Rimmon, was also a city in the half tribe of Manasseh, on this side Jordan, and was also given for a place of abode to the Levites of Kohath's family.

Gath Rimmon, was likewise a city in the tribe of Ephraim, given to the Kohathites.

GATTON, a borough in the county of Surry, 19 miles from London. It lies under the side of a hill going to Reygate; and is supposed to have been known to the Romans, by reason of their coins and other antiquities that have been found here. It is a borough by prescription; and has sent members to parliament ever since the 29th of Henry VI. It was formerly a large town; but is now a mean village, with a small church, and without either fair or market. The members are returned by its constable, who is annually chosen at the lord of the manor's court.

GAUBIUS, Jerome-David, M. D. professor of medicine at Leyden, and afterwards fellow of the Royal Society of London, was born at Heidelberg in the year 1705. From the Jesuits he received the rudiments of his education, and was much esteemed by them on account of his abilities; but his father afterwards sent him to the orphan house of Halle, lest he should be obliged to abjure his religion. The nature of the discipline, however, he here found to be much too severe, which induced him to request his father to remove him from it, which was accordingly complied with. His teacher at this hospital attributing the dislike of young Gaubius to the want of genius, urged him to give his son some mechanical employment; but the father thought proper to indulge his ardent desire after knowledge, and accordingly sent him to Amsterdam to study under his uncle John, who was an eminent physician. After prosecuting his medical studies for some time at Hordwyk, he resolved to visit Leyden, where the immortal Boerhaave was an eminent professor, and whose penetrating eye soon discovered that Gaubius was possessed of talents above mediocrity. He honoured him with unlimited access to his house, delighted in imparting instruction to him, and gradually forwarded the cultivation of his mind. He took the degree of doctor at the age of 20, after a disputation on the nature of solids, containing an abstract of the system which he himself followed through life.

He travelled through various parts of Europe, and when he returned to Heidelberg by the way of Strasburgh, he was appointed city-physician at Deventer in the province of Overyssel; but he soon after removed to Amsterdam. Boerhaave never lost sight of his favourite pupil; for when the infirmities of old age and indefatigable labour made him anxious to resign his chair, Gaubius on his recommendation was appointed to succeed him. He published his Instructions for writing Recipes in the year 1738, by which he acquired great and justly merited approbation, as he reduced the art from a mere mechanical to a scientific form. His Principles of Nosology is perhaps his most masterly performance, as it evinced that he was highly worthy of such a preceptor. His next publication, which appeared in 1771, was his "Adversaria varii Argumenti," a work which was particularly interesting to chemists; and his oration on the 200th anniversary of the academy of Leyden attracted considerable notice, as in it he traced out, with his accustomed acumen, the chief epochs of the arts and sciences in Holland.

He was likewise the author of numerous and valuable papers in the Transactions of the Society of Haerlem, and was editor of many excellent performances, among which we may rank Cramer's *Elementa artis docimasticæ; Albinus de presagienda vita et morte*, and Swammerdam's Book of Nature, which he partly translated. His literary merit spread his fame so far beyond the bounds of his native country, that pupils repaired to Leyden from every quarter of Europe. In addition to his widely extended reputation, he was blessed with the enjoyment of good health till he was 70 years of age, and died on the 29th of November 1780, in his seventy-fifth year.

One work of his, entitled "Institutiones Pathologiæ Medicinalis," was deemed so valuable by Professor Ackerman, and of such singular advantage in academical lectures, that he gave the world a fourth edition of it, published at Nuremberg in 1787.

GAUDEN, Dr Joseph, son of John Gauden vicar of Mayfield in Essex, was born there in 1605. At the commencement of the civil war, he was chaplain to Robert earl of Warwick; who taking part with the parliament against the king, was followed by his chaplain. Upon the establishment of the Presbyterian model of church government, he complied with the ruling powers, and was nominated one of the assembly of divines who met at Westminister in 1643, and took the covenant; yet having offered some scruples and objections to it, his name was afterwards struck out of the list. Nor did he espouse the parliament cause any longer than they adhered to their first avowed principles of reforming only, instead of destroying, monarchy and episcopacy. In this spirit he was one of those divines who signed a protestation to the army against the violent proceedings that affected the life of the king: and a few days after his execution published the famous Εικων Βασιλικη, *A Portraiture of his Sacred Majesty in his Solitude and Sufferings;* which ran through 50 editions in the course of a year. Upon the return of Charles II. he was promoted to the see of Exeter; and in 1662 was removed to Worcester, much to his regret,

regret, having flattered himſelf with the hopes of a tranſlation to Wincheſter; and his death happened the ſame year. He wrote many controverſial pieces ſuited to the circumſtances of the times, and to his own views from them. The *Eikon Baſilike* above-mentioned he publiſhed as the king's private meditations: though on this point there has been a long controverſy. After the biſhop's death, his widow, in a letter to one of her ſons, calls it *The Jewel;* and ſaid, her huſband had hoped to make a fortune by it; and that ſhe had a letter of a very great man's, which would clear up that he writ it. This aſſertion, as the earl of Clarendon had predicted, was eagerly eſpouſed by the anti-royaliſts, in the view of diſparaging Charles I. But it has been obſerved, that Gauden had too luxuriant an imagination, which betrayed him into a rankneſs of ſtyle in the Aſiatic way; and from thence, as Biſhop Burnet argues with others, it may be certainly concluded, that not he, but the king himſelf, was the true author of the Εικων Βασιλικη; in which there is a nobleneſs and juſtneſs of thought, with a greatneſs of ſtyle, that made it be looked on as the beſt written book in the Engliſh language.

GAVEL, or GABEL, among builders. See GABEL.

GAVEL, in *Law*, tribute, toll, cuſtom, or yearly revenue; of which we had in old time ſeveral kinds. See GABEL.

GAVEL Kind, a tenure or cuſtom belonging to lands in the county of Kent. The word is ſaid by Lambard to be compounded of three Saxon words, *gyfe*, *eal*, *kyn*, "*omnibus cognatione proximis data.*" Verſtegan calls it *gavelkind*, quaſi "give all kind," that is, to each child his part: and Taylor, in his hiſtory of *gavelkind*, derives it from the Britiſh *gavel*, i. e. a hold or tenure, and *cenned*, "*generatio* aut *familia*;" and ſo *gavel cenned* might ſignify *tenura generationis.*—It is univerſally known what ſtruggles the Kentiſh men made to preſerve their ancient liberties, and with how much ſucceſs thoſe ſtruggles were attended. And as it is principally here that we meet with the cuſtom of gavelkind (though it was and is to be found in ſome other parts of the kingdom), we may fairly conclude, that this was a part of theſe liberties: agreeable to Mr Selden's opinion, that gavelkind, before the Norman conqueſt, was the general cuſtom of the realm. The diſtinguiſhed properties of this tenure are various: ſome of the principal are theſe: 1. The tenant is of age ſufficient to alienate his eſtate by feoffment, at the age of 15. 2. The eſtate does not eſcheat in caſe of an attainder and execution for felony; their maxim being, "the father to the bough, the ſon to the plough." 3. In moſt places he had the power of deviſing lands by will, before the ſtatute for that purpoſe was made. 4. The lands deſcend, not to the eldeſt, youngeſt, or any one ſon only, but to all the ſons together; which was indeed anciently the moſt uſual courſe of deſcent, all over England, though in particular places particular cuſtoms prevailed.

GAVELET, in *Law*, an ancient and ſpecial ceſſavit uſed in Kent, where the cuſtom of gavelkind continues, by which the tenant, if he withdraws his rent and ſervices due to the lord, forfeits his land and tenements.

The proceſs of the gavelet is thus. The lord is firſt to ſeek by the ſteward of his court, from three weeks to three weeks, to find ſome diſtreſs upon the tenement, till the fourth court; and if at that time he find none, at this fourth court it is awarded, that he take the tenement in his hand in name of a diſtreſs, and keep it a year and a day without manuring; within which time, if the tenant pay his arrears, and make reaſonable amends for the withholding, he ſhall have and enjoy his tenement as before: if he come not before the year and day be paſt, the lord is to go to the next county court with witneſſes of what had paſſed at his own court, and pronounce there his proceſs, to have further witneſſes; and then by the award of his own court, he ſhall enter and manure the tenement as his own: ſo that if the tenant deſired afterwards to have and hold it as before, he muſt agree with the lord; according to this old ſaying: "Has he not ſince any thing given, or any thing paid, then let him pay five pound for his were, e'er he become healder again." Other copies have the firſt part with ſome variation; "Let him nine times pay, and nine times repay."

GAVELET, in London, is a writ uſed in the huſtings, given to lords of rents in the city of London. Here the parties, tenant and demandant, appear by *ſcire facias*, to ſhow cauſe why the one ſhould not have his tenement again on payment of his rent, or the other recover the lands on default thereof.

GAUGAMELA, in *Ancient Geography*, a village of Aturia, lying between the rivers Lycus and Tigris; famous for Alexander's victory over Darius. It is ſaid to have been allowed to Darius Hyſtaſpes for the maintenance of a camel; and hence the name. It was not far from a more conſiderable place called *Arbela;* whence the latter gave the name to the victory. See ARBELA.

GAUGE-POINT of a ſolid meaſure, the diameter of a circle whoſe area is equal to the ſolid content of the ſame meaſure.

GAUGER, a king's officer, who is appointed to examine all tons, pipes, hogſheads, and barrels, of wine, beer, ale, oil, honey, &c. and give them a mark of allowance, before they are ſold in any place within the extent of his office.

GAUGING. See GEOMETRY.

GAUGING-Rod, an inſtrument uſed in gauging or meaſuring the contents of any veſſel. That uſually employed is the four-foot gauging rod. It is commonly made of box, and conſiſts of four rules, each a foot long and about three-eighths of an inch ſquare, joined together by three braſs joints; by which means the rod is rendered four feet long when the four rules are quite opened, and but one foot when they are all folded together. On the firſt face of this rod, marked 4, are placed two diagonal lines; one for beer and the other for wine: by means of which the content of any common veſſel in beer or wine gallons may be readily found, by putting the rod in at the bung hole of the veſſel till it meets the interſection of the head of the veſſel with the ſtaves oppoſite to the bung hole. For diſtinction of this line, there is written thereon, *beer* and *wine gallons*. On the ſecond face, 5, are a line of inches and the gauge-line; which is a line expreſſing the areas of circles, whoſe diameters are the correſpondent inches in ale gallons. At the beginning is written, *ale area.* On the third face, 6, are three ſcales of lines; the firſt, at the end of which is written *hogſhead*, is for finding how many gallons there are in

Plate CCXXVIII.

a

Gauging-Rod.

a hogſhead when it is not full, lying with its axis parallel to the horizon. The ſecond line, at the end of which is written *B. L.* ſignifying a *butt lying* is for the ſame uſe as that for the hogſhead. The third line is to find how much liquor is wanting to fill up a butt when it is ſtanding: at the end of it is written *B. S.* ſignifying a *butt ſtanding.* In the half of the fourth face of the gauging rod, 7, there are the three ſcales of lines, to find the wants in a firkin, kilderkin, and barrel, lying with their areas parallel to the horizon. They are diſtinguiſhed by letters *F. K. B.* ſignifying a *firkin*, *kilderkin*, and *barrel.*

Uſe of the diagonal lines on this rod. To find the content of a veſſel in beer or wine gallons, put the braſed end of the gauging rod into the bung hole of the caſk, with the diagonal lines upwards, and thruſt this braſed end to the meeting of the head and ſtaves; then with chalk make a mark at the middle of the bung hole of the veſſel, and alſo on the diagonal lines of the rod, right againſt, over one another, when the braſed end is thruſt home to the head and ſtaves: then turn the gauging rod to the other end of the veſſel, and thruſt the braſed end home to the end, as before. Laſtly, See if the mark made on the gauging rod come even with the mark made on the bung hole, when the rod was thruſt to the other end; which if it be, the mark made on the diagonal lines will, on the ſame lines, ſhow the whole content of the caſk in beer or wine gallons.

If the mark made on the bung hole be not right againſt that made on the rod when you put it the other way, then right againſt the mark made on the bung hole make another on the diagonal line; and the diviſion on the diagonal line between the two chalks will ſhow the veſſel's whole contents in beer or wine gallons. Thus, *e. gr.* if the diagonal line of the veſſel be 28 inches four-tenths, its contents in beer gallons will be near 51, and in wine gallons 62.

If a veſſel be open, as a half barrel, tun, or copper, and the meaſure from the middle of one ſide to the head and ſtaves be 38 inches, the diagonal line gives 122 beer gallons; half of which, viz. 61, is the content of the open half tub.

If you have a large veſſel, as a tun or copper, and the diagonal line taken by a long rule proves 70 inches; the content of that veſſel may be found thus: Every inch at the beginning end of the diagonal line call ten inches. Thus ten inches becomes 100 inches; and every tenth of a gallon call 100 gallons; and every whole gallon call 1000 gallons.

Example. At 44.8 inches on the diagonal beer line is 200 gallons; ſo that 4 inches 48 parts, now called 44 inches 8-tenths, is juſt two tenths of a gallon, now called 200 gallons; ſo alſo if the diagonal line be 76 inches and 7-tenths, a cloſe caſk of ſuch diagonal will hold 1000 beer gallons; but an open caſk but half ſo much, viz. 500 beer gallons.

Uſe of the Gauge *Line.* To find the content of any cylindrical veſſel in ale gallons; ſeek the diameter of the veſſel in inches, and juſt againſt it on the gauge line is the quantity of ale gallons contained in one inch deep: this multiplied by the length of the cylinder will give its content in ale gallons.

For example, ſuppoſe the length of the veſſel 32.06, and the diameter of its baſe 25 inches; to find what is the content in ale gallons? Right againſt 25 inches on the gauge line is one gallon and .745 of a gallon; which multiplied by 32.06, the length, gives 55.9447 gallons for the content of the veſſel.

The bung diameter of a hogſhead being 25 inches, the head diameter 22 inches, and the length 32.06 inches; to find the quantity of ale gallons contained in it?—Seek 25, the bung diameter, on the line of inches; and right againſt it on the guage line you will find 1.745: take one third of it, which is .580, and ſet it down twice; ſeek 22 inches in the head diameter, and againſt it you will find on the gauge line 1.356; one-third of which added to twice .580 gives 1.6096; which multiplied by the length 32.06, the product will be 51.603776, the content in ale gallons. Note, this operation ſuppoſes, that the aforeſaid hogſhead is in the figure of the middle fruſtum of a ſpheroid.

The uſe of the lines on the two other faces of the rod is very eaſy; you need only put it downright into the bung hole (if the veſſel you deſire to know the quantity of ale gallons contained therein be lying) to the oppoſite ſtaves; and then where the ſurface of the liquor cuts any one of the lines appropriated to that veſſel, will be the number of gallons contained in that veſſel.

Gaul.

GAUL, the name given by the Romans to the country that now forms the kingdom of France.—The original inhabitants were deſcended from the Celtes or Gomerians, by whom the greateſt part of Europe was peopled; the name of *Galli*, or *Gauls*, being probably given them long after their ſettlement in that country. See Gallia.

The ancient hiſtory of the Gauls is entirely wrapped up in obſcurity and darkneſs; all we know concerning them for a long time is, that they multiplied ſo faſt, that, their country being unable to contain them, they poured forth in vaſt multitudes into other countries, which they generally ſubdued, and ſettled themſelves in. It often happened, however, that theſe colonies were ſo moleſted by their neighbours, that they were obliged to ſend for aſſiſtance to their native country. This was always very eaſily obtained. The Gauls were upon every occaſion, ready to ſend forth great numbers of new adventurers; and as theſe ſpread deſolation wherever they came, the very name of *Gauls* proved terrible to moſt of the neighbouring nations.—The earlieſt excurſion of theſe people, of which we have any diſtinct account, was into Italy, under a famed leader, named *Belloveſus*, about 622 years before Chriſt. He croſſed the Rhone and the Alps, till then unattempted; defeated the Hetrurians; and ſeized upon that part of their country, ſince known by the names of *Lombardy* and *Piedmont.*—The ſecond grand expedition was made by the Cœnomani, a people dwelling between the rivers Seine and Loire, under a general named *Elitonis.* They ſettled in thoſe parts of Italy, now known by the names of *Breſciano*, the *Cremoneſe*, the *Mantuan*, *Carniola*, and the *Venetian.*—In a third excurſion, two other Gauliſh nations ſettled on both ſides of the river Po; and in a fourth, the Boii and Lingones ſettled in the country between Ravenna and Bologna. The time of theſe three laſt expeditions is uncertain.

Account of the Gauliſh incurſions into Italy.

The third expedition of the Gauls was more remarkable than any of the former, and happened about 200 years after that of Belloveſus. The Senones ſettled between

Gaul.

between Paris and Meaux, were invited into Italy by a Hetrurian lord, and settled themselves in Umbria. Brennus their king laid siege to Clusium, a city in alliance with Rome; and this produced a war with the Romans, in which the latter were at first defeated, and their city taken and burnt; but at length the whole army was cut off by Camillus, insomuch, that not a single person escaped.

Some other expeditions the Gauls undertook against the Romans: in which, though they always proved unsuccessful, by reason of their want of military discipline; yet their fierceness and courage made them so formidable to the republic, that, on the first news of their march, extraordinary levies of troops were made, sacrifices and public supplications offered to the gods, and the law which granted an immunity from military service to priests and old men, was, for the time, abolished.

2 Expedition against the Greeks.

Against the Greeks, the expeditions of the Gauls were very little more successful than against the Romans. The first of these we hear of was about 279 years before Christ, in the year after Pyrrhus had invaded Italy. At this time, the Gauls finding themselves greatly overstocked at home, sent out three great colonies to conquer new countries for themselves. One of these armies was commanded by *Brennus*, another by *Cerethrius*, and the third by *Belgius*. The first entered Pannonia or Hungary; the second Thrace; and the third marched into Illyricum and Macedonia. Here Belgius at first met with great success; and enriched himself by plunder to such a degree, that Brennus envying him, resolved to enter the same countries, in order to share the spoil. In a short time, however, Belgius met with such a total defeat, that his army was almost entirely destroyed; upon which Brennus hastened to the same place. His army at first consisted of 150,000 foot and 15,000 horse: but two of his principal officers revolted, and carried off 20,000 men, with whom they marched into Thrace; where, having joined Cerethrius, they seized on Byzantium and the western coast of the Propontis, making the adjacent parts tributary to them.—To retrieve this loss, Brennus sent for fresh supplies from Gaul; and having increased his army to 150,000 foot, and upwards of 60,000 horse, he entered Macedonia, defeated the general who opposed him, and ravaged the whole country. He next marched towards the straits of Thermopylæ, with a design to invade Greece; but was stopped by the forces sent to defend that pass against him. He passed the mountains, however, as Xerxes had formerly done; upon which the guards retired, to avoid being surrounded. Brennus then having ordered Acichorius, the next to him in command, to follow at a distance with part of his army, marched with the bulk of the forces to Delphi, in order to plunder the rich temple there. This enterprise proved exceedingly unfortunate: a great number of his men were destroyed by a dreadful storm of hail, thunder, and lightning; another part of his army was destroyed by an earthquake; and the remainder, somehow or other, imagining themselves attacked by the enemy, fought against each other the whole night, so that in the morning scarce one half of them remained. The Greek forces then poured in upon them from all parts; and that in such numbers, that though Acichorius came up in due time with his forces, Brennus found himself unable to make head against the Greeks, and was defeated with great slaughter. He himself was desperately wounded; and so disheartened by his misfortune, that, having assembled all his chiefs, he advised them to kill all the wounded and disabled, and to make the best retreat they could; after which he put an end to his own life. On this occasion, it is said that 20,000 of these unhappy people were executed by their own countrymen. Acichorius then set out with the remainder for Gaul; but, by being obliged to march through the country of their enemies, the calamities they met with by the way were so grievous, that not one of them reached their own country. A just judgement, say the Greek and Roman authors, for their sacrilegious intentions against Delphi.

3 Miserable fate of the army.

4 Gaul invaded by the Romans.

The Romans having often felt the effects of the Gaulish ferocity and courage, thought proper at last, in order to humble them, to invade their country. Their first successful attempt was about 118 years before Christ, under the command of Quintus Marcius, surnamed *Rex*. He opened a way betwixt the Alps and the Pyrenees, which laid the foundation for conquering the whole country. This was a work of immense labour of itself, and rendered still more difficult by the opposition of the Gauls, especially those called the Stæni, who lived at the foot of the Alps. These people, finding themselves overpowered by the consular army, set fire to their houses, killed their wives and children, and then threw themselves into the flames. After this Marcius built the city of Narbonne, which became the capital of a province. His successor Scaurus also conquered some Gaulish nations; and in order to facilitate the sending troops from Italy into that country, he made several excellent roads between them, which before were almost impassable. These successes gave rise to the invasion of the Cimbri and Teutones; an account of whose unfortunate expedition is given under the articles Cimbri, Rome, Teutones, &c.

5 Surprising success of Julius Cæsar.

From this time, the Gauls ceased to be formidable to the Romans, and even seem to have been for some time on good terms with them. At last, however, the Helvetii kindled a war with the republic, which brought Cæsar over the Alps, and ended in the total subjection of the country. Orgetorix was the first cause of it; who had engaged a vast number of his countrymen to burn their towns and villages, and to go in search of new conquests. Julius Cæsar, to whose lot the whole country of Gaul had fallen, made such haste to come and suppress them, that he was got to the Rhone in eight days; broke down the bridge of Geneva, and, in a few days more, finished the famed wall between that city and Mount Jura, now St Claude, which extended seventeen miles in length, was sixteen feet high, fortified with towers and castles at proper distances, and a ditch that ran the whole length of it. If his own account of it may be relied upon, he did not set out till the beginning of April; and yet this huge work was finished by the ides or 13th of the month: so that, subtracting the eight days he was a-coming, it must have been all done in about five days; a prodigious work, considering he had but one legion there, or even though the whole country had given him assistance. Whilst this was doing, and the reinforcements he wanted were coming, he amused the Helvetii,

Gaul.

Helvetii, who had ſent to demand a paſſage through the country of the Allobroges, till he had got his reinforcements; and then flatly refuſed it to them: whereupon a dreadful battle enſued; in which they loſt one hundred and thirty thouſand men, in ſpite of all their valour; beſides a number of priſoners, among whom were the wife and daughter of Orgetorix, the leader of this unfortunate expedition. The reſt ſubmitted, and begged they might be permitted to go and ſettle among the Ædui, from whom they originally ſprung; and, at the requeſt of theſe laſt, were permitted to go.

The Gauls were conſtantly in a ſtate of variance with one another; and Cæſar, who knew how to make the moſt of theſe inteſtine broils, ſoon became the protector of the oppreſſed, a terror to the oppreſſor, and the umpire of all their contentions. Among thoſe who applied to him for help, were his allies the Ædui; againſt whom Arioviſtus, king of the Germans, had joined with the Arverni, who inhabited the banks of the Loire, had taken the country of the Sequani from them, and obliged them to ſend hoſtages to him. Cæſar forthwith ſent to demand the reſtitution of both, and, in an interview which he ſoon after obtained of that haughty and treacherous prince, was like to have fallen a ſacrifice to his perfidy: upon which he bent his whole power againſt him, forced him out of his ſtrong intrenchments, and gave him a total overthrow. Arioviſtus eſcaped, with difficulty, over the Rhine; but his two wives, and a daughter, with a great number of Germans of diſtinction, fell into the conqueror's hand. Cæſar, after this ſignal victory, put his army into winter quarters, whilſt he went over the Alps to make the

6
A general confederacy againſt him.

neceſſary preparations for the next campaign. By this time all the Belgæ in general were ſo terrified at his ſucceſs, that they entered into a confederacy againſt the Romans as their common enemy. Of this, Labienus, who had been left in Gaul, ſent Cæſar notice; upon which he immediately left Rome, and made ſuch diſpatch, that he arrived upon their confines in about fifteen days. On his arrival, the Rhemi ſubmitted to him; but the reſt, appointing Galba king of the Sueſſiones general of all their forces, which amounted to one hundred and fifty thouſand men, marched directly againſt him. Cæſar, who had ſeized on the bridge of the Axona, now Aiſne, led his light horſe and infantry over it; and whilſt the others were

7
The Gauls defeated with great ſlaughter.

encumbered in croſſing that river, made ſuch a terrible ſlaughter of them, that the river was filled with their dead, inſomuch that their bodies ſerved for a bridge to thoſe who eſcaped. This new victory ſtruck ſuch terror into the reſt, that they diſperſed themſelves; immediately after which, the Sueſſiones, Bellovaci, Ambiones, and ſome others, ſubmitted to him. The Nervii, indeed, joined with the Atrebates and Veromandui againſt them; and having firſt ſecured their wives and children, made a vigorous reſiſtance for ſome time; but were at length defeated, and the greateſt part of them ſlain. The reſt, with their wives and old men, ſurrendered themſelves, and were allowed to live in their own cities and towns as formerly. The Aduatici were next ſubdued; and, for their treachery to the conqueror, were ſold for ſlaves, to the number of 50,000. Young Craſſus, the ſon of the triumvir, ſubdued likewiſe ſeven other nations, and took poſſeſſion of their cities; which not only completed the conqueſt of the Belgæ, but brought ſeveral nations from beyond the Rhine to ſubmit to the conqueror. The Veneti, or ancient inhabitants of Vannes in Brittany, who had been likewiſe obliged to ſend hoſtages to the conqueror, were, in the mean time, making great preparations by ſea and land to recover their liberty. Cæſar, then in Illyricum, was forced to equip a fleet on the Loire; and having given the command of it to Brutus, went and defeated them by land, as Brutus did by ſea; and having put their chief men to death, ſold the reſt for ſlaves. The Unelli, with Veridorix their chief, together with the Lexovii and Aulerci, were about the ſame time ſubdued by Sabinus, and the Aquitani by Craſſus, with the loſs of 30,000 men. There remained nothing but the countries of the Morini and Menapii to be conquered of all Gaul. Cæſar marched himſelf againſt them: but he found them ſo well intrenched in their inacceſſible fortreſſes, that he contented himſelf with burning and ravaging their country; and having put his troops into winter quarters, again paſſed over the Alps, to have a more watchful eye on ſome of his rivals there. He was, however, ſoon after obliged to come to defend his Gauliſh conqueſts againſt ſome nations of the Germans, who were coming to ſettle there, to the number of 400,000. Theſe he totally defeated, and then reſolved to carry his conquering arms into Germany; but for an account of his exploits there, ſee the article GERMANY.

8
The Gauls revolt, but are ſubdued.

Upon his return into Gaul, he found it labouring under a great famine, which had cauſed a kind of univerſal revolt. Cotta and Sabinus, who were left in the country of the Eburones, now Liege, were betrayed into an ambuſh by Ambiorix, one of the Gauliſh chiefs, and had moſt of their men cut off. The Aduatici had fallen upon Q. Cicero, who was left there with one legion, and had reduced him to great ſtraits: at the ſame time Labienus, with his legion, was attacked by Indutiomarus, at the head of the Rhemi and Senones; but had better luck than the reſt, and by one bold ſally upon them, put them to flight, and killed their general. Cæſar acquired no ſmall credit by quelling all theſe revolts; but each victory loſt the lives of ſo many of his troops, that he was forced to have recourſe to Pompey for a freſh ſupply, who readily granted him two of his own legions to ſecure his Gauliſh conqueſts.

9
A ſecond revolt.

But it was not long before the Gauls, ever reſtleſs under a foreign yoke, raiſed up a new revolt, and obliged him to return thither. His fear leſt Pompey ſhould gain the affections of the Roman people, had obliged him to ſtrip the Gauls of their gold and ſilver, to bribe them over to his intereſt; and this gave no ſmall handle to thoſe frequent revolts which happened during his abſence. He quickly, however, reduced the Nervii, Aduatici, Menapii, and Treviri; the laſt of whom had raiſed the revolt, under the command of Ambiorix: but he found the flame ſpread much farther, even to the greateſt part of the Gauls, who had choſen Vercingetorix their generaliſſimo. Cæſar was forced to leave Inſubria, whither he had retired to watch the motions of Pompey, and, in the midſt of winter and ſnow, to repaſs the Alps into the province of Narbonne. Here he gathered his ſcattered troops with all poſſible ſpeed; and, in ſpite of the hard weather, beſieged and took Noviodunum, now Noyons; and defeated Vercingetorix, who was come to the relief of that place. He next

Gaul.

next took the city of Avaricum, now Bourges, one of the ſtrongeſt in Gaul, and which had a garriſon of 40,000 men; of whom he made ſuch a dreadful ſlaughter, that hardly 800 eſcaped. Whilſt he was beſieging Gergovia, the capital of the Arverni, he was informed that the Nitiobriges, or Agenois, were in arms; and that the Ædui were ſending to Vercingetorix 10,000 men, which they were to have ſent to reinforce Cæſar. Upon this news, he left Fabius to carry on the ſiege, and marched againſt the Ædui. Theſe, upon his approach, ſubmitted, in appearance, and were pardoned; but ſoon after that whole nation roſe up in arms, and murdered all the Italian troops in their capital. Cæſar, at this, was in great ſtraits what meaſures to take; but reſolved at length to raiſe the ſiege of Gergovia, and at once attack the enemy's camp, which he did with ſome ſucceſs; but when he thought to have gone to Noviodunum, or Noyons, where his baggage, military cheſt, &c. were left, he heard that the Ædui had carried it off, and burnt the place. Labienus, juſtly thinking that Cæſar would want his aſſiſtance in the condition he now was, went to join him, and in his way defeated a Gauliſh general named *Camulogenus*, who came to oppoſe his march; but this did not hinder the revolt from ſpreading itſelf all over Celtic Gaul, whither Vercingetorix had ſent for freſh ſupplies, and, in the mean time, attacked Cæſar; but was defeated, and forced to retire to Aleſia, a ſtrong place, now Aliſe in Burgundy, as is ſuppoſed. Hither Cæſar haſtened, and beſieged him; and having drawn a double circumvallation, with a deſign to ſtarve him in it, as he was likely to have done, upon that account refuſed all offers of a ſurrender from him. At length, the long-expected reinforcement came, conſiſting of 160,000 men, under four

10 generals: theſe made ſeveral fruitleſs attacks on Cæſar's trenches; but were defeated in three ſeveral battles, which at length obliged Vercingetorix to ſurrender at diſcretion. Cæſar uſed all his priſoners with great ſeverity, except the Ædui and Arverni, by whoſe means he hoped to gain their nations, which were the moſt potent of Celtic Gaul: nor was he diſappointed; for both of them ſubmitted to him, and the former received him into the capital, where he ſpent the winter, after he put his army into winter quarters. This campaign, as it proved one of the hardeſt he ever had, ſo he gained more glory by it than any Roman general had done before: yet could not at all by this procure from the ſervile ſenate, now wholly dedicated to his rival, a prolongation of his proconſulſhip; upon which he is reported to have laid his hand upon his ſword, and ſaid, that that ſhould do it.

They are again ſubdued.

He was as good as his word; and the Gauls, upon their former ill ſucceſs, reſolving to have as many ſeparate armies as provinces, in order to embarraſs him the more, Cæſar, and his generals Labienus and Fabius, were forced to fight them one after another; which they did, however, with ſuch ſucceſs, that, notwithſtanding the hardneſs of the ſeaſon, they ſubdued the Bituriges, Carnutes, Rhemi, and Bellovaci, with their general Correus, by which he at once quieted all the Belgic provinces bordering on Celtic Gaul. The next who followed were the Treviri, the Eburones, and the Andes, under their general Dumnacus. The laſt place which held out againſt him was Uxellodunum; which was defended by the two laſt acting generals of the Gauls, Drapes the Senonian, and Luterius the Cadurcean. The place being ſtrong and well garriſoned, Cæſar was obliged to march thither from the fartheſt part of Belgic Gaul; and ſoon after reduced it, for want of water. Here again he cauſed the right hands of all that were fit to bear arms to be cut off, to deter the reſt from revolting afreſh. Thus was the conqueſt of Gaul finiſhed from the Alps and Pyrenees to the Rhine, all which vaſt tract was now reduced to a Roman province under the government of a prætor. During his ſeveral expeditions into Gaul, Cæſar is ſaid to have taken 800 cities; to have ſubdued 300 different nations; and to have defeated, in ſeveral battles, three millions of men, of whom one million were killed, and another taken priſoners.—The hiſtory of the country, from the time of its conqueſt by the Romans to the preſent, is given under the articles ROME and FRANCE.

11 Gaul reduced to a Roman province.

12 Character, &c. of the ancient Gauls.

The Gauls anciently were divided into a great number of different nations, which were continually at war with one another, and at variance among themſelves. Cæſar tells us, that not only all their cities, cantons, and diſtricts, but even almoſt all families, were divided and torn by factions; and this undoubtedly facilitated the conqueſt of the whole. The general character of all theſe people was an exceſſive ferocity and love of liberty. This laſt they carried to ſuch an extreme, that either on the appearance of ſervitude, or incapacity of action through old age, wounds, or chronic diſeaſes, they put an end to their own lives, or prevailed upon their friends to kill them. In cities, when they found themſelves ſo ſtraitly beſieged that they could hold out no longer, inſtead of thinking how to obtain honourable terms of capitulation, their chief care very often was to put their wives and children to death, and then to kill one another, to avoid being led into ſlavery. Their exceſſive love of liberty and contempt of death, according to Strabo, very much facilitated their conqueſt by Cæſar; for pouring their numerous forces upon ſuch an experienced enemy, as Cæſar, their want of conduct very ſoon proved the ruin of the whole.

The chief diverſion of the Gauls was hunting; and indeed, conſidering the vaſt foreſts with which their country abounded, and the multitude of wild beaſts which lodged in them, they were under an abſolute neceſſity to hunt and deſtroy them, to prevent the country from being rendered totally uninhabitable. Beſides this, however, they had alſo their hippodromes, horſe and chariot races, tilts and tournaments; at all of which the bards aſſiſted with their poems, ſongs, and muſical inſtruments.—For an account of their religion, ſee the article DRUID.

The Gauls were exceſſively fond of feaſting, in which they were very profuſe; as, like all other northern nations, they were great lovers of good eating and drinking. Their chief liquors were beer and wine. Their tables were very low. They ate but little bread, which was baked flat and hard, and eaſily broken in pieces: but devoured a great deal of fleſh, boiled, roaſted, or broiled; and this they did in a very ſlovenly manner, holding the piece in their hands, and tearing it with their teeth. What they could not part by this way, they cut with a little knife which hung at their girdle. When the company was numerous, the *Coryphee*,

phee, or chief of the feaſt, who was either one of the richeſt, or nobleſt, or braveſt, ſat in the middle, with the maſter of the houſe by his ſide; the reſt took their places next according to their rank, having their ſervants holding their ſhields behind them. Theſe feaſts ſeldom ended without bloodſhed; but if by chance the feaſt proved a peaceable one, it was generally accompanied not only with muſic and ſongs, but likewiſe with dances, in which the dancers were armed cap-a-pee, and beat time with their ſwords upon their ſhields. On certain feſtivals they were wont to dreſs themſelves in the ſkins of beaſts, and in that accompany the proceſſions in honour of their deities or heroes. Others dreſſed themſelves in maſquerade habits, ſome of them very indecent, and played ſeveral antic and immodeſt tricks. This laſt cuſtom continued long after their converſion to Chriſtianity.

GAULANITIS, or Gaulonitis (Joſephus); in *Ancient Geography*, according to the different manner of writing the capital, *Gaulan* or *Gaulon*; the extreme part of Baſhan to the ſouth, and bordering on the tribe of Gad. It was divided into the Superior, which to the eaſt extended to Arabia; and into the Inferior, which lay on the lake of Geneſareth, (Joſephus).

GAULON, or Golan, the capital of the Gaulanitis Superior; a Levitical city and place of refuge, (Moſes, Joſhua.)

GAULOS, in *Ancient Geography*, a ſmall iſland of Sicily, in the African ſea, adjoining to Melite or Malta; with commodious harbours; a colony of Phœnicians, with a cognominal town. Gaulonitæ, the people, (Inſcription). Now called *Gozo*, five miles to the weſt of Malta.

GAULTHERIA, a genus of plants belonging to the decandria claſs; and in the natural method ranking under the 18th order, *Bicornes*. See Botany *Index*.

GAUNT-Bellied, in the manege, is ſaid of a horſe whoſe belly ſkrinks up towards his flanks.

GAUNTLET. See Gantlet.

GAUNTLOPE, pronounced *Gauntlet*, a military puniſhment for felony, or ſome other heinous offence.

In veſſels of war, it is executed in the following manner. The whole ſhip's crew is diſpoſed in two rows, ſtanding face to face on both ſides of the deck, ſo as to form a line whereby to go *forward* on one ſide, and return *aft* on the other; each perſon being furniſhed with a ſmall twiſted cord, called a *knittle*, having two or three knots upon it. The delinquent is then ſtripped naked above the waiſt, and ordered to paſs forward between the two rows of men, and aft on the other ſide, a certain number of times, rarely exceeding three; during which every perſon gives him a ſtripe as he runs along. In his paſſage through this painful ordeal, he is ſometimes tripped up, and very ſeverely handled while incapable of proceeding. This puniſhment, which is called *running the gauntlet*, is ſeldom inflicted, except for ſuch crimes as will naturally excite a general antipathy among the ſeamen: as, on ſome occaſions, the culprit would paſs without receiving a ſingle blow, particularly in caſes of mutiny and ſedition, to the puniſhment of which our ſailors ſeem to have a conſtitutional averſion.

In the land ſervice, when a ſoldier is ſentenced to run the gauntlope, the regiment is drawn out in two ranks facing each other; each ſoldier, having a ſwitch in his hand, laſhes the criminal as he runs along naked from the waiſt upwards. While he runs, the drums beat at each end of the ranks. Sometimes he runs three, five, or ſeven times, according to the nature of the offence. The major is on horſeback, and takes care that each ſoldier does his duty.

GAVIES, or Gaurs. See Gabres.

GAVOTTA, or Gavotte, is a kind of dance, the air of which has two briſk and lively ſtrains in common time, each of which ſtrains is twice played over. The firſt has uſually four or eight bars; and the ſecond contains eight, twelve, or more. The firſt begins with a minim, or two crotchets, or notes of equal value, and the hand riſing; and ends with the fall of the hand upon the dominant or mediant of the mode, but never upon the final, unleſs it be a rondeau: and the laſt begins with the riſe of the hand, and ends with the fall upon the final of the mode.

Tempi di Gavotta, is when only the time or movement of a gavotte is imitated, without any regard to the meaſures or number of bars or ſtrains.—Little airs are often found in ſonatas, which have this phraſe to regulate their motions.

GAURA, a genus of plants belonging to the octandria claſs; and in the natural method ranking under the 17th order, *Calycanthemæ*. See Botany *Index*.

GAUSE, or Gawse, in *Commerce*, a very thin, ſlight, tranſparent kind of ſtuff, woven ſometimes of ſilk, and ſometimes only of thread.—To warp the ſilk for making of gauſe, they uſe a peculiar kind of mill, upon which the ſilk is wound: this mill is a wooden machine about ſix feet high, having an axis perpendicularly placed in the middle thereof, with ſix large wings, on which the ſilk is wound from off the bobbins by the axis turning round. When all the ſilk is on the mill, they uſe another inſtrument to wind it off again on two beams: this done, the ſilk is paſſed through as many little beads as there are threads of ſilk; and thus rolled on another beam to ſupply the loom.

The gauſe loom is much like that of the common weavers, though it has ſeveral appendages peculiar to itſelf. See Loom.

There are figured gauſes; ſome with flowers of gold and ſilver, on a ſilk ground: theſe laſt are chiefly brought from China.

GAY, John, a celebrated Engliſh poet, deſcended from an ancient family in Devonſhire, was born at Exeter, and received his education at the free ſchool of Barnſtaple in that county, under the care of Mr William Rayner.—He was bred a mercer in the Strand; but having a ſmall fortune, independent of buſineſs, and conſidering the attendance on a ſhop as a degradation of thoſe talents which he found himſelf poſſeſſed of, he quitted that occupation, and applied himſelf to other views, and to the indulgence of his inclination for the Muſes. In 1712 we find him ſecretary, or rather domeſtic ſteward, to the ducheſs of Monmouth, in which ſtation he continued till the beginning of the year 1714; at which time he accompanied the earl of Clarendon to Hanover, whither that nobleman was deſpatched by Queen Anne. In the latter end of the ſame year, in conſequence of the queen's death, he returned to England, where he lived in the higheſt eſtimation and intimacy of friendſhip with many

Gay.

many persons of the first distinction both in rank and abilities.—He was even particularly taken notice of by Queen Caroline, then princess of Wales, to whom he had the honour of reading in manuscript his tragedy of the *Captives;* and in 1726 dedicated his *Fables*, by permission, to the duke of Cumberland.—From this countenance shown to him, and numberless promises made him of preferment, it was reasonable to suppose, that he would have been genteelly provided for in some office suitable to his inclination and abilities. Instead of which, in 1727, he was offered the place of gentleman usher to one of the young princesses; an office which, as he looked on it as rather an indignity to a man whose talents might have been so much better employed, he thought proper to refuse; and some pretty warm remonstrances were made on the occasion by his sincere friends and zealous patrons the duke and duchess of Queensberry, which terminated in those two noble personages withdrawing from court in disgust. Mr Gay's dependencies on the promises of the great, and the disappointments he met with, he has figuratively described in his fable of the *Hare with many friends.* However, the very extraordinary success he met with from public encouragement made an ample amends, both with respect to satisfaction and emolument, for those private disappointments.—For, in the season of 1727-8, appeared his *Beggar's Opera;* the vast success of which was not only unprecedented, but almost incredible.—It had an uninterrupted run in London of 63 nights in the first season, and was renewed in the ensuing one with equal approbation. It spread into all the great towns of England; was played in many places to the 30th and 40th time, and at Bath and Bristol 50; made its progress into Wales, Scotland, and Ireland, in which last place it was acted for 24 successive nights; and last of all it was performed at Minorca. Nor was the fame of it confined to the reading and representation alone, for the card table and drawing room shared with the theatre and closet in this respect; the ladies carried about the favourite songs of it engraven upon their fan mounts; and screens, and other pieces of furniture were decorated with the same. In short, the satire of this piece was so striking, so apparent, and so perfectly adapted to the taste of all degrees of people, that it overthrew the Italian opera, that Dagon of the nobility and gentry, which had so long seduced them to idolatry, and which Dennis, by the labours and outcries of a whole life, and many other writers by the force of reason and reflection, had in vain endeavoured to drive from the throne of public taste. The profits of this piece were so very great, both to the author and Mr Rich the manager, that it gave rise to a quibble, which became frequent in the mouths of many, viz. *That it had made* Rich gay, *and* Gay rich; and it has been asserted, that the author's own advantages from it were not less than 2000l. In consequence of this success, Mr Gay was induced to write a second part to it, which he entitled *Polly.* But the disgust subsisting between him and the court, together with the misrepresentations made of him as having been the author of some disaffected libels and seditious pamphlets, occasioned a prohibition and suppression of it to be sent from the lord chamberlain, at the very time when every thing was in readiness for the rehearsal of it. A very considerable sum, however, accrued to him from the publication of it afterwards in quarto.—Mr Gay wrote several other pieces in the dramatic way, and many very valuable ones in verse. Among the latter, his *Trivia*, or the *Art of Walking the Streets of London*, though his first poetical attempt, is far from being the least considerable, and is what recommended him to the esteem and friendship of Mr Pope: but as, among his dramatic works, his *Beggar's Opera* did at first, and perhaps ever will, stand as an unrivalled masterpiece, so, among his poetical works, his *Fables* hold the same rank of estimation; the latter having been almost as universally read as the former was represented, and both equally admired. Mr Gay's disposition was sweet and affable, his temper generous, and his conversation agreeable and entertaining. But he had one foible, too frequently incident to men of great literary abilities, and which subjected him at times to inconveniencies which otherwise he needed not to have experienced, viz. an excess of indolence, without any knowledge of economy. So that, though his emoluments were, at some periods of his life, very considerable, he was at others greatly straitened in his circumstances; nor could he prevail on himself to follow the advice of his friend Dean Swift, whom we find in many of his letters endeavouring to persuade him to the purchasing of an annuity, as a reserve for the exigencies that might attend on old age.—Mr Gay chose rather to throw himself on patronage, than secure to himself an independent competency by the means pointed out to him; so that, after having undergone many vicissitudes of fortune, and being for some time chiefly supported by the liberality of the duke and duchess of Queensberry, he died at their house in Burlington gardens, in December 1732. He was interred in Westminster Abbey, and a monument erected to his memory, at the expence of his aforementioned noble benefactors, with an inscription expressive of their regards and his own deserts, and an epitaph in verse by Mr Pope.

Gay, Gaza.

GAZA, Theodore, a famous Greek in the 15th century, was born in 1398. His country being invaded by the Turks, he retired into Italy; where he at first supported himself by transcribing ancient authors, an employment the learned had frequent recourse to before the invention of printing. His uncommon parts and learning soon recommended him to public notice; and particularly to Cardinal Bessarion, who procured him a benefice in Calabria. He was one of those to whom the revival of polite literature in Italy was principally owing. He translated from the Greek into Latin, Aristotle's History of Animals, Theophrastus on Plants, and Hippocrates's Aphorisms; and from the Latin into Greek, Scipio's Dream, and Cicero's Treatise on Old Age. He wrote several other works in Greek and Latin; and died at Rome in 1475.

Gaza, in *Ancient Geography*, a principal city and one of the five satrapies of the Philistines. It was situated about 100 stadia from the Mediterranean, on an artificial mount, and strongly walled round. It was destroyed by Alexander the Great, and afterwards by Antiochus. In the time of the Maccabees it was a strong and flourishing city; but was destroyed a third time by Alexander Jannæus. At present it has a miserable appearance. The buildings are mean, both as to the form and matter. Some remains of its ancient grandeur

grandeur appear in the handſome pillars of Parian marble which ſupport ſome of the roofs; while others are diſpoſed of here and there, in different parts of almoſt every beggarly cottage. On the top of the hill, at the north-eaſt corner of the town, are the ruins of large arches ſunk low into the earth, and other foundations of a ſtately building, from whence ſome of the baſhaws have carried off marble pillars of an incredible ſize. The caſtle is a contemptible ſtructure, and the port is ruined. E. Long. 34. 55. N. Lat. 31. 28.

GAZE-HOUND, or *Gaſt-hound*, one that makes more uſe of his ſight than of his noſe. Such dogs are much uſed in the north of England: they are fitter in an open champaign country than in buſhy and woody places. If at any time a well-taught gaze-hound takes a wrong way, he will return upon a ſignal, and begin the chaſe afreſh. He is alſo excellent at ſpying out the fatteſt of a herd; and having ſeparated it from the reſt, will never give over the purſuit till he has worried it to death.

GAZEL, in *Zoology*, a ſpecies of CAPRA. See MAMMALIA *Index*.

GAZETTE, a newſpaper, or printed account of the tranſactions of all the countries in the known world, in a looſe ſheet or half ſheet. This name is with us confined to that paper of news publiſhed by authority. The word is derived from *gazetta*, a Venetian coin, which was the uſual price of the firſt newſpaper printed there, and which was afterwards given to the paper itſelf.

The firſt gazette in England was publiſhed at Oxford, the court being there, in a folio half ſheet, November 7. 1665. On the removal of the court to London, the title was changed to the *London Gazette*. The Oxford gazette was publiſhed on Tueſdays, the London on Saturdays: and theſe have continued to be the days of publication ever ſince.

GAZNA, a city of Aſia, once much celebrated, and the capital of a very extenſive empire; but which is now either entirely ruined, or become of ſo little conſideration, that it is not taken notice of in our books of geography. The city was anciently an empory and fortreſs of Sableſtan, not far from the confines of India. During the vaſt and rapid conqueſts of the Arabs, all this country had been reduced under their ſubjection. On the decline of the power of the caliphs, however, the vaſt empire eſtabliſhed by Mahomet and his ſucceſſors was divided into a number of independent principalities, moſt of which were but of ſhort duration. In the year of the Hegira 384, anſwering to the 994th of the Chriſtian era, the city of Gazna, with ſome part of the adjacent country, was governed by Mahmud Gazni; who became a great conqueror, and reduced under his ſubjection a conſiderable part of India and moſt of Perſia.

This empire continued in the family of Mahmud Gazni for upwards of 200 years. None of his ſucceſſors, however, were poſſeſſed of his abilities; and therefore the extent of the empire, inſtead of increaſing, was very conſiderably diminiſhed ſoon after Mahmud's death. The Seljuks made themſelves maſters of Khoraſan, and could not be driven out; the greateſt part of the Perſian dominions alſo fell off; and in the 547th year of the Hegira, the race of Gazni ſultans was entirely ſet aſide by one Gauri, who conquered Khoſru Shah the reigning prince, and beſtowed his dominions on his own nephew Gayathoddin Mohammed. Theſe new ſultans proved greater conquerors than the former, and extended their dominions farther than even Mahmud Gazni himſelf had done. They did not however, long enjoy the ſovereignty of Gazna; for in 1218, Jenghiz Khan having conquered the greateſt part of China and almoſt all Tartary, began to turn his arms weſtward; and ſet out againſt the ſultan of Gazna at the head of 700,000 men.

To oppoſe this formidable army, Mohammed, the reigning ſultan, could muſter only 400,000 men; and, in the firſt battle, 160,000 of his troops are ſaid to have periſhed. After this victory, Jenghiz Khan advanced; Mohammed not daring to riſk a ſecond battle, the loſs of which would have been attended with the entire ruin of his kingdom. He therefore diſtributed his army among the ſtrongeſt fortified towns he had in his dominions; all of which Jenghiz Khan took one after another. The rapid progreſs of his conqueſts, indeed, almoſt exceeds belief. In 1219 and 1220, he had reduced Zarnuk, Nur, Bokhara, Otrar, Saganak, Uzkant, Alſhaſh, Jund, Tonkat, Khojend, and Samarcand. Mohammed, in the mean time, fled firſt to Bokhara; but on the approach of Jenghiz Khan's army, quitted that place, and fled to Samarcand. When this laſt city was alſo in danger of being inveſted, the ſultan did not think proper to truſt himſelf in it more than in the other, though it was garriſoned by 110,000 of his braveſt troops; and therefore fled through byways into the province of Ghilan in Perſia, where he took refuge in a ſtrong fortreſs called *Eſtabad*. But being alſo found out in this retreat, he fled to an iſland in the Caſpian ſea called *Abiſkun;* where he ended his days, leaving his empire, ſuch as it was, to his ſon Jaloloddin.

The new ſultan was a man of great bravery and experience in war; but nothing was able to ſtop the progreſs of the Moguls. In 1220 and 1221, they made themſelves maſters of all the kingdoms of Karazim and Khoraſan, committing everywhere ſuch maſſacres as were never heard of before or ſince that time. In the mean time Jaloloddin aſſembled his forces with the utmoſt diligence, and defeated two detachments of the Mogul army. This happened while Jenghiz Khan was beſieging Bamiyan; but anſwered little other purpoſe, than ſerving to bring upon that city the terrible deſtruction of which an account is given under the article BAMIYAN. Immediately after the reduction of that city, Jenghiz Khan marched towards Gazna; which was very ſtrongly fortified, and where he expected to have found Jaloloddin. But he had left the place 15 days before; and, as Jenghiz Khan's army was much reduced, he might perhaps have ſtood his ground, had it not been for an accident. He had been lately joined by three Turkiſh commanders, each of whom had a body of 10,000 men under his command. After his victories over the Moguls, theſe officers demanded the greateſt ſhare of the ſpoils; which being refuſed, they ſeparated themſelves from the ſultan. He uſed his utmoſt endeavours to make them hearken to reaſon; and ſent ſeveral meſſages and letters to them, repreſenting the inevitable ruin which muſt attend their ſeparation, as Jenghiz Khan was

Gazna. was advancing againſt them with his whole army. At laſt they were perſuaded to lay aſide their animoſities: but it was now too late; for Jenghiz Khan, being informed of what paſſed, detached 60,000 horſe to prevent their joining the ſultan's army; who, finding himſelf deprived of this powerful aid, retired towards the river Indus. When he was arrived there, he ſtopped in a place where the ſtream was moſt rapid and the place confined, with a view both to prevent his ſoldiers from placing any hopes of ſafety in flight, and to hinder the whole Mogul army from attacking him at once. Ever ſince his departure from Gazna he had been tormented with a colic: yet, at a time when he ſuffered moſt, hearing that the enemy's vanguard was arrived at a place in that neighbourhood called *Herder*, he quitted his litter, and, mounting a horſe, marched with ſome of his choſen ſoldiers in the night; ſurpriſed the Moguls in their camp; and having cut them almoſt all in pieces, without the loſs of a ſingle man on his ſide, returned with a conſiderable booty.

Jenghiz Khan, finding by this that he had a vigilant enemy to deal with, proceeded with great circumſpection. When he came near the Indus, he drew out his army in battalia: to Jagatay, one of his ſons, he gave the command of the right wing; to Oktay, another ſon, he gave the command of the left: and put himſelf in the centre, with 6000 of his guards. On the other ſide, Jaloloddin prepared for battle like one who had no reſource but in victory. He firſt ſent the boats on the Indus farther off; reſerving only one to carry over his mother, wife, and children: but unluckily the boat ſplit when they were going to embark, ſo that they were forced to remain in the camp. The ſultan took to himſelf the command of the main body of the army. His left wing, drawn up under ſhelter of a mountain which hindered the whole right wing of the Moguls from engaging at once, was commanded by his vizir; and his right by a lord named *Amin Malek*. This lord began the fight; and forced the enemy's left wing, notwithſtanding the great diſparity of numbers, to give ground. The right wing of the Moguls likewiſe wanting room to extend itſelf, the ſultan made uſe of his left as a body of reſerve, detaching from thence ſome ſquadrons to the aſſiſtance of the troops who ſtood in need of them. He alſo took one part of them with him when he went at the head of his main body to charge that of Jenghiz Khan; which he did with ſo much reſolution and vigour, that he not only put it in diſorder, but penetrated into the place where Jenghiz Khan had originally taken his ſtation: but that prince, having had a horſe killed under him, was retired from thence, to give orders for all the troops to engage.

This diſadvantage had like to have loſt the Moguls the battle; for a report being immediately ſpread that the enemy had broken through the main body, the troops were ſo much diſcouraged, that they would certainly have fled, had not Jenghiz Khan encouraged them by riding from place to place in order to ſhow himſelf. At laſt, however, Jaloloddin's men, who were in all but 30,000, having fought a whole day with ten times their number, were ſeized with fear and fled. One part of them retired to the rocks which were on the ſhore of the Indus, where the enemy's horſe could not follow them; others threw themſelves into the river, where many were drowned, though ſome had the good fortune to croſs over in ſafety; while the reſt ſurrounding their prince, continued the fight through deſpair. The ſultan, however, conſidering that he had ſcarce 7000 men left, began to think of providing for his own ſafety: therefore, having bidden a final adieu to his mother, wife, and children, he mounted a freſh horſe, and ſpurred him into the river, which he croſſed in ſafety, and even ſtopped in the middle of it to inſult Jenghiz Khan, who was now arrived at the bank. His family fell into the hands of the Moguls; who killed all the males, and carried the women into captivity.

Jaloloddin being now ſecurely landed in India, got up into a tree in order to preſerve himſelf from wild beaſts. Next day, as he walked melancholy among the rocks, he perceived a troop of his ſoldiers, with ſome officers, three of whom proved to be his particular friends. Theſe, at the beginning of the defeat, had found a boat in which they had ſailed all night, with much danger from the rocks, ſhelves, and rapid current of the river. Soon after, he ſaw 500 horſe coming towards him; who informed him of 4000 more that had eſcaped by ſwimming over the river; and theſe alſo ſoon after joined the reſt. In the mean time an officer of his houſehold, named *Jamalarrazad*, knowing that his maſter and many of his people were eſcaped, ventured to load a very large boat with arms, proviſions, money, and ſtuff to clothe the ſoldiers; with which he croſſed the river. For this important ſervice Jaloloddin made him ſteward of his houſehold, and ſurnamed him the *Choſen* or the *Glory of the Faith*. For ſome time after, the ſultan's affairs ſeemed to go on proſperouſly: he gained ſome battles in India; but the princes of that country, envying his proſperity, conſpired againſt him, and obliged him to repaſs the Indus. Here he again attempted to make head againſt the Moguls; but was at laſt defeated and killed by them, and a final end put to the once mighty empire of Gazna.

The metropolis was reduced by Otkay; who no ſooner entered the country in which it was ſituated, than he committed the moſt horrid cruelties. The city was well provided with all things neceſſary for ſuſtaining a ſiege; had a ſtrong garriſon, and a brave and reſolute governor. The inhabitants, expecting no mercy from Jenghiz Khan, who they knew had ſworn their ruin, were reſolved to make a deſperate defence. They made frequent ſallies on the beſiegers, ſeveral times overthrew their works, and broke above 100 of their battering rams. But one night, after an obſtinate fight, part of the city walls fell down; and a great number of Moguls having filled up the ditch, entered the city ſword in hand. The governor perceiving all was loſt, at the head of his braveſt ſoldiers ruſhed into the thickeſt of his enemies, where he and his followers were all ſlain. However, Gazna was not entirely deſtroyed, nor were the people all killed; for after the maſſacre had continued for four or five hours, Otkay ordered it to ceaſe, and taxed thoſe who were left alive at a certain rate, in order to redeem themſelves and the city. It does not, however, appear that after this time the city of Gazna ever made any conſiderable figure.—It was taken by the Moguls in the year 1222.

Gebres || Geddes.

GEBRES. See GABRES.

GECCO, in *Natural Hiſtory*, a name given by the Indians to their terrible poiſon, which kills when mixed with the blood in ever ſuch a ſmall quantity. They ſay that this gecco is a venomous froth or humour vomited out of the mouths of their moſt poiſonous ſerpents; which they procure in this fatal ſtrength, by hanging up the creatures by the tails, and whipping them to enrage them: they collect this in proper veſſels as it falls; and when they would uſe it, they either poiſon a weapon with it, or wounding any part of the fleſh introduce the ſmalleſt quantity imaginable into it; and this is ſaid to be immediate death.

GECKO. See LACERTA, ERPETOLOGY *Index*.

GED, WILLIAM, an ingenious though unſucceſsful artiſt, who was a goldſmith in Edinburgh, deſerves to be recorded for his attempt to introduce an improvement in the art of printing. The invention, firſt practiſed by Ged in 1725, was ſimply this. From any types of Greek or Roman, or any other character, he formed a plate for every page, or ſheet, of a book, from which he printed, inſtead of uſing a type for every letter, as is done in the common way. This was firſt practiſed, but on blocks of wood, by the Chineſe and Japaneſe, and purſued in the firſt eſſays of Coſter the European inventor of the preſent art. "This improvement (ſays James Ged the inventor's ſon) is principally conſiderable in three moſt important articles, viz. expence, correctneſs, beauty and uniformity."

In July 1729, William Ged entered into partnerſhip with William Fenner, a London ſtationer, who was to have half the profits, in conſideration of his advancing all the money requiſite. To ſupply this, Mr John James, then an architect at Greenwich (who built Sir Gregory Page's houſe, Bloomſbury church, &c.) was taken into the ſcheme, and afterwards his brother Mr Thomas James, a letter founder, and James Ged the inventor's ſon. In 1730, theſe partners applied to the univerſity of Cambridge for printing Bibles and common prayer books by blocks inſtead of ſingle types; and, in conſequence, a leaſe was ſealed to them, April 23. 1731. In their attempt they ſunk a large ſum of money, and finiſhed only two prayer books; ſo that it was forced to be relinquiſhed, and the leaſe was afterwards given up. Ged imputed his diſappointment to the villany of the preſsmen, and the ill treatment of his partners (which he ſpecifies at large), particularly Fenner, whom John James and he were adviſed to proſecute, but declined it. He returned to Scotland in 1736, where he gave his friends a ſpecimen of his performance, by an edition of Salluſt. But being ſtill unſucceſsful, and having failed in obtaining redreſs from Fenner, who died inſolvent, he was preparing again to ſet out for London, in order to join with his ſon James as a printer there, when he died October 19. 1749. Ged's ſon attempted unſucceſsfully, in 1751, to revive this invention; Meſſrs Tilloch and Foulis about the year 1782 practiſed it on a ſmall ſcale at Glaſgow; and of late years many beautiful editions of the claſſics have been printed in this way by Didot of Paris.*

* See *Printing* and *Phil. Mag.* x. 267.

GEDDES, ALEXANDER, a learned Scots catholic divine and eminent bible critic, was born in the pariſh of Ruthven in Banffſhire, in the year 1737. His parents were reſpectable, although not opulent. His father was a farmer, who deemed no trouble too great, in order to procure for his children as liberal an education as poſſible. Both father and mother were of the catholic perſuaſion, and the only book of conſequence which the former had in his library was an Engliſh tranſlation of the bible, in which young Geddes was inſtructed with ſuch care and attention, that he was able to give an account of the hiſtory of it before he had reached the eleventh year of his age. The firſt inſtructions he received, after thoſe of his parents, were communicated by a ſchool-miſtreſs in the vicinity, by whom he was ſo much diſtinguiſhed, that it became the firſt mental gratification which, in his own opinion, he ever felt. He was next put under the tuition of a young man from the city of Aberdeen, who had been engaged by the *laird* for the education of his own children; and afterwards went to a place called Scalan, in the Highlands, where thoſe were to be trained up who deſigned to devote themſelves to the catholic prieſthood, and to finiſh their education at ſome foreign univerſity. Here it was, in this obſcure retreat, that Geddes laid the foundation of that intimate acquaintance with the learned languages, by which he was ſo eminently diſtinguiſhed in the ſubſequent part of his life. He went to the Scots univerſity at Paris in the year 1758, and ſoon after began the ſtudy of rhetoric in the college of Navarre. By the ſtrength of his genius and his indefatigable attention, he was ſoon at the head of this claſs, although he had to contend with two veterans, and became the favourite of Vicaire the profeſſor, whoſe friendſhip laſted to the cloſe of life.

Inſtead of entering into the philoſophical claſs at the uſual time, he ſtudied that ſubject at home, in order to facilitate his theological ſtudies, on which he entered under M. M. Buré and de Sauvent, at the college of Navarre, and Lavocat at the Sorbonne was his Hebrew preceptor. So great, or rather aſtoniſhing, was his progreſs, that Profeſſor Lavocat urged him ſtrongly to continue at Paris; but his friends prevailed with him to return to his native country in 1764. His firſt charge as a prieſt was in a catholic chapel in the county of Angus, from which he removed to Traquair in 1765, and became chaplain to the earl of that name, where he remained for about three years. This ſituation was moſt agreeable to his literary purſuits, as he had unlimited acceſs to a very extenſive library, which greatly aſſiſted him in the proſecution of his darling ſtudies. He left the earl's houſe in the year 1768, and returned to Paris, where he devoted his time during the following winter to the peruſal of books and manuſcripts in the king's libraries, making large extracts from ſcarce copies, particularly ſuch as were in the Hebrew tongue.

In the ſpring of 1769, he returned to his native country, and became paſtor of a congregation at Auchinhalrig in Banffſhire, where he was for ſome time involved in pecuniary difficulties, out of which he was extricated by the liberality of the then duke of Norfolk. Theſe were occaſioned by the debts he incurred in building a new chapel for his flock, and in making the parſon's houſe one of the neateſt and moſt convenient in Scotland. With the view of bettering his circumſtances he commenced farmer; but as he had to borrow money to ſtock his farm, and as the crops failed for three ſucceſſive ſeaſons, he was under the neceſſity of abandoning this ſcheme in a much poorer ſtate than when he

firſt

Geddes.

first projected it. But his unwearied exertions, joined to the assistance of friends, again relieved him, and he was enabled to discharge every claim against him of a pecuniary nature in an honourable manner.

In the year 1779 he resigned his pastoral charge at Auchinhalrig, which was a heavy stroke to the members of his congregation, as the zeal and diligence with which he discharged the duties of his ministerial function had endeared him to all. He was also justly esteemed for his attention to the instruction of youth. Next year the university of Aberdeen conferred on him the degree of LL. D. a literary honour which was never bestowed on any Roman-catholic by that body since the Reformation. He afterwards went to London, that he might prosecute his favourite studies with greater facility, and give the world his English translation of the Old and New Testament, to which he had turned his attention for a number of years. He officiated for some months after his arrival in the imperial ambassador's chapel in Duke-street, till the term of easter 1782, at which time it was suppressed by order of the emperor Joseph II. after which Dr Geddes seems to have declined entirely the exercise of his clerical functions.

No sooner had the design of Mr Geddes, relative to a new translation of the Bible been made public, than he met with formidable opposition from his Catholic brethren; an event which the doctor with good reason seems to have anticipated. His own words on this occasion were: "I expect not excessive profits from excessive exertion. I trust I shall never want *meat*, and *clothes*, and *fire*; to a philosophical and contented mind, what more is necessary?" He was many years employed in preparing this important work for the press, before he had any prospect of adequate success. In addressing the English Catholics on the subject of his translation, he has these memorable words: "At any rate, I do what I think it my duty to do, and do it fairly and openly. In the following pages ye will find neither palliation nor disguise. I pour out my sentiments with the same sincerity as if I were before the tribunal of Him who is to judge the living and the dead. Mistake I may, but prevaricate I never will." He discovered this noble spirit in every action of his life, and in all his transactions and intercourse with mankind, although he did not conciliate the regard of those who could have bestowed upon him the most effectual assistance.

After spending much of his life in biblical studies, he met with a long and cruel interruption, of which he thus speaks: "I had but little hope of ever living in a situation to resume them, when Providence threw me into the arms of such a patron as Origen himself might have been proud to boast of—a patron, who, for these ten years past, has, with a dignity peculiar to himself, afforded me every conveniency that my heart could desire towards the carrying on and completing of my arduous work."

It is needless to inform the public, that the patron to whom the learned doctor here alludes was Lord Petre. For this munificence continued through the whole of his life, and even beyond it by his latter will, Christians of every denomination will feel sentiments of gratitude, when they are qualified to make a true estimate of the advantages of free and impartial enquiry.

In the year 1792, the first volume of his translation was published, dedicated to his patron Lord Petre, containing the first six books of the Old Testament. Soon after this volume made its appearance, three apostolic vicars, calling themselves the bishops of Rama, Acanthos and Centuriæ, issued a pastoral letter, addressed to their respective flocks over which they presided, warning them against the reception of Dr Geddes's translation. In his reply to the bishop of Centuriæ we find these words: "Perhaps, my lord, you wish to have another occasion of exercising your episcopal authority, and of playing with censures as children do with a new ball.—I wish your lordship much joy of the bauble; but however, my lord, beware of playing too often with it. Read St Chrysostom on Ecclesiastical Censures, and learn from him a little more moderation. Permit an old priest to tell you, that it is a very great ornament in a *young bishop*. As to myself, my lord, I am not afraid of your threats, and shall laugh at your censures as long as I am conscious that I deserve them not.—You cannot hinder me from praying at home; and at home I will pray, in defiance of your censure, as often as I please. The chief Bishop of our souls is always accessible; and through him I can, at all times, have free access to the Father, who will not reject me, but for voluntary unrepented crimes. In the panoply of conscious innocence, the whole thunder of the Vatican would in vain be levelled at my head."

The second volume of his translation, owing to a variety of interruptions, did not make its appearance till the year 1797, to which was prefixed a dedication to her royal highess the duchess of Gloucester, as an "early, spontaneous, and liberal encourager of the work." In this volume the doctor gives up, and boldly combats, the absolute inspiration of scripture, believing that the Hebrew, like all other historians, wrote from such human documents as they could find, and were of consequence liable to similar mistakes. This latitude of thinking naturally led the doctor to give up as fabulous, and wholly unworthy of the divine philanthropy, every command, precept, and injunction, which appeared unworthy even of human authority. He denied of consequence, that the command given to destroy the Canaanites could have God for its author. His volume of Critical Remarks was published in 1800, in which he enters into an able vindication of his own theory, which rather increased than diminished the number of his enemies, for as he wrote to please no party, he foresaw that he would have enemies in every party, and so it happened.

Dr Geddes was a man of extensive literature, uncommon liberality of thinking, the friend of all mankind; a man of integrity, honour and benevolence; in the strictest sense of the word, a truly genuine Catholic, and whose love of truth was so invincible, that neither hopes nor fears could induce him to conceal it.

His prospectus of a new translation of the Bible in 4to was published in 1786, and a letter to the bishop of London on the same subject in 1787. His proposals were printed in 1788. As a controversial writer, Dr Geddes was eminently distinguished by his letter to Dr Priestley, in defence of the divinity of Jesus Christ, and by one to a member of parliament, on the expediency of a general repeal of the penal statutes

tutes which have a respect to religious opinions. In the spring of the year 1800, he published an apology for the Roman Catholics of Great Britain, in which he zealously defended his peculiar tenets, but displayed a commendable moderation, when he mentioned the injuries to which he himself and brethren were subjected by the continuance of persecuting laws; and, when he argued in behalf of abolishing all legal disabilities, he discovered the soundest logical understanding.

We shall close our short account of this great man in the words of one who was well acquainted with him, and fully qualified to appreciate his merits. "It must be lamented, that, in the death of Dr Geddes, the world has lost the services of a man, who by his acute and penetrating genius—his various, profound, and extensive erudition—his deep research—his indefatigable application—and his independent, dignified, and unfettered spirit, rising superior to the prejudices of education; nobly disdaining the shackles of system; spurning the petty temporizing arts of unmanly accommodation; and setting at defiance all the terrors of malignity, bigotry, and intolerance, was supereminently qualified for the great, laborious, and important work in which he had, for a long series of years, been engaged, of giving an English version of the venerable literary remains of sacred antiquity, the scriptures of the Old and New Testament. During his life, this work did not meet with encouragement adequate to the magnitude of the design; or, it may be added, to the merit of the execution. In this last respect, it will be matter of surprise to all who are competent to judge of the nature of such an enterprise, how much has been done, and with what uncommon ability and success. It everywhere displays the skilful hand of a master."

He had corrected and prepared his translation for the press up to the hundredth and eighteenth psalm, when he was seized with a most painful and excruciating distemper, which put a period to his inestimable life on the 26th of February 1802. The learned world will unquestionably have cause to lament, that Dr Geddes was arrested by the hand of death in the midst of his career, unless that unexpected phenomenon, another Geddes, should make his appearance, and happily finish what his extraordinary predecessor conducted so far with such astonishing abilities;— but, *rara avis in terris*.

GEHENNA, a scripture term which has given some pain to the critics. It occurs in St Matthew, v. 22. 29. 30. x. 28. xviii. 9. xxiii 15. 33. Mark ix. 43. 45. 47. Luke xii. 5. James iii. 6.

The authors of the Louvain and Geneva versions retain the word *gehenna* as it stands in the Greek; the like does M. Simon: the English translators render it by *hell* and *hell fire*, and so do the translators of Mons and Father Bohours.

The word is formed from the Hebrew *gehinnom*, i. e. "valley of Hinnom." In that valley, which was near Jerusalem, there was a place named *Tophet*, where some Jews sacrificed their children to Moloch, by making them pass through the fire. King Josias, to render this place for ever abominable, made a cloaca or common sewer thereof, where all the filth and carcases in the city were cast.

The Jews observed farther, that there was a continual fire kept up there, to burn and consume those carcases; for which reason, as they had no proper term in their language to signify *hell*, they made use of that of *gehenna* or *gehinnon*, to denote a fire unextinguishable.

GELA, in *Ancient Geography*, a city of great extent on the south of Sicily, taking its name from the river Gelas, which washes it. It was built by colonists from Rhodes and Crete, 45 years after the building of Syracuse, or in the third year of the 22d Olympiad, 690 before Christ; originally called *Lindii*, from the colonists of *Lindus*, a city of Rhodes, who settled there first. Now *Terra Nuova*, and the river called *Fiume di Terra Nuova*. The people were called *Geloi*, *Gelenses*, and *Gelani*. The city Gela, after having stood 408 years, was destroyed by Phintias, tyrant of Agrigentum; and the inhabitants were removed to a new city, called *Phintias* after his name.

GELATINA, JELLY. See JELLY.

GELATINOUS, among the physicians, is applied to any thing approaching to the glutinous consistence of a jelly.

GELD, in the English old customs, a Saxon word signifying *money*, or *tribute*. It also denoted a compensation for some crimes committed: Hence *wergeld*, in their ancient laws, was used for the value of a man slain; and *orfgeld*, of a beast.

GELDENHAUR, GERARD, in Latin *Geldenharius*, an historian and Protestant divine in the 16th century. He was a native of Nimeguen, and studied classical learning at Deventer. He went through his course of philosophy at Louvain, where he contracted a very strict friendship with several learned men, and particularly with Erasmus. He became reader and historian to Charles of Austria, and afterwards to Maximilian of Burgundy. At length he embraced the Protestant religion; taught history at Marpurg, and afterwards divinity till his death, in 1542. He wrote, 1. History of Holland. 2. History of the Low Countries. 3. History of the bishops of Utrecht; and other works.

GELDERLAND. See GUELDERLAND.

GELDERS. See GUELDERS.

GELDING, the operation of castrating any animal. See CASTRATION, FARRIERY *Index*.

GELE'E, CLAUDE. See CLAUDE.

GELENHAUSEN, a small imperial town of Wetteravia in Germany, with a castle built by the emperor Frederic I. E. Long. 8. 13. N. Lat. 50. 20.

GELLENIUS, SIGISMUND, a learned and excellent man, born of a good family at Prague, about the year 1498. Erasmus conceiving an esteem for him at Basil, recommended him to John Frobenius as a corrector for his printing-house; which laborious charge he accepted, and had a great number of Hebrew, Greek, and Latin books to correct: he also translated many works himself from the Greek into Latin; and published a dictionary in four languages, Greek, Latin, German, and Sclavonian. Profitable and honourable employments were offered him in other places; but nothing could tempt him to quit his peaceful situation at Basil. He died in 1555. All his translations are highly esteemed.

GELINOTTE, or GRUS. See TETRAO, ORNITHOLOGY *Index*.

GELLERT, CHRISTIAN FURCHTEGOLT, was born at Haynichen, in July 1715, near Freyberg, where his

Gellert, Gelli.

his father was a clergyman. He was extraordinary professor of philosophy at Leipsic, and a distinguished writer among the Germans. When but 13 years of age he discovered a poetical genius; but having none to guide his taste for this kind of composition, he was led to imitate Gunther, Neukerch, and Hanke, men of indifferent abilities. He studied theology at Leipsic in 1734, and returned home at the expiration of four years, when he commenced public speaker; but his timid disposition prevented him from shining as an orator in the pulpit. The delicacy of his constitution forbidding him to aspire after extensive learning, he confined himself to the acquisition of that which might render him useful. He was much respected for his first attempts in poetry, called Amusements of Reason and Wit, which appeared in 1742.

The labour which he found requisite for the composition of sermons, inclined him to lay aside the clerical profession, and devote himself wholly to the instruction of youth, in which he not only diffused knowledge through the minds of his pupils, but also inspired them with the love of religion and virtue. He was made A. M. in 1744, and published the first volume of his fables in the ensuing year. His "Swedish Countess" was the first German romance deserving of notice. He gave the world the second part of his fables in 1748, although two years before this period he was much afflicted with hypochondriacal affections. In 1751, he was solicited to accept the office of extraordinary professor of philosophy, together with a decent salary, which was augmented on the termination of the war.

Assailed by unconquerable lowness of spirits and confirmed melancholy, he still exhibited the same patience, resignation, and universal philanthropy as he had ever shewn, and which excited the admiration of the enemy during the war. His sufferings continued to increase in severity, and at last terminated his existence on the 13th of December 1769. He contributed much to the improvement of the taste and morals of his countrymen, and their gratitude for his services made them deeply lament his loss. His praise was resounded by every voice, his likeness was cast in gypsum, and moulded in wax; it was engraved on copper, and represented in sculpture and painting.

It is said of this amiable man and captivating writer, by Kutner, who wrote the lives of German authors, that it will probably be a century before the appearance of another poet, so fully qualified to excite the love and admiration of his cotemporaries, and obtain such a powerful influence over the taste and way of thinking of all descriptions of men. If it would indicate too much partiality to call him a genius of the first class, he certainly was a most agreeable and fertile writer; the poet to whom religion and virtue are deeply indebted; an able reformer of public manners, and fonder of affording consolation, than of plunging into despondency. Kutner gives him a most excellent and enviable character, in these words: "As long as the Germans shall understand their present language, will the works of Gellert be read; and his character will be honoured while virtue is known and respected."

GELLI, John Baptist, an eminent Italian writer, was born of mean parents at Florence, in the year 1498. He was bred a taylor, some say a shoemaker; but had such an extraordinary genius, that he acquired several languages, and made an uncommon progress in the belles lettres: and though he continued always to work at his trade, became acquainted with all the wits and learned men at Florence, and his merit was universally known. He was chosen a member of the academy there, and the city made him a burgess. He acquired the highest reputation by his works, which are, 1. *I. Caprici del Bottaio*, quarto; which contains ten dialogues. 2. *La Circe*, octavo. This, which also contains ten dialogues, and treats of human nature, has been translated into Latin, French, and English. 3. Differtations in Italian on the poems of Dante and Petrarch. 4. The comedies of *La Sporta* and *La Errore*; and other works. He died in 1563.

Gellibrand || Gem.

GELLIBRAND, Henry, a laborious astronomer of the 17th century, was born in 1597. Though he was not without good views in the church, yet he became so enamoured with mathematical studies, that on the death of his father he became a student at Oxford, contented himself with his private patrimony, and devoted himself solely to them. On the death of Mr Gunter, he was recommended by Mr Briggs to the trustees of Gresham college, for the astronomical professorship there; to which he was elected in 1627. His friend Mr Briggs dying in 1630, before he had finished his *Trigonometria Britannica*, it was finished by Gellibrand at his request. He wrote several other things, chiefly tending to the improvement of navigation; and died in 1636.

GELLIUS, Aulus, a celebrated grammarian who lived in the 2d century under Marcus Aurelius and some succeeding emperors. He wrote a collection of observations on authors, for the use of his children; and called it *Noctes Atticæ*, because composed in the evenings of a winter he spent at Athens. The chief value of it is for preserving many facts and monuments of antiquity not to be found elsewhere. Critics and grammarians have bestowed much pains on this writer.

GELLY. See Jelly.

GELO, or Gelon, a son of Dinomenes who made himself absolute at Syracuse 484 years before the Christian era. He conquered the Carthaginians at Himera, and made his oppression popular by his great equity and moderation. He reigned seven years, and his death was universally lamented at Syracuse. He was called the father of his people, and the patron of liberty, and honoured as a demigod. His brother Hiero succeeded him. See Syracuse.

GEM, in *Natural History*, a common name for all precious stones; of which there are two classes, the pellucid and semipellucid.

The bodies composing the class of pellucid gems are bright, elegant, and beautiful fossils, which are found in small detached masses, extremely hard, and of great lustre.

The bodies composing the class of semipellucid gems, are stones naturally compound, not inflammable or soluble in water, found in detached masses, and composed of crystalline matter debased by earth: however, they are but slightly debased; and are of great beauty and brightness, of a moderate degree of transparency, and are usually found in small masses.

The knowledge of gems depends principally on observing their hardness and colour. Their hardness is commonly

commonly allowed to ſtand in the following order: The diamond the hardeſt of all; then the ruby, ſapphire, jacinth, emerald, amethyſt, garnet, carneol, chalcedony, onyx, jaſper, agate, porphyry, and marble. This difference, however, is not regular and conſtant, but frequently varies. Good cryſtals may be allowed to ſucceed the onyx; but the whole family of metallic glaſſy fluors ſeems to be ſtill ſofter.—In point of colour, the diamond is valued for its tranſparency, the ruby for its purple, the ſapphire for its blue, the emerald for its green, the jacinth for its orange, the amethyſt carneol for its carnation, the onyx for its tawny, the jaſper, agate, and porphyry, for their vermilion, green, and variegated colours, and the garnet for its tranſparent blood red.

All theſe gems are ſometimes found coloured and ſpotted, and ſometimes quite limpid and colourleſs. In this caſe the diamond cutter or poliſher knows how to diſtinguiſh their different ſpecies by their different degrees of hardneſs upon the mill. For the cutting or poliſhing of gems, the fine powder of the fragments of thoſe that are next in degree of hardneſs is always required to grind away the ſofter; but as none of them are harder than the diamond, this can only be poliſhed by its own powder.

Cronſtedt obſerves of gems in general, that the colour of the ruby and emerald are ſaid to remain in the fire, while that of the topaz flies off: hence it is uſual to burn the topaz, and thence ſubſtitute it for the diamond. "Their colours (ſays our author) are commonly ſuppoſed to depend upon metallic vapours; but may they not more juſtly be ſuppoſed to ariſe from a phlogiſton united with a metallic or ſome other earth? becauſe we find that metallic earths which are perfectly well calcined give no colour to any glaſs: and that the manganeſe, on the other hand, gives more colour than can be aſcribed to the ſmall quantity of metal which is to be extracted from it." M. Magellan is of opinion, that their colour is owing chiefly to the mixture of iron which enters their compoſition; but approves the ſentiment of Cronſtedt, that phlogiſton has a ſhare in their production, it being well known that the calces of iron when dephlogiſticated produce the red and yellow colours of marble, and when phlogiſticated to a certain degree produce the blue or green colours.

With regard to the texture of gems, M. Magellan obſerves, that all of them are foliated or laminated, and of various degrees of hardneſs. Whenever the edges of theſe laminæ are ſenſible to the eye, they have a fibrous appearance, and reflect various ſhades of colour, which change ſucceſſively according to their angular poſition to the eye. Theſe are called by the French *chatoyantes;* and what is a blemiſh in their tranſparency, often enhances their value on account of their ſcarcity. But when the ſubſtance of a gem is compoſed of a broken texture, conſiſting of various ſets of laminæ differently inclined to each other, it emits at the ſame time various irradiations of different colours, which ſucceed one another according to their angle of poſition. This kind of gems has obtained the name of *opals*, and are valued in proportion to the brillancy, beauty, and variety of their colours. Their cryſtallization, no doubt, depends on the ſame cauſe which produces that of ſalts, earths, and metals, which is treated of under the article CRYSTALLIZATION. The following table ſhows the component parts of gems according to the analyſis of Bergman and M. Achard; the letter B prefixed to each denoting Bergman's analyſis, and A that of Achard.

		Argil.	Silic.	Calc.	Iron.
Red oriental ruby, -	B	40	39	9	10
Ditto, - -	A	37.5	42.5	9	11
Blue oriental ſapphire, -	B	58	35	5	2
Ditto, - -	A	58	33	6	3
Yellow topaz from Saxony,	B	46	39	8	6
Green oriental emerald, -	B	60	24	8	6
Ditto, - -	A	60	23	10	7
Yellow brown orient. hyacinth,	B	40	25	20	13
Ditto, - -	A	42	22	20	16
Tourmalin from Ceylon,	B	39	37	15	9
Ditto from Braſil, -	B	50	34	11	5
Ditto from Tyrol, -	B	42	40	12	6
Garnet from Bohemia, -	A	30	48	11	10

But later analyſes ſhew that the component parts are different from the above, particularly the colouring matters which are here aſcribed to iron. See MINERALOGY.

The chryſopraſe from Koſeinitz in Sileſia was likewiſe analyzed by M. Achard; who found that it contained 456 grains of ſiliceous earth, 13 of calcareous, ſix of magneſia, three of copper, and two of iron. "This (ſays M. Magellan) ſeems to be the only gem that contains no argillaceous earth."

Imitation or Counterfeiting of GEMS *in Glaſs.* The art of imitating gems in glaſs is too conſiderable to be paſſed without notice: ſome of the leading compoſitions therein we ſhall mention upon the authority of Neri and others.

Theſe gems are made of paſtes; and are noway inferior to the native ſtones, when carefully made and well poliſhed, in brightneſs or tranſparence, but want their hardneſs.

The general rules to be obſerved in making the paſtes are theſe: 1. That all the veſſels in which they are made be firmly luted, and the lute left to dry before they are put into the fire. 2. That ſuch veſſels be choſen for the work as will bear the fire well. 3. That the powders be prepared on a porphyry ſtone; not in a metal mortar, which would communicate a tinge to them. 4. That the juſt proportion in the quantity of the ſeveral ingredients be nicely obſerved. 5. That the materials be all well mixed; and, if not ſufficiently baked the firſt time, to be committed to the fire again, without breaking the pot; for if this be not obſerved, they will be full of bliſters and air bladders. 6. That a ſmall vacuity be always left at the top of the pot, to give room to the ſwelling of the ingredients.

To make paſte of extreme hardneſs, and capable of all the colours of the gems, with great luſtre and beauty.—Take of prepared cryſtal, ten pounds; ſalt of polverine, ſix pounds; ſulphur of lead, two pounds: mix all theſe well together into a fine powder; make the whole with common water into a hard paſte; and make this paſte into ſmall cakes of about three ounces weight each, with a hole made in their middle; dry them in the ſun, and afterwards calcine them in the ſtraiteſt part of a potter's furnace. After this, powder

der them, and levigate them to a perfect fineneſs on a porphyry ſtone, and ſet this powder in pots in a glaſs furnace to purify for three days: then caſt the whole into water, and afterwards return it into the furnace, where let it ſtand 15 days, in which time all foulneſs and bliſters will diſappear, and the paſte will greatly reſemble the natural jewels. To give this the colour of the emerald, add to it braſs thrice calcined; for a ſea green, braſs ſimply calcined to a redneſs; for a ſapphire, add zaffer, with mangancſe; and for a topaz, manganeſe and tartar. All the gems are thus imitated in this, by the ſame way of working as the making of coloured glaſſes; and this is ſo hard, that they very much approach the natural gems.

The colour of all the counterfeit gems made of the ſeveral paſtes, may be made deeper or lighter according to the work for which the ſtones are deſigned; and it is a neceſſary general rule, that ſmall ſtones for rings, &c. require a deeper colour, and large ones a paler. Beſides the colours made from manganeſe, verdigris, and zaffer, which are the ingredients commonly uſed, there are other very fine ones which care and ſkill may prepare. Very fine red may be made from gold, and one not much inferior to that from iron; a very fine green from braſs or copper; a ſky colour from ſilver, and a much finer one from the granates of Bohemia.

A very ſingular and excellent way of making the paſte to imitate the coloured gems is this: Take a quantity of ſaccharum ſaturni, or ſugar of lead, made with vinegar in the common way; ſet it in ſand, in a glaſs body well luted from the neck downwards; leave the mouth of the glaſs open, and continue the fire 24 hours; then take out the ſalt, and if it be not red but yellowiſh, powder it fine, and return it into the veſſel, and keep it in the ſand heat 24 hours more, till it becomes as red as cinnabar. The fire muſt not be made ſo ſtrong as to melt it, for then all the proceſs is ſpoiled. Pour diſtilled vinegar on this calcined ſalt, and ſeparate the ſolution from the dregs; let the decanted liquor ſtand ſix days in an earthen veſſel, to give time for the finer ſediment to ſubſide; filter this liquor, and evaporate it in a glaſs body, and there will remain a moſt pure ſalt of lead; dry this well, then diſſolve it in fair water; let the ſolution ſtand ſix days in a glazed pan; let it ſubſide, then filter the clear ſolution, and evaporate it to a yet more pure white and ſweet ſalt; repeat this operation three times; put the now perfectly pure ſalt into a glaſs veſſel, ſet it in a ſand heat for ſeveral days, and it will be calcined to a fine impalpable powder of a lively red. This is called *the ſulphur of lead.*

Take all the ingredients as in the common compoſition of the paſtes of the ſeveral colours, only inſtead of red lead, uſe this powder; and the produce will well reward the trouble of the operation, as experience has often proved.

A paſte proper for receiving colours may be readily made by well pounding and mixing ſix pounds of white ſand cleanſed, three pounds of red lead, two pounds of purified pearl-aſhes, and one pound of nitre. A ſofter paſte may be made in the ſame manner, of ſix pounds of white ſand cleanſed; red lead, and purified pearl-aſhes, of each three pounds; one pound of nitre, half a pound of borax, and three ounces of arſenic. For common uſe a pound of common ſalt may be ſubſtituted for the borax. This glaſs will be very ſoft, and will not bear much wear if employed for rings, buckles, or ſuch imitations of ſtones as are expoſed to much rubbing; but for ear-rings, ornaments worn on the breaſt, and thoſe little uſed, it may laſt a conſiderable time.

In order to give paſte different colours, the proceſs is as follows: For

Amethyſt. Take ten pounds of either of the compoſitions deſcribed under *Colouring of* GLASS, one ounce and a half of manganeſe, and one drachm of zaffer; powder and fuſe them together.

Black. Take ten pounds of either of the compoſitions juſt referred to, one ounce of zaffer, ſix drachms of manganeſe, and five drachms of iron, highly calcined; and proceed as before.

Blue. Take of the ſame compoſition, ten pounds; of zaffer, ſix drachms; and of manganeſe, two drachms: and proceed as with the foregoing.

Chryſolite. Take of either of the compoſitions for paſte above deſcribed, prepared without ſaltpetre, ten pounds, and of calcined iron five drachms; and purſue the ſame proceſs as with the reſt.

Red Cornelian. Take of the compoſitions mentioned under *Colouring of* GLASS, two pounds; of glaſs of antimony, one pound; of the calcined vitriol called *ſcarlet ochre*, two ounces; and of manganeſe, one drachm. Fuſe the glaſs of antimony and manganeſe with the compoſition; then powder them, and mix them with the other, by grinding them together, and fuſe them with a gentle heat.

White Cornelian. Take of the compoſition juſt referred to, two pounds; of yellow ochre well waſhed, two drachms; and of calcined bones, one ounce. Mix them, and fuſe them with a gentle heat.

Diamond. Take of the white ſand, ſix pounds; of red lead, four pounds; of pearl aſhes, purified, three pounds; of nitre two pounds; of arſenic five ounces; and of manganeſe, one ſcruple. Powder and fuſe them.

Eagle-marine. Take ten pounds of the compoſition under GLASS; three ounces of copper highly calcined with ſulphur; and one ſcruple of zaffer. Proceed as before.

Emerald. Take of the ſame compoſition with the laſt nine pounds; three ounces of copper precipitated from aquafortis; and two drachms of precipitated iron. See EMERALD, MINERALOGY *Index.*

Garnet. Take two pounds of the compoſition under GLASS; two pounds of the glaſs of antimony, and two drachms of manganeſe. For vinegar garnet, take of the compoſition for paſte, deſcribed in this article, two pounds; one pound of glaſs of antimony, and half an ounce of iron, highly calcined: mix the iron with the uncoloured paſte, and fuſe them: then add the glaſs of antimony powdered, and continue them in the heat till the whole is incorporated.

Gold or *full Yellow.* Take of the compoſition for paſte ten pounds; and one ounce and a half of iron ſtrongly calcined; proceeding as with the others.

Deep Purple. Take of either of the compoſitions for paſte, ten pounds; of manganeſe, one ounce; and of zaffer, half an ounce.

Ruby. Take one pound of either of the compoſitions

tions for paſte, and two drachms precipitate of gold by tin; powder the paſte, and grind the calx of gold with it in a glaſs, flint, or agate mortar, and then fuſe them together. A cheaper ruby paſte may be made with half a pound of either of the above compoſitions, half a pound of glaſs of antimony, and one drachm and a half of the calx of gold; proceeding as before.

Sapphire. Take of the compoſition for paſte, ten pounds; of zaffer, three drachms and one ſcruple; and of the *calx Caſſii*, one drachm. Powder and fuſe them. Or the ſame may be done, by mixing with the paſte one-eighth of its weight of ſmalt.

Topaz. Take of the compoſitions under Glass ten pounds, omitting the ſaltpetre; and an equal quantity of the *Gold-coloured hard Glass*. Powder and fuſe them. See Topaz, Mineralogy *Index*.

Turquoiſe. Take of the compoſition for blue paſte already deſcribed, ten pounds; of calcined bone, horn, or ivory, half a pound. Powder and fuſe them.

Opaque white. Take of the compoſition for paſte ten pounds; and one pound of calcined horn, ivory, or bone; and proceed as before.

Semitranſparent white, like opal. See Opal, Mineralogy *Index*.

To the above we ſhall add the following receipts and proceſſes, contained in a memoir by M. Fontanieu of the Royal Academy of Sciences at Paris, and ſaid to have met with much approbation.

I. *Of the Baſes.* Although the different calces of lead are all adapted to produce the ſame effect in vitrification; yet M. Fontanieu prefers lead in ſcales, and next to that minium, as being the moſt conſtantly pure. It is neceſſary to ſift through a ſilk ſieve the preparations of lead one wiſhes to make uſe of in the vitrification, in order to ſeparate the groſſer parts, as alſo the lead found in a metallic ſtate when white lead in ſcales is employed.

The baſe of factitious gems is calx of lead and rock cryſtal, or any other ſtone vitrifiable by the calces already mentioned. Pure ſand, flint, and the tranſparent pebbles of rivers, are ſubſtances equally fit to make glaſs: but as it is firſt neceſſary to break the maſſes of cryſtal, ſtones, or pebbles, into ſmaller parts; ſo by this operation particles of iron or copper are frequently introduced, and to theſe duſt or greaſy matters are alſo apt to adhere. Our author therefore begins by putting the pounded cryſtal or pebbles into a crucible, which he places in a degree of heat capable of making the maſs red hot; he then pours it into a wooden bowl filled with very clear water; and ſhaking the bowl from time to time, the ſmall portions of coals furniſhed by the extraneous bodies ſwim on the ſurface of the water, and the vitrifiable earth, with the iron, &c. reſts on the bottom. He then decants the water; and having dried the maſs, he pounds it, and ſifts the powder through the fineſt ſilk ſieve: he then digeſts the powder during four or five hours with marine acid, ſhaking the mixture every hour. After having decanted the marine acid from the vitrifiable earth, he waſhes the latter until the water no longer reddens the tincture of turnſol. The ſaid earth being dried, is paſſed through a ſilk ſieve, and is then fit for uſe. Nitre, ſalt of tartar, and borax, are the three ſpecies of ſalts that enter with quartz and the ſeveral calces of lead into M. Fontanieu's vitrifications.

Much of the ſucceſs in the art of making coloured ſtones depends on the accurate proportion of the ſubſtances made uſe of to form the cryſtal which ſerves as a baſe to the factitious ſtones. After having tried a great variety of receipts, our author found they might be reduced to the following.

1. Take two parts and a half of lead in ſcales, one part and a half of rock cryſtal or prepared flints, half a part of nitre, as much borax, and a quarter part of glaſs of arſenic. Theſe being well pulverized and mixed together, are to be put into a Heſſian crucible, and ſubmitted to the fire. When the mixture is well melted, pour it into cold water: then melt it again a ſecond and a third time; taking care, after each melting, to throw it into freſh cold water, and to ſeparate from it the lead that may be revived. The ſame crucible ſhould not be uſed a ſecond time, becauſe the glaſs of lead is apt to penetrate it in ſuch a manner as to run the riſk of loſing the contents. One muſt alſo be careful to cover the crucible well, to prevent any coals getting into it, which would reduce the calx of lead, and ſpoil the compoſition.

2. Take two parts and a half of white ceruſe, one part of prepared flints, half a part of ſalt of tartar, and a quarter part of calcined borax: melt the mixture in a Heſſian crucible, and then pour it into cold water; it is then to be melted again, and waſhed a ſecond and a third time, the ſame precautions being obſerved as for the firſt baſe.

3. Take two parts minium, one part rock cryſtal, half a part of nitre, and as much ſalt of tartar: this mixture being melted, muſt be treated as the former.

4. Take three parts of calcined borax, one part of prepared rock cryſtal, and one part of ſalt of tartar; theſe being well mixed and melted together, muſt be poured into warm water: the water being decanted and the maſs dried, an equal quantity of minium muſt be added to it; it is then to be melted and waſhed ſeveral times as directed above.

5. That called by our author the *Mayence baſe*, and which he conſiders as one of the fineſt cryſtalline compoſitions hitherto known, is thus compoſed: Take three parts of fixed alkali of tartar, one part of rock cryſtal or flint pulverized: the mixture to be well baked together, and then left to cool. It is afterwards poured into a crucible of hot water to diſſolve the frit; the ſolution of the frit is then received into a ſtone-ware pan, and aquafortis added gradually to the ſolution till it no longer effervеſces: this water being decanted, the frit muſt be waſhed in warm water till it has no longer any taſte: the frit is then dried, and mixed with one part and a half of fine ceruſe or white lead in ſcales; and this mixture muſt be well levigated with a little diſtilled water. To one part and a half of this powder dried add an ounce of calcined borax: let the whole be well mixed in a marble mortar, then melted and poured into cold water as the other baſes already deſcribed. Theſe fuſions and lotions having been repeated, and the mixture dried and powdered, a 12th part of nitre muſt be added to it, and then melted for the laſt time; when a very fine cryſtal will be found in the crucible.

6. As a compoſition for furniſhing very fine white ſtones: Take eight ounces of ceruſe, three ounces of

 rock

rock cryſtal pulverized, two ounces of borax finely powdered, and half a grain of mangancſe: having melted and waſhed this mixture in the manner directed above, it will produce a very fine white cryſtal.

II. *Of the Colours*. The calces of metals, as already obſerved, are the ſubſtances employed to colour factitious gems; and on the preparation of theſe calces depends the vividneſs of their colours.

a, From *Gold*.] To obtain the mineral purple known by the name of *precipitate of Caſſius*, M. Fontanieu employs the following different proceſſes.

1. Diſſolve ſome pure gold in aqua regia, prepared with three parts of precipitated nitrous acid and one part of marine acid; and to haſten the diſſolution, the matraſs ſhould be placed in a ſand bath. Into this ſolution pour a ſolution of tin in aqua regia. The mixture becomes turbid, and the gold is precipitated with a portion of the tin, in the form of a reddiſh powder; which, after being waſhed and dried, is called *precipitate of Caſſius*.—The aqua regia employed to diſſolve the tin is compoſed of five parts of nitrous acid and one part of marine acid: to eight ounces of this aqua regia, are added fixteen ounces of diſtilled water. Some leaves of Malacca tin, about the ſize and thickneſs of a ſixpence, are then put into this diluted aqua regia, till it will diſſolve no more of them: which operation our author obſerves, requires commonly twelve or fourteen days; though it might probably be haſtened by beating the tin ſtill thinner, and then rolling it into the form of a hollow cylinder, or turning it round into ſpiral convolutions, and thus expoſing a greater extent of ſurface to the action of the menſtruum. In order to prepare more readily the precipitate of Caſſius, M. Fontanieu puts into a large jug eight ounces of ſolution of tin, to which he adds four pints of diſtilled water: he afterwards pours into this metallic lye ſome ſolution of gold, drop by drop, taking care to ſtir the whole with a glaſs tube: when the mixture becomes of a deep purple colour, he ceaſes dropping the ſolution of gold; and in order to haſten the precipitation of the mineral purple, pours into the mixture a pint of freſh urine. Six or ſeven hours after, the precipitate is collected at the bottom of the veſſel: the fluid is then decanted; and the precipitate, waſhed once or twice, is dried till it becomes a brown powder.

2. Pour into a veſſel of fine tin with a thick bottom four ounces of the ſolution of gold; three minutes after add two pints of diſtilled water. Let this mixture ſtand in the tin veſſel during ſeven hours, taking care to ſtir it every hour with a glaſs tube; afterwards pour it into a conical glaſs jug, and add to it a pint of new urine: the mineral purple is ſoon precipitated, and then is to be waſhed and dried.

3. Diſtil in a glaſs retort placed in a bath of aſhes, ſome gold diſſolved in aqua regia, made with three parts nitrous and one part marine acid; when the acid is paſſed over and the gold contained in the retort appears dry, leave the veſſel to cool, then pour into it ſome new aqua regia, and proceed to diſtil as before. Replace the aqua regia twice upon the gold, and diſtil the ſame. After theſe four operations, pour by little and little into the retort ſome oil of tartar *per deliquium*, which will occaſion a briſk effervescence: when this ceaſes, diſtil the mixture till it becomes dry, and then put ſome warm water into the retort. Shake the whole and pour it into a cucurbit, when a precipitate is depoſited, the colour of which is ſometimes brown and ſometimes yellow: After having waſhed this precipitate, dry it. Our author ſays, this mineral purple was much ſuperior to the foregoing, ſince two grains of it only were ſufficient to an ounce of the baſe, whilſt it required of the other two a 20th part of the baſe. And he adds, that he found a means of exalting the colour of the precipitate of Caſſius, by putting to it a ſixth part of its weight of glaſs of antimony finely powdered, and of nitre in the proportion of a drachm to eight ounces of the baſe.

b, From *Silver*.] The oxide of ſilver, being vitrified, produces a yellowiſh gray colour. This oxide enters only into the compoſition of the yellow artificial diamond and the opal. M. Fontanieu introduces it into the baſe in the form of luna cornea.

In order to prepare it, he directs to diſſolve the ſilver in precipitated nitrous acid, and afterwards to pour into it a ſolution of ſea ſalt: a white precipitate is obtained; which, being waſhed and dried, melts very readily in the fire, and is ſoon volatilized if not mixed with vitrifiable matters. To make the yellow diamond, 25 grains of this luna cornea are put to an ounce of the fourth baſe: the doſe of ſilver may be diminiſhed according to the ſhade of yellow that one wiſhes to procure.

c, From *Copper*.] The oxide of copper imparts to white glaſs the fineſt green colour; but if this metal be not exactly in a ſtate of oxide, it produces a browniſh red colour. *Mountain blue verdigris*, and the reſidue of its diſtillation, are the different preparations of copper which our author employs to make the artificial emeralds.

d, From *Iron*.] Although it has been aſſerted that the oxides of iron introduce a very fine tranſparent red colour into white glaſs, M. Fontanieu could only obtain from it a pale red a little opake. The oxide of iron that he employed was in the proportion of the 20th part of the baſe.

There are ſeveral ways of preparing the oxide of iron called *crocus Martis*, or *ſaffron of Mars*. In general, it is neceſſary that this metal be ſo far oxidated that the magnet ceaſes to attract it: thus one may uſe the ſcales of iron found upon the bars of the furnaces, which ſerve to diſtil aquafortis. By digeſting filings of ſteel with diſtilled vinegar, then evaporating and replacing the vinegar 10 or 12 times upon theſe filings and drying them alternately, an oxide of iron is obtained, which muſt be ſifted through a ſilk ſieve, and then calcined. The oxide of iron thus obtained by the vinegar, our author ſays, only introduced into his baſes a green colour inclining to a yellow.

By the following proceſs a ſaffron of Mars of the fineſt red colour is obtained: Let an ounce of iron filings be diſſolved in nitrous acid in a glaſs retort, and diſtilled over a ſand bath to dryneſs. After having replaced the acid or the dry oxide, and re-diſtilled it a ſecond and a third time, it is then edulcorated with ſpirits of wine, and afterwards waſhed with diſtilled water.

e, From the *Magnet*.] It is neceſſary to calcine the magnet before it be introduced into the vitrifications: Having therefore torrefied the magnet during two hours,

hours, it muſt be waſhed and dried. It is only employed in the compoſition of the opal.

f, From *Cobalt.*] The oxide of cobalt is only proper to introduce a blue colour into glaſs; but this ſemimetal is rarely found free from iron and biſmuth, and therefore it is firſt neceſſary to ſeparate them from it. This is done by calcining the ore of cobalt in order to diſengage the arſenic; afterwards the oxide muſt be diſtilled in a retort with ſal ammoniac, and the iron and the biſmuth are found ſublimed with this ſalt. The diſtillation muſt be repeated with the ſal ammoniac till this ſalt is no longer coloured yellow. The cobalt which remains in the cornute is then calcined in a potſherd, and becomes a very pure oxide; which being introduced into the baſe, in the proportion of a 900dth part, gives it a very fine blue colour, the intenſity of which may be increaſed at diſcretion by the addition of oxide of cobalt. In order to prepare *black enamel* reſembling that which is called *black agate* of Iceland; melt together a pound and a half of one of the baſes, two ounces of the oxide of cobalt, two ounces of *crocus Martis* prepared with vinegar, and two ounces of manganeſe.

g, From *Tin.*] The oxide of tin, which is of a white colour, renders opake the glaſs with which it is melted, and forms white enamel. For this purpoſe, calcine the putty of tin; then waſh and dry it, and ſift it through a ſilk ſieve. Take ſix pounds of the ſecond baſe, the ſame quantity of the calcined putty of tin, and 48 grains of manganeſe.

h, From *Antimony.*] Antimony is only ſuſceptible of vitrification in a certain ſtate of oxidation, and then it produces a reddiſh or hyacinth coloured glaſs; but if the antimony be in a ſtate of abſolute calx, ſuch as the diaphoretic antimony, then it is no longer vitrifiable, and may be ſubſtituted for oxide of tin to make white enamel. M. Fontanieu introduces the glaſs of antimony in the compoſition of artificial topazes. For the *oriental topaz*, he takes 24 ounces of the firſt baſe, and five drachms of the glaſs of antimony. To imitate the *topaz of Saxony*, he adds to each ounce of the baſe five grains of the glaſs of antimony. For the *topaz of Brazil*, he takes 24 ounces of the firſt baſe, one ounce 24 grains of glaſs of antimony, and 8 grains of the *precipitate of Caſſius*.

i, From *Manganeſe.*] This mineral employed in a ſmall quantity, renders the glaſs whiter; a larger quantity produces a very fine violet colour, and a ſtill larger doſe of it renders the glaſs black and opake.

There are two ways of preparing manganeſe. 1. The moſt ſimple conſiſts in expoſing it to a red heat, and then quenching it with diſtilled vinegar; it is afterwards dried and powdered, in order to paſs it through a ſilk ſieve. 2. Haudiquer de Blancour deſcribes the ſecond manner of preparing the manganeſe, proper to furniſh a red colour, and names it *fuſible manganeſe.* Take of manganeſe of Piedmont one pound; torrefy and pulverize it; then mix it with a pound of nitre, and calcine the mixture during 24 hours; afterwards waſh it repeatedly in warm water, till the water of the lyes has no longer any taſte; dry the manganeſe, and mix with it an equal weight of ſal ammoniac; levigate this mixture on a ſlab of porphyry with oil of vitriol diluted with water to the ſtrength of vinegar. Dry the mixture, and introduce it into a cornute; diſtil by a graduated fire; and when the ſal ammoniac is ſublimed weigh it, and add to the mixture an equal quantity. Then diſtil and ſublime as before, and repeat the operation ſix times, being careful at each time to mix the ſal ammoniac and the manganeſe upon the porphyry with diluted oil of vitriol.

At Tournhault in Bohemia, there is ſold a fuſible glaſs of a yellow colour, very like that of the topaz of Brazil, which, when expoſed to a degree of fire in a cupel ſufficient to redden it, becomes of a very fine ruby colour, more or leſs deep according to the degree of fire to which it has been expoſed. Our author aſſayed this glaſs, and found it to contain a great deal of lead, but was not able to diſcover any gold in it.

III. *Of the different degrees of fire neceſſary for Factitious Gems.* Our author obſerves, that there are three degrees of heat very different in their energy. The fire kept up in the wind furnaces in the laboratories of chemiſts, is leſs active than that whoſe effect is accelerated by the means of bellows; and a fire ſupported by wood, and kept up during 60 hours without interruption, produces ſingular effects in vitrification, and renders the glaſs finer and leſs alterable.

When recourſe is had to the forge, in order to operate a vitrification, it is neceſſary to turn about the crucible from time to time, that the maſs may melt equally. Some coal alſo ſhould be replaced, in proportion as it conſumes towards the nozel of the bellows; for without this precaution, we ſhould run the riſk of cooling the crucible oppoſite to the flame, and probably of cracking it, when all the melted maſs running among the coals would be totally loſt. Though this is the readieſt way of melting, it ſhould not be employed out of choice; for the crucible often breaks, or coals get into it, which may reduce the lead to the metallic ſtate.

The wind furnace is either ſquare or round. A ſmall cake of baked clay or brick, of the thickneſs of an inch, is placed upon the grate; and upon this cake is placed the crucible, ſurrounded with coals. The degree of heat produced by this furnace is much leſs than that of the forge: but in order to ſucceed in the vitrification, M. Fontanieu recommends the uſe of a furnace deſcribed by Kunckel, of which, the interior part is ſo diſpoſed, that we may place crucibles at three different heights; and the name of *chambers* is given to thoſe ſteps upon which the crucibles are placed.

It is obvious, that the degree of heat cannot be equal in the ſaid three chambers. In the firſt or loweſt chamber the heat is greateſt, afterwards in the next, and laſtly, in the higheſt. We ſhould begin by placing the crucibles according to their ſize, in theſe different chambers; by which means the beſt effect in vitrification is produced.

In order to conduct the fire well, only three billets of white wood ſhould be put into the furnace at a time for the firſt 20 hours, four billets at a time for the next 20 hours, and ſix billets for the laſt 20 hours; in all 60 hours. The furnace is then left to cool, care being taken to ſtop the air holes with ſome lute; and in about 48 hours after, when the kiln is quite cold, the crucible is to be withdrawn.

IV. *The Compoſitions.* 1. For the white diamond: Take

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Take the base of Mayence. This crystal is very pure, and has no colours.

2. For the yellow diamond: To an ounce of the fourth base, add for colour 25 grains of luna cornea or 10 grains of glass of antimony.

3. For the emerald: 1. To 15 ounces of either of the bases, add for colour one drachm of mountain blue and six grains of glass of antimony; or, 2. To an ounce of the second base, add for colour 20 grains of glass of antimony and three grains of calx of cobalt.

4. For the sapphire: To 24 ounces of the Mayence base, add for colour two drachms 46 grains of the calx of cobalt.

5. For the amethyst: To 24 ounces of the Mayence base, add for colour four drachms of prepared manganese and four grains of precipitate of Cassius.

6. For the beryl: To 24 ounces of the third base, add for colour 96 grains of glass of antimony and four grains of calx of cobalt.

7. For the black agate: To 24 ounces of either of the bases, add two ounces of the mixture directed above in par. *f*.

8. For the opal: To an ounce of the third base, add for colour 10 grains of luna cornea, two grains of magnet, and 26 grains of absorbent earth.

9. For the oriental topaz: To 24 ounces of the first or third base, add for colour five drachms of glass of antimony.

10. For the topaz of Saxony: To 24 of the same base, add for colour six drachms of the glass of antimony.

11. For the topaz of Brasil: to 24 ounces of the second or third base, add for colour one ounce 24 grains of the glass of antimony and eight grains of precipitate of Cassius.

12. For the hyacinth: To 24 ounces of the base made with rock crystal, add for colour two drachms 48 grains of glass of antimony.

13. For the oriental ruby: 1. To 16 ounces of the Mayence base, add for colour a mixture of two drachms 48 grains of the precipitate of Cassius, the same quantity of crocus Martis prepared in aquafortis, the same of golden sulphur of antimony and of fusible manganese, with the addition of two ounces of mineral crystal: or, 2. To 20 ounces of the base made with flint, add half an ounce of fusible manganese and two ounces of mineral crystal.

14. For the balass rubby: 1. To 16 ounces of the Mayence base, add the above colouring powder, but diminished a fourth part; or, 2. To 20 ounces of the base made with flints, add the same colouring powder, but with a fourth less of the manganese.

The *factitious* gems are easily distinguished from the *natural*, by their softness and fusibility; by their solubility in acids; by their causing only a single refraction of the rays of light; and in many cases, by their specific gravity, which exceeds 2.76 in all precious gems of the first order, as the diamond, ruby, sapphire, &c.

Imitation of Antique GEMS. There has been at different times a method practised by particular persons of taking the impressions and figures of antique gems, with their engravings, in glass of the colour of the original gem. This has always been esteemed a very valuable method, and greatly preferable to the more ordinary ones of doing it on sealing wax or brimstone; but, to the misfortune of the world, this art being a secret only in the hands of some particular persons who got their bread by it, died with them, and every new artist was obliged to re-invent the method; till at length Mr Homberg having found it in great perfection, gave the whole process to the world to be no more forgotten or lost; and since that time it has been very commonly practised in France, and sometimes in other places.

Mr Homberg was favoured in his attempts with all the engraved gems of the king's cabinet; and took such elegant impressions, and made such exact resemblances of the originals, and that in glasses so artfully tinged to the colour of the gems themselves, that the nicest judges were deceived in them, and often took them for the true antique stones. The counterfeit gems also serve, as well as the original ones, to make more copies from afterwards; so that there is no end of the numbers that may be made from one; and there is this farther advantage, that the copy may be easily made perfect, though the original should not be so, but should have sustained some damage from a blow or otherwise.

The great care in the operation is to take the impression of the gem in a very fine earth, and to press down upon this a piece of proper glass, softened or half melted at the fire, so that the figures of the impression made in the earth may be nicely and perfectly expressed upon the glass. In general, the whole process much resembles that of the common founders. But when it is brought to the trial, there is found a number of difficulties which were not to be foreseen, and which would not at all affect the common works of the founder. For his purpose, every earth will serve that is fine enough to receive the impressions, and tough enough not to crack in the drying: these all serve for their use, because the metals which they cast are of a nature incapable of mixing with earth, or receiving it into them, even if both are melted togther, so that the metal always easily and perfectly separates itself from the mould; but it is very difficult in these casts of glass. They are composed of a matter which differs in nothing from that of the mould, but that it has been run into this form by the force of fire, and the other has not yet been so run, but is on any occasion ready to be so run, and will mix itself inseparably with the glass in a large fire: consequently, if there be not great care used, as well in the choice of the glass as in the manner of using it, when the whole is finished there will be found great difficulty in the separating the glass from the mould, and often this cannot be done without wholly destroying the impression.

All earths run more or less easily in the fire as they are more or less mixed with saline particles in their natural formation. As all salts make earths run into glass, and as it is necessary to use an earth on this occasion for the making a mould, it being also necessary to the perfection of the experiment that this earth should not melt or run, it is our business to search out for this purpose some earth which naturally contains very little salt. Of all the species of earth which Mr Homberg examined on this occasion, none proved so much

much divested of salts, or so fit for the purpose, as the common tripela, or TRIPOLI, used to polish glass and stones. Of this earth there are two common kinds: the one reddish, and composed of several flakes or strata; the other yellowish, and of a simple structure. These are both to be had in the shops. The latter kind is from the Levant; the former is found in England, France, and many other places. The tripela must be chosen soft and smooth to the touch, and not mixed with sandy or other extraneous matter. The yellowish kind is the best of the two, and is commonly called *Venetian tripoli.* This receives the impressions very beautifully; and never mixes with the glass in the operation, which the red kind sometimes does. Mr Homberg usually employed both kinds at once in the following manner: first powder a quantity of the red tripela in an iron mortar, and sifting it through a fine sieve set it by for use; then scrape with a knife, a quantity of the yellow tripela into a sort of powder, and afterwards rub it till very fine in a glass mortar with a glass pestle. The finer this powder is, the finer will be the impression, and the more accurately perfect the cast. The artificer might naturally suppose, that the best method to obtain a perfect fine powder of this earth would be by washing it in water; but he must be cautioned against this. There is naturally in this yellowish tripoli a sort of unctuosity, which when it is formed into a mould keeps granules together, and gives the whole an uniform glossy surface: now the washing the powder takes away this unctuosity; and though it renders it much finer, it makes it leave a granulated surface, not this smooth one, in the mould; and this must render the surface of the cast less smooth.

When the two tripelas are thus separately powdered, the red kind must be mixed with so much water as will bring it to the consistence of paste, so that it may be moulded like a lump of dough between the fingers: this paste must be put into a small crucible of a flat shape, and about half an inch or a little more in depth, and of such a breadth at the surface as is a little more than that of the stone whose impression is to be taken. The crucible is to be nicely filled with this paste lightly pressed down into it, and the surface of the paste must be strewed over with the fine powder of the yellow tripela not wetted. When this is done, the stone, of which the impression is to be taken, must be laid upon the surface, and pressed evenly down into the paste with a finger and thumb, so as to make it give a strong and perfect impression; the tripela is then to be pressed nicely even to its sides with the fingers, or with an ivory knife. The stone must be thus left a few moments, for the humidity of the paste to moisten the dry powder of the yellow tripela which is strewed over it: then the stone is to be carefully raised by the point of a needle fixed in a handle of wood; and the crucible being then turned bottom upwards, it will fall out, and the impression will remain very beautifully on the tripoli.

If the sides of the cavity have been injured in the falling out of the stone, they may be repaired; and the crucible must then be set, for the paste to dry, in a place where it will not be incommoded by the dust.

The red tripoli being the more common and the cheaper kind, is here made to fill the crucible only to save the other, which alone is the substance fit for taking the impression. When the stone is taken out, it must be examined, to see whether any thing be lodged in any part of the engraving, because if there be any of the tripela left there, there will certainly be so much wanting in the impression. When the crucible and paste are dry, a piece of glass must be chosen of a proper colour, and cut to a size proper for the figure; this must be laid over the mould, but in such a manner that it does not touch the figures, otherwise it would spoil them. The crucible is then to be brought near the furnace by degrees, and gradually heated till it cannot be touched without burning the fingers; then it is to be placed on the furnace under a muffle, surrounded with charcoal. Several of these small crucibles may be placed under one muffle; and when they are properly disposed, the aperture of the muffle should have a large piece of burning charcoal put to it, and then the operator is to watch the process, and see when the glass begins to look bright: this is the signal of its being fit to receive the impression. The crucible is then to be taken out of the fire; and the hot glass must be pressed down upon the mould with an iron instrument to make it receive the regular impression: as soon as this is done, the crucible is to be set at the side of the furnace out of the way of the wind, that it may cool gradually without breaking. When it is cold, the glass is to be taken out, and its edges should be grated round with pincers, which will prevent its flying afterwards, which is an accident that sometimes happens when this caution has been omitted, especially when the glass is naturally tender. The different coloured glasses are of different degrees of hardness, according to their composition; but the hardest to melt are always the best for this purpose, and this is known by a few trials.

If it be desired to copy a stone in relief which is naturally in creux, or to take one in creux which is naturally in relief, there needs no more than to take an impression first in wax or sulphur, and to mould that upon the paste of tripela instead of the stone itself; then proceeding in the manner before directed, the process will have the desired success.

A more simple and easy method than the above, is by taking the casts in gypsum, or plaster of Paris as it is commonly called. For this purpose, the gypsum must be finely pulverized, and then mixed with clear water to the consistence of thick cream. This is poured upon the face of the gem or seal of which the impression is wanted, and which must be previously moistened with oil to facilitate the separation of the cast; and in order to confine the liquid plaster, it is only necessary to pin a slip of oiled paper round the sides of the seal by way of a cap or rim. When the plaster is dry, it is to be taken off, and set before the mouth of the furnace, in order to free it entirely from moisture; when it is fit to be used as a matrix in the same way as that formed with the tripoli earths. Only no crucible or other receptacle is at all necessary; the casts being formed like so many small cakes half an inch thick, and thus put into the furnace with bits of glass upon them. The glass, after coming to a proper heat, is pressed down upon the mould with an iron spatula to receive the desired impression, the pressure requisite being more or less according to the size of the stone. This method has been long practised very successfully, and

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with no ſmall emolument, by that ingenious ſeal engraver Mr Deuchar of Edinburgh. The only reſpect in which it is inferior to the other more operoſe and expenſive methods, conſiſts in the chance of air bubbles ariſing in pouring on the plaſter; which chance, however, is leſs in proportion to the fineneſs of the gypſum employed. When air bubbles do occur, the caſts may be laid aſide, as it is ſo eaſy to replace them.

The application of paſtes to multiply and preſerve the impreſſions of camaieux and intaglios, is an object very intereſting to artiſts and to antiquaries, as well as to men of learning and taſte in the fine arts.

This art, though only lately reſtored in any degree of perfection, is of very conſiderable antiquity. The great prices which the ancients paid for the elegant gems engraved by the celebrated Greek artiſts, could not but early ſuggeſt to them the idea of multiplying their numbers, by taking off their impreſſions in wax, in ſulphur, in plaſter, or in clay; but more particularly in coloured glaſs, or that vitrified ſubſtance commonly called *paſte*.

As the impreſſions on paſte are durable, and imitate the colours and brilliancy of the original ſtones, they ſerve the ſame purpoſes as the gems themſelves. This art was therefore practiſed not only by the Greeks, but by all the nations who cultivated Grecian taſte.

Many of the fineſt gems of antiquity are now loſt, and their impreſſions are to be found only on ancient paſtes. Great therefore is the value of theſe paſtes. Numerous collections of them have been formed by the curious. Inſtances of this are found in the Florentine Muſæum, in Stoſch's work on ancient gems with inſcriptions, in Winckelmann's deſcription of Stoſch's cabinet, and in the noble collection of Mr Charles Townley in London.

The art of taking impreſſions of gems ſeems not to have been altogether loſt even in the Gothic ages; for Heraclius, who probably lived in the ninth century, and wrote a book *De coloribus et artibus Romanorum*, teaches in very plain though not elegant terms how to make them. Indeed, ſome of the few perſons who then poſſeſſed this art, taking advantage of the ignorance of the times, ſold paſtes for original gems. Thus the famous emerald of the abbey of Reichnaw near Conſtance, although a preſent made by Charlemagne, is now found to be a piece of glaſs. And thus the celebrated emerald vaſe in the cathedral of Genoa is likewiſe found to be a piece of paſte (A). The Genoſe got this vaſe at the taking of Ceſarea in the year 1101 as an equivalent for a large ſum of money; nor was any impoſition then ſuſpected, for in the year 1319 they pawned it for 1200 merks of gold.

But this ingenious art, revived indeed in Italy in the time of Laurence of Medici and Pope Leo X. was not cultivated in an extenſive manner till the beginning of the preſent century, when M. Homberg reſtored it, as already mentioned. In this he is ſaid to have been greatly aſſiſted and encouraged by the then duke of Orleans regent of France, who uſed to amuſe himſelf with that celebrated chemiſt in taking off impreſſions in paſte from the king of France's, from his own, and other collections of gems.

According to the French Encyclopediſts, M. Clachant the elder, an engraver of ſome note, who died at Paris in 1781, learned this art from his royal highneſs, to whoſe houſehold his father or he ſeems to have belonged. Mademoiſelle Feloix next cultivated this art, and it is believed ſtill carries it on. She had been taught by her father, who in quality of garçon de chambre to the regent had often aſſiſted in the laboratory of his maſter, where he acquired this knowledge. Her collection conſiſts of 1800 articles.

Baron Stoſch, a Pruſſian, who travelled over Europe in queſt of original engraved ſtones and impreſſions of ancient gems, for the elegant work which he publiſhed and Picart engraved (B), was well acquainted with this art. He had taught it to his ſervant Chriſtian Dehn, who ſettled at Rome, where he made and ſold his well known ſulphur impreſſions and paſtes. He had collected 2500 articles. Dolce has arranged them in a ſcientific order, and given a deſcriptive catalogue of them.

It was chiefly from Dehn's collection that the taſte for ſulphurs and paſtes has become ſo univerſal. They are great objects of ſtudy, and often require much learning to explain them. They have unqueſtionably ſerved to extend and improve the art of engraving on ſtones; and have been of infinite uſe to painters, to ſtatuaries, and to other artiſts, as well as to men of claſſical learning and fine taſte.

It is very difficult to take off impreſſions, and perfectly to imitate various-coloured cameos. It cannot be properly done in wax, ſulphur, plaſter, or glaſs of one colour only. The difficulties ariſing from their ſize and form, and from the various nature of the different ſorts of glaſs which do not well unite into different ſtrata, are very numerous: nor could the completeſt ſucceſs in this chemical and mechanical branch of the art produce a tolerable cameo. Impreſſions or imitations, if unaſſiſted by the tool of the engraver, do not ſucceed: becauſe the undercutting and deep work of moſt of the originals require to be filled up with clay or wax, that the moulds may come off ſafe without injuring them. Hence the impreſſions from theſe moulds come off hard and deſtitute of delicacy, ſharpneſs, and preciſion of outline, till the underworking of the moulder is cut away. But Mr Reiffenſtein at Rome, by his genius, perſeverance, and the aſſiſtance of able artiſts, has overcome theſe difficulties; and has had the ſatisfaction of ſucceeding, and producing variegated cameos which can hardly be diſtinguiſhed from the originals.

Mr Lippart of Dreſden, an ingenious glazier, and an enthuſiaſt in the fine arts, practiſed this branch not unſucceſsfully; but not finding ſufficient encouragement for his paſtes of coloured glaſs, or perhaps from local difficulties in making them well and cheap, he abandoned

(A) See M. de la Condamine's Diſſ. in Memoir. de l'Acad. Roy. de Paris, 1757.

(B) Gemmæ antiquæ colorata, ſculptorum nominibus inſignitæ, ære inciſæ per Bernardum Picart. Amſtelodam. 1724, folio.

doned this art. He substituted in its place impressions of fine white alabaster or selenite plaster. Such impressions, when carefully soaked in a solution of white Castile soap, then dried, and rubbed over with a soft brush, take a very agreeable polish. They show the work perhaps to better advantage than red or white sulphurs do; but they are not so durable, and are liable to be defaced by rubbing.

Of these impressions Mr Lippart published three different collections, each of them containing 1000 articles; and to the merit of having increased the number of Madamoiselle Feloix and Christiano Dehn's collections, which are all inserted in his, he added that of employing two learned Germans to arrange and describe them. The first thousand were arranged and described by the late Professor Christ at Leipsic, and the second and third thousand by Professor Heine at Goettingen. Nor did Mr Lippart stop here: but to make the study of antiquity more easy and acceptable to artists, he selected out of the whole collection of 3000, a smaller one of 2000 of the best and more instructive subjects, of which he himself drew up and published a description in German.

But of all the artists and ingenious men who have taken impressions of engraved gems in sulphur and in paste, no one seems to have carried that art to such perfection as Mr James Tassie, a native of Glasgow, who resided in London from the year 1766 till his death. His knowledge in various branches of the fine arts, particularly in that of drawing, naturally led him to it. The elegant portraits which he modelled in wax, and afterwards moulded and cast in paste, and which entirely resemble cameos, are well known to the public.

Mr Tassie, profiting of all the former publications of this sort, and by expence, industry, and access to many cabinets in England and other kingdoms to which former artists had not obtained admission, was enabled to increase his collection of impressions of ancient and modern gems to the number of above 15,000 articles. It is the greatest collection of this kind that ever existed; and serves for all the purposes of artists, antiquaries, scholars, men of taste, and even philosophers. The great demand for his pastes was perhaps owing in the beginning to the London jewellers, who introduced them into fashion by setting them in rings, seals, bracelets, necklaces, and other trinkets.

The reputation of this collection having reached the empress of Russia, she was pleased to order a complete set; which being accordingly executed in the best and most durable manner, were arranged in elegant cabinets, and are now placed in the noble apartments of her imperial majesty's superb palace at Czarsko Zelo.

Mr Tassie, in executing this commission, availed himself of all the advantages which the improved state of chemistry, the various ornamental arts, and the knowledge of the age, seemed to afford. The impressions were taken in a beautiful white enamel composition, which is not subject to shrink or form air bladders; which emits fire when struck with steel, and takes a fine polish; and which shows every stroke and touch of the artist in higher perfection than any other substance. When the colours, mixed colours, and nature of the respective originals, could be ascertained, they were imitated as completely as art can imitate them; insomuch that many of the paste intaglios and cameos in this collection are such faithful imitations, that artists themselves have owned they could hardly be distinguished from the originals. And when the colour and nature of the gems could not be authenticated, the pastes were executed in agreeable, and chiefly transparent, colours; constant attention being bestowed to preserve the outlines, extremities, attributes, and inscriptions.

It was the learned Mr Raspe (from whom this account (c) is taken) who arranged this great collection, and made out the descriptive catalogue. His arrangement is nearly the same with that of the late Abbé Winkelmann, in his description of the gems which belonged to Baron Stosch. But as modern works were inserted in this collection, he found it necessary to make a few alterations, and added some divisions to those of M. Winkelmann, as will appear from the following conspectus, with which we shall conclude this detail.

I. Ancient Art and Engravings.
- Egyptian hieroglyphics, sacred animals, divinities, priests.
- Basilidian, Gnostic, and other talismans, &c.
- Oriental and barbarous ancient and modern engravings.
- Greek and Roman original copies, and imitations (the Etruscan are classed with the Greek works.)
- A, Mythology or fabulous age. Gods, inferior divinities, religious ceremonies.
- B, Heroic age before the siege of Troy.
- C, Siege of Troy.
- D, Historic age. Of Carthage, Greece, Rome, subjects unknown.
- E, Fabulous animals and chimeras.
- F, Vases and urns.

II. Modern Art and Engravings.
- A, Religious subjects.
- B, Portraits of kings and sovereigns.
- C, Portraits of illustrious men in alphabetical order.
- D, Portraits unknown.
- E, Devices and emblems.
- F, Cyphers, arms, supporters, and medley of modern history.

GEMAPPE, a village of Austrian Hainault, three miles west-by-south of Mons, rendered memorable for a victory which the French under General Dumourier obtained over the Austrians, Nov. 5. 1792; in which the carnage on both sides was so dreadful, that three coal pits in the vicinity were filled up with the dead bodies of men and horses.

GEMARA, or Ghemara, the second part of the Talmud.

The

(c) Account of the present state and arrangement of Mr James Tassie's collection of pastes and impressions from ancient and modern gems, by R. C. Raspe, London, 1786, 8vo.

The word גמרה *gemara*, is commonly ſuppoſed to denote a ſupplement; but in ſtrictneſs it rather ſignifies complement, perfection: being formed of the Chaldee גמר, *gemar*, or *ghemer*, "to finiſh, perfect, or complete any thing."

The rabbins call the Pentateuch ſimply the *law*: the firſt part of the Talmud, which is only an explication of that law, or an application thereof to particular caſes, with the deciſions of the ancient rabbins thereon, they call the *Miſchna*, i. e. "ſecond law:" and the ſecond part, which is a more extenſive and ample explication of the ſame law, and a collection of deciſions of the rabbins poſterior to the Miſchna, they call *Gemara*, q. d. "perfection, completion, finiſhing;" becauſe they eſteem it the finiſhing of the law, or an explication beyond which there is nothing farther to be deſired.

The Gemara is uſually called ſimply *Talmud*, the common name of the whole work. In this ſenſe we ſay, there are two Gemaras or Talmuds; that of Jeruſalem and that of Babylon: though in ſtrictneſs the Gemara is only an explication of the Miſchna, given by the Jewiſh doctors in their ſchools: much as the commentaries of our ſchool divines on St Thomas, or the maſter of the ſentences, are an explication of the writings of thoſe authors.

A commentary, Monſ. Tillemont obſerves, was wrote on the Miſchna, by one Jochanan, whom the Jews place about the end of the ſecond century: but Fa. Morin proves, from the work itſelf, wherein mention is made of the Turks, that it was not wrote till the time of Heraclius, or about the year 620; and this is what is called the *Gemara*, or *Talmud of Jeruſalem*, which the Jews do not uſe or eſteem much becauſe of its obſcurity.

They ſet a much greater value on the Gemara, or Talmud of Babylon, begun by one Aſa; diſcontinued for 73 years, on occaſion of the wars with the Saracens and Perſians; and finiſhed by one Joſa, about the cloſe of the ſeventh century. See TALMUD.

Though the name Talmud, in its latitude, includes both the Miſchna and the two Gemaras, yet it is properly that of Aſa and Joſa alone which is meant under that name. This the Jews prize above all their other writings, and even ſet it on a level with Scripture itſelf: in effect, they conceive it as the word of God, derived by tradition from Moſes, and preſerved without interruption to their time. R. Jehuda, and afterwards R. Johanan, R. Aſa, and R. Joſa, fearing the traditions ſhould be loſt in the diſperſion of the Jews, collected them into the Miſchna and the Gemara. See CARAITES and RABBINISTS.

GEMINI, in *Aſtronomy*, the TWINS; a conſtellation or ſign of the zodiac, the third in order, repreſenting Caſtor and Pollux; and it is marked thus, ♊. The ſtars in the ſign Gemini, in Ptolemy's catalogue, are 25; in Tycho's, 25; in Hevelius's, 38; in the Britannic Catalogue, 85.

GEMINIANI, a celebrated muſician and compoſer, was born at Lucca in the year 1680. He received his firſt inſtructions in muſic from Aleſſandro Scarlatti; and after that became a pupil of Carlo Ambroſio Lunati, ſurnamed *Il Gobbo*, a moſt celebrated performer on the violin; after which he became a diſciple of Corelli, and under him finiſhed his ſtudies on that inſtrument. In the year 1714 he came to England; where in a ſhort time he ſo recommended himſelf by his exquiſite performance, that all who profeſſed to love and underſtand muſic were captivated with hearing him.—Many of the nobility laid claim to the honour of being his patrons; but he ſeemed chiefly to attach himſelf to Baron Kilmanſegge, chamberlain to King George I. as elector of Hanover, and a favourite of that prince. In 1716, he publiſhed and dedicated to his patron 12 ſonatas *a violino violone e cembalo*: the firſt ſix with fugues, or double ſtops as they are vulgarly called; the laſt with airs of various meaſures, ſuch as allemandes, courantes, and jiggs. This publication was ſo well reliſhed by the baron, that he mentioned Geminiani to the king as an excellent performer; in conſequence of which our muſician had the honour to perform before his majeſty, in concert with the celebrated Handel, who played on the harpſichord. But though Geminiani was exceedingly admired, yet he had not a talent at aſſociating muſic with poetry, nor do we find that he ever became a public performer: he was therefore obliged to depend for his ſubſiſtence on the friendſhip of his patrons and the profits which accrued to him from teaching. He had alſo the misfortune to be an enthuſiaſt in painting; and the verſatility of his temper was ſuch, that, in order to gratify this paſſion, he not only ſuſpended his ſtudies, and neglected to exerciſe his talents, but involved himſelf in debts. In 1727, he was offered the place of maſter and compoſer of the ſtate muſic in Ireland; but this could not be conferred on a Catholic, and Geminiani refuſed to change his religion: upon which it was given to Matthew Dubourg, a young man who had been one of his pupils, and was a celebrated performer on the violin. Geminiani then ſet himſelf to compoſe parts to the *opera quinta* of Corelli; or, in other words, to make concertos of the firſt ſix of his ſolos. This work he completed, and, with the help of a ſubſcription, at the head of which were the names of the royal family, publiſhed in 1726. In 1732, he publiſhed his *opera ſeconda*, which contains a celebrated minuet that goes by his name. He publiſhed many other pieces, the profits of which did not much mend his circumſtances; but this perhaps was owing to his rambling diſpoſition and enthuſiaſtic fondneſs of painting. He was alſo an utter ſtranger to the buſineſs of an orcheſtra, and had no idea of the labour and pains neceſſary in the inſtruction of ſingers for the performance of muſic to which they were ſtrangers. The conſequence of this was, that a *concerto ſpirituale*, which he had advertiſed for his own benefit in 1748, failed in the performance. The audience, however, compaſſionated his diſtreſs, and ſat very ſilent till the books were changed; when the performance was continued with compoſitions of the author's own, and which he executed in ſuch a manner as was never forgot. The profits ariſing from this performance enabled him to take a journey to Paris; where he ſtaid long enough to get plates engraven for a ſcore of ſolos, and the parts of two operas of concertos. About the year 1755 he returned to England, and advertiſed them for ſale.—In 1761 Geminiani went over to Ireland; and was kindly entertained there by Mr Matthew Dubourg, who had been his pupil, and was then maſter of the king's band in Ireland. This perſon through the

Gemma. course of his life had ever been disposed to render him friendly offices; and it was but a short time after Geminiani's arrival at Dublin that he was called upon to do him the last. It appears that Geminiani had spent many years in compiling an elaborate treatise on music, which he intended for publication; but soon after his arrival at Dublin, by the treachery of a female servant, who, it was said, was recommended to him for no other end than that she might steal it, it was conveyed away, and could not be recovered. The greatness of this loss, and his inability to repair it, made a deep impression on his mind; and, as it is conjectured, hastened his end; at least he survived it but a short time, ending his days on the 17th of September 1762. The following list comprises the whole of his publications, except two or three articles of small account: Twelve solos for a violin, *opera prima;* six concertos in seven parts, *opera seconda;* six concertos in seven parts, *opera terza;* twelve solos for a violin, *opera quarta;* six solos for a violoncello, *opera quinta;* the same made into solos for a violin; six concertos from his *opera quarta;* six concertos in eight parts, *opera settima;* rules for playing in taste; a treatise on good taste; the art of playing the violin; 12 sonatas from his first solos, *opera undecima;* Ripieno parts to ditto; lessons for the harpsichord; *Guida Armonica;* supplement to ditto; the art of accompaniment, two books; his first two operas of concertos in score; and the Enchanted Forest.—Of his solos the *opera prima* is esteemed the best. Of his concertos some are excellent, others of them scarce pass the bounds of mediocrity. The sixth of the third opera not only surpasses all the rest, but, in the opinion of the best judges of harmony, is the finest instrumental composition extant.

GEMMA, or Bud, in *Botany:* a compendium or epitome of a plant, seated upon the stem and branches, and covered with scales, in order to defend the tender rudiments enclosed from cold and other external injuries, till, their parts being unfolded, they acquire strength, and render any further protection unnecessary.

Buds, together with bulbs, which are a species of buds generally seated upon or near the root, constitute that part of the herb called by Linnæus *hybernacula;* that is, the winter quarters of the future vegetable: a very proper appellation, as it is during that severe season that the tender rudiments are protected in the manner just mentioned.

Plants, considered in analogy to animals, may properly enough be reckoned both viviparous and oviparous. Seeds are the vegetable eggs; buds, living fetuses, or infant plants, which renew the species as certainly as the seeds.

Buds are placed at the extremity of the young shoots, and along the branches, being fixed by a short footstalk upon a kind of brackets, the remainder of the leaves, in the wings or angles of which the buds in question were formed the preceding year. They are sometimes placed single; sometimes two by two, and those either opposite or alternate; sometimes collected in greater numbers in whirls or rings.

With respect to their construction, buds are composed of several parts artificially arranged. Externally, we find a number of scales that are pretty hard, frequently armed with hairs, hollowed like a spoon, and placed over each other like tiles. These scales are fixed into the inner plates of the bark, of which they appear to be a prolongation. Their use is to defend the internal parts of the bud; which, being unfolded, will produce, some, flowers, leaves, and stipulæ; others, footstalks and scales. All these parts, while they remain in the bud, are tender, delicate, folded over each other, and covered with a thick clammy juice, which is sometimes resinous and odoriferous, as in the tacamahac tree. This juice serves not only to defend the more tender parts of the embryo plant from cold, the assaults of insects, and other external injuries; but likewise from excessive perspiration, which, in its young and infant state, would be very destructive. It is conspicuous in the buds of horse chesnut, poplar, and willow trees.

In general, we may distinguish three kinds of buds; that containing the flower, that containing the leaves, and that containing both flower and leaves.

The first, termed *gemma florifera*, and by the French *bouton à fleur* or *à fruit*, contains the rudiments of one or several flowers, folded over each other, and surrounded with scales. In several trees, this kind of bud is commonly found at the extremity of certain small branches, which are shorter, rougher, and less garnished with leaves, than the rest. The external scales of this species of bud are harder than the internal; both are furnished with hairs, and in general more swelled than those of the second sort. The bud containing the flower too is commonly thicker, shorter, almost square, less uniform, and less pointed; being generally terminated obtusely. It is called by Pliny *oculus gemmæ;* and is employed in that species of grafting called *inoculation*, or *budding*.

The second species of bud, viz. that containing the leaves, termed *gemma folifera*, and by the French *bouton à feuilles* or *à bois*, contains the rudiments of several leaves, which are variously folded over each other, and outwardly surrounded by scales, from which the small stipulæ that are seated at the foot of the young branches are chiefly produced. These buds are commonly more pointed than the former sort. In the hazel nut, however, they are perfectly round; and in horse chesnut, very thick.

The third sort of bud is smaller than either of the preceding; and produces both flowers and leaves, though not always in the same manner. Sometimes the flowers and leaves are unfolded at the same time. This mode of the flower and leaf bud is termed by Linnæus *gemma folifera et florifera*. Sometimes the leaves proceed or emerge out of this kind of bud upon a small branch, which afterwards produces flowers. This mode of the flower and leaf bud is termed by Linnæus *gemma folifera florifera*, and is the most common bud of any.

Such buds as produce branches adorned only with leaves, are called *barren;* such as contain both leaves and flowers, *fertile*. From the bulk of the bud we may often with ease foretel whether it contains leaves only, or leaves and flowers together, as in cherry and pear trees.

Neither the buds produced on or near the root, called by some authors *turiones*, nor those produced on the trunk, and from the angles or wings of the leaves, contain, in strict propriety, an entire delineation of the plant; since the roots are wanting; and in various buds,

buds, as we have feen, fhoots are contained with leaves only, and not with flowers: but as a branch may be confidered as a part fimilar to the whole plant, and, if planted, would in procefs of revegetation exhibit or produce roots and flowers, we may in general allow, that the bud contains the whole plant, or the principles of the whole plant, which may be unfolded *ad libitum;* and thus refembles the feed, in containing a delineation of the future plant in embryo: for although the bud wants a radicle, or plumula, of which the feed is poffeffed, yet it would undoubtedly form one, if planted in the earth. But as the medullary part adhering to the bud is too tender, and by the abundance of juice flowing into it from the earth would be difpofed to putrefaction, the buds are not planted in the foil, but generally inferted within the bark of another tree; yet placed fo that the production of the marrow, or pith, adhering to them, may be inferted into the pith of the branch in which the fiffure or cleft is made; by which means there is a large communication of juice. This propagation by gems or buds, called *inoculation*, is commonly practifed with the firft fort of buds above defcribed.

From the obvious ufes of the buds, we may collect the reafon why the Supreme Author of nature has granted this fort of protection to moft of the trees that are natives of cold climates: and, on the other hand, denied it to fuch as, enjoying a warm benign atmofphere, have not the tender parts of their embryo fhoots expofed to injuries and depredations from the feverities of the weather. Of this latter kind are the plants of the following lift; fome of them very large trees; others fmaller woody vegetables, of the fhrub and under-fhrub kind: Citron, orange, lemon, caffava, mock orange, blad apple, fhrubby fwallow-wort, alaternus, fhrubby geraniums, berry-bearing alder, Chrift's thorn, Syrian mallow, boabab or Ethiopian four gourd, jufticia, mild fena, the acacias and fenfitive plant, coral tree, ftinking bean trefoil, medicago, oleander, viburnum, fumach, ivy, tamarifk, heath, Barbadoes cherry, lavatera, rue, fhrubby nightfhades, Guinea henweed, cyprefs, lignum vitæ, and favine, a fpecies of juniper.

On annual plants, whofe root as well as ftalk perifhes after a year, true buds are never produced; in their ftead, however, are produced fmall branches, like a little feather, from the wings of the leaves, which wither without any farther expanfion if the plants climb and have no lateral branches; but if, either by their own nature or from abundance of fap, the plants become branched, the ramuli juft mentioned obtain an increafe fimilar to that of the whole plant.

The fame appearance obtains in the trees of warm countries, fuch as thofe enumerated in the above lift, in which a plumula, or fmall feather, fends forth branches without a fcaly covering; as, in fuch countries, this tender part requires no defence or protection from cold. A fcaly covering then is peculiar to buds, as it protects the tender embryo enclofed from all external injuries. When we therefore fpeak of trees having buds that are naked or without fcales, our meaning is the fame as if we had faid that they have no buds at all.

The buds that are to be unfolded the following year, break forth from the evolved buds of the prefent year, in fuch a manner as to put on the appearance of fmall eminences in the wings or angles of the leaves. Thefe eminences or knots grow but little during the fummer; as, in that feafon, the fap is expended on the increafe of the parts of the plant: but in autumn, when the leaves begin to wither and fall off, the buds, placed on the wings, increafe; and the embryo plant contained in the bud is fo expanded, that the leaves and flowers, the parts to be evolved the following year, are diftinctly vifible. Thus in horfe chefnut the leaves, and in cornel tree the flowers, are each to be obferved in their refpective buds.

As each bud contains the rudiments of a plant, and would, if feparated from its parent vegetable, become every way fimilar to it; Linnæus, to fhow the wonderful fertility of nature, has made a calculation, by which it appears, that, in a trunk fcarce exceeding a fpan in breadth, 10,000 buds (that is, herbs) may be produced. What an infinite number, then, of plants might be raifed from a very large tree!

GEMMATIO, from *gemma*, "a bud;" a term ufed by Linnæus, expreffive of the form of the buds, their origin, and their contents. It includes both thofe properly called *buds*, and thofe which are feated at the roots, ftyled *bulbs*.

As to the origin of buds, they are formed either of the footftalks of the leaves, of ftipulæ, or of fcales of the bark. Their contents have been already difcovered, in the preceding article, to be either flowers, leaves, or both.

GEMONIÆ SCALÆ, or *Gradus* GEMONII, among the Romans, was much the fame as gallows or gibbet in England.—Some fay they were thus denominated from the perfon who raifed them; others, from the firft criminals that fuffered on them; and others, from the verb *gemo*, "I figh or groan."

The *gradus gemonii*, according to Publius Victor or Sextus Rufus, was a place raifed on feveral fteps, from whence they precipitated their criminals; others reprefent it as a place whereon offenders were executed, and afterwards expofed to public view. The *gemoniæ fcalæ* were in the tenth region of the city, near the temple of Juno. Camillus firft appropriated the place to this ufe, in the year of Rome 358.

GENDARMES, or GENS D'ARMES, in the French armies, a denomination given to a felect body of horfe, on account of their fucceeding the ancient gendarmes, who were thus called from their being completely clothed in armour; (fee *Scots* GENDARMES, *infra.*) Thefe troops were commanded by captain lieutenants, the king and the princes of the blood being their captains; the king's troop, befides a captain-lieutenant, had two fublieutenants, three enfigns, and three guidons.

Grand GENDARMES, latterly were a troop compofed of 250 gentlemen; the king himfelf was their captain, and one of the firft peers their captain-lieutenant, who had under him two lieutenants, three enfigns, three guidons, and other officers.

Small GENDARMES, were the Scots gendarmes, the queen's, the dauphin's, the gendarmes of Anjou, Burgundy, the Englifh and Flemifh gendarmes, having each a captain lieutenant, fub-lieutenant, enfign, guidon, and quarter-mafter.

Scots GENDARMES, were originally inftituted by Charles VII. of France, about the middle of the 15th century, Gender, Genealogy.

Stuart's Constit. of Scotland.

century, and formed a part of his guard; in which station also they acted under other princes. It was their prerogative to take precedence of all the companies of the gendarmerie of France; and, on particular occasions, they even preceded the two companies of the king's mousquetaires. The sons of the Scottish monarchs were the usual captains of this company; and, after Mary's accession to the throne, its command belonged to them as a right. It was thence that James VI. made a claim of it for his son Prince Henry. This honour, and its emoluments, were also enjoyed by Charles I. and the next in command to this prince was Louis Stuart duke of Lennox. George Gordon marquis of Huntly succeeded the duke of Lennox in the year 1624, and took the title of captain or commander in chief when Charles I. mounted the English throne. It is not certain whether Charles II. was ever captain of this company; but it was conferred on his brother the duke of York, who was captain of the Scots gendarmes till the year 1667, when he resigned his commission into the hands of the French king. Since that time no native of Great Britain has enjoyed this command. See *Scots Guards*.

All the different gendarmeries are now abolished, in consequence of the reforming systems that have lately taken place in France.

GENDER, among grammarians, a division of nouns, or names, to distinguish the two sexes.

This was the original intention of gender: but afterwards other words, which had no proper relation either to one sex or the other, had genders assigned them, rather out of caprice than reason; which is at length established by custom. Hence genders vary according to the languages, or even according to the words introduced from one language into another. Thus, *arbor* in Latin is feminine, but *arbre* in French is masculine; and *dens* in Latin is masculine, but *dent* in French is feminine.

The oriental languages frequently neglect the use of genders, and the Persian language has none at all.

The Latins, Greeks, &c. generally content themselves to express the different genders by different terminations; as *bonus equus*, "a good horse;" *bona equa*, "a good mare," &c. But in English we frequently go further, and express the difference of sex by different words: as boar, sow; boy, girl; buck, doe; bull, cow; cock, hen; dog, bitch, &c.—We have only about 24 feminines, distinguished from the males, by the variation of the termination of the male into *ess*; of which number are abbot, abbess; count, countess; actor, actress; heir, heiress; prince, princess, &c. which is all that our language knows of any thing like genders.

The Greek and Latin, besides the masculine and feminine, have the neuter, common, and the doubtful gender; and likewise the epicene, or promiscuous, which under one single gender and termination includes both the kinds.

GENEALOGY, an enumeration of a series of ancestors; or a summary account of the relations and alliances of a person or family, both in the direct and collateral line.

The word is Greek, γενεαλογια; which is formed of γενος, "race or lineage," and λογος, "discourse."

In divers chapters and military orders, it is required, that the candidates produce their genealogy, to show that they are noble by so many descents.

Genealogica, General.

GENEALOGICA ARBOR, or *Tree of Consanguinity*, signifies a genealogy or lineage drawn out under the figure of a tree, with its root, stock, branches, &c. The genealogical degrees are usually represented in circles, ranged over, under, and aside each other. This the Greeks called *stemmata*, a word signifying crown, garland, or the like. See the articles CONSANGUINITY and DESCENT, and the plates there referred to.

GENEP, a strong town of Germany, in the circle of Westphalia, subject to the king of Prussia. E. Long. 4. 29. N. Lat. 51. 42.

GENERAL, an appellation given to whatever belongs to a whole genus.

General Assembly. See ASSEMBLY.

General Charge, in *Law*. See *Charge to enter Heir*.

General Terms, among logicians, those which are made the signs of general ideas. See LOGIC and METAPHYSICS.

General Warrant. See WARRANT.

General of an Army, in the art of WAR, he who commands in chief. See the article WAR, where his office and duties are particularly explained.

General of the Artillery. See ORDNANCE.

General of Horse, and *General of Foot*, are posts next under the general of the army, and these have upon all occasions an absolute authority over all the horse and foot in the army.

Adjutant General, one who attends the general, assists in council, and carries the general's orders to the army. He distributes the daily orders to the majors of brigade. He is likewise charged with the general detail of the duty of the army. The majors of brigade send every morning to the adjutant general an exact return, by battalion and company, of the men of his brigade. In a day of battle the adjutant general sees the infantry drawn up; after which, he places himself by the general, to receive any orders which may regard the corps of which he has the detail. In a siege, he orders the number of workmen demanded, and signs the warrant for their payment. He receives the guards of the trenches at their rendezvous, and examines their condition; he gives and signs all orders for parties. He has an orderly serjeant from each brigade of infantry in the line, to carry such orders as he may have occasion to send from the general.

Lieutenant General, is the next in command after the general; and provided he should die or be killed, the order is, that the oldest lieutenant general shall take the command. This office is the first military dignity after that of general. One part of their function is, to assist the general with their council: they ought therefore, if possible, to possess the same qualities with the general himself; and the more, as they often command armies in chief.

The number of lieutenant generals has been multiplied of late in Europe, in proportion as the armies have become numerous. They serve either in the field, or in sieges, according to the dates of their commissions. In battle, the oldest commands the right wing of the army, the second the left wing, the third the centre, the fourth the right wing of the second line, the fifth the left wing, the sixth the centre; and so on. In sieges, the lieutenant generals always command the right of the principal attack, and order what they judge proper for the advancement of the siege during the 24 hours they are in the trenches: except the attacks, which they are not to make without an order from the general in chief.

Lieutenant GENERAL *of the Ordnance*. See ORDNANCE.

Lieutenant GENERAL *of Artillery*, is, or ought to be, a very great mathematician, and an able engineer; to know all the powers of artillery; to understand the attack and defence of fortified places, in all its different branches; how to dispose of the artillery in the day of battle to the best advantage; to conduct its march and retreat; as also to be well acquainted with all the numerous apparatus belonging to the train, and to the laboratory, &c.

Major GENERAL, the next officer to the lieutenant general. His chief business is to receive orders from the general, or in his absence from the lieutenant general of the day; which he is to distribute to the brigade majors, with whom he is to regulate the guards, convoys, detachments, &c. On him rests the whole fatigue and detail of duty of the army roll. It is the major general of the day who is charged with the encampment of the army, who places himself at the head of it when they march, who marks out the ground of the camp to the quartermaster general, and who places the new guards for the safety of the camp.

The day the army is to march, he dictates to the field officers the order of the march, which he has received from the general, and on other days gives them the parole.

In a fixed camp he is charged with the foraging, with reconnoitring the ground for it, and posting the escorts, &c.

In sieges, if there are two separate attack, the second belongs to him; but if there is but one, he takes, either from the right or left of the attack, that which the lieutenant general has not chosen.

When the army is under arms, he assists the lieutenant general, whose orders he executes.

If the army marches to an engagement, his post is at the head of the guards of the army, until they are near enough to the enemy to rejoin their different corps; after which he retires to his own proper post: for the major generals are disposed on the order of battle as the lieutenant generals are; to whom, however, they are subordinate, for the command of their divisions. The major general has one aid-de-camp, paid for executing his orders.

GENERAL is also used for a particular march, or beat of drum; being the first which gives notice, commonly in the morning early, for the infantry to be in readiness to march.

GENERAL is likewise an appellation by which officers in law, in the revenues, &c. are distinguished; as, *attorney general*, *solicitor general*, &c. *receiver general*, *comptroller general*, &c. See ATTORNEY, &c.

GENERAL is also used for the chief of an order of monks, or of all the houses and congregations established under the same rule. Thus we say, the general of the Franciscans, Cistertians, &c.

GENERALISSIMO, called also *captain general*, and simply *general*, is an officer who commands all the military powers of a nation; who gives orders to all the other general officers; and receives no orders himself but from the king.

M. Balzac observes, that the cardinal de Richelieu first coined this word, of his own absolute authority, upon his going to command the French army in Italy.

GENERATE, in *Music*, is used to signify the operation of that mechanical power in nature, which every sound has in producing one or more different sounds. Thus any given sound, however simple, produces along with itself, its octave, and two other sounds extremely sharp, viz. its twelfth above, that is to say, the octave of its fifth; and the other the seventeenth above, or, in other words, the double octave of its third major.

Whether we suppose this procreation of sounds to result from an aptitude in the texture and magnitude of certain particles in the air, for conveying to our ears vibrations that bear those proportions, one to another, as being determined at once by the partial and total oscillations of any musical string; or from whatever economy of nature we choose to trace it; the power of one sound thus to produce another, when in action, is said to *generate*. The same word is applied, by Signior Tartini and his followers, to any two sounds which, simultaneously heard, produce a third.

GENERATED, or GENITED, is used, by some mathematical writers, for whatever is produced, either in arithmetic, by the multiplication, division, or extraction of roots; or in geometry, by the invention of the contents, areas, and sides; or of extreme and mean proportionals, without arithmetical addition and subtraction.

GENERATING LINE, or FIGURE, in *Geometry*, is that which, by its motion of revolution, produces any other figure, plane or solid. See GENESIS.

GENERATION, in *Physiology*, the act of procreating and producing a being similar to the parent. See ANATOMY, N° 157.

GENERATION *of Fishes*. See COMPARATIVE *Anatomy*, N° 304, and ICHTHYOLOGY.

GENERATION *of Plants*. See BOTANY.

GENERATION *of Insects*. See COMPARATIVE *Anatomy*, p. 312, and ENTOMOLOGY, p. 234.

Parts of GENERATION. See ANATOMY, N° 157.

GENERATION, in *Mathematics*, is used for formation or production. Thus we meet with the generation of equations, curves, solids, &c.

GENERATION, in *Theology*. The Father is said by some divines to have produced his Word or Son from all eternity, by way of generation; on which occasion the word *generation* raises a peculiar idea: that procession, which is really effected in the way of understanding, is called *generation*, because in virtue thereof, the Word becomes like to him from whom he takes this original; or, as St Paul expresses it, is the figure or image of his substance, i. e. of his being and nature. And hence it is, they say, that the second Person in the Trinity is called the Son.

GENERATION is also used, though somewhat improperly, for genealogy, or the series of children issued from the same stock. Thus the gospel of St Matthew commences with the book of the generation of Jesus Christ, Chrift, &c. The latter and more accurate tranflators, inftead of *generation* ufe the word *genealogy*.

GENERATION is alfo ufed to fignify a people, race, or nation, efpecially in the literal tranflations of the Scripture, where the word generally occurs wherever the Latin has *generatio*, and the Greek γενεσις. Thus, "A wicked and perverfe generation feeketh a fign," &c. "One generation paffes away, and another cometh," &c.

GENERATION is alfo ufed in the fenfe of an age, or the ordinary period of man's life. Thus we fay, "to the third and fourth generation." In this fenfe hiftorians ufually reckon a generation the fpace of 33 years or thereabouts. See AGE.

Herodotus makes three generations in a hundred years; which computation appears from the latter authors of political arithmetic to be pretty juft.

GENERATOR, in *Mufic*, fignifies the principal found or founds by which others are produced. Thus the loweft C for the treble of the harpfichord, befides its octave, will ftrike an attentive ear with its twelfth above, or G in alt, and with its feventeenth above, or E in alt. The C, therefore, is called their *generator*, the G and E its products or harmonics. But in the approximation of chords, for G, its octave below is fubftituted, which conftitutes a fifth from the generator, or loweft C; and for E, is likewife fubftituted its fifteenth below, which, with the above-mentioned C, forms a third major. To the loweft notes, therefore, exchanged for thofe in alt by fubftitution, the denominations of products or harmonics are likewife given, whilft the C retains the name of their *generator*. But ftill according to the fyftem of Tartini, two notes in concord, which when founded produce a third, may be termed the *concurring generators* of that third. (See *Generation Harmonique, per M. Rameau;* fee alfo that delineation of Tartini's fyftem called The Power and Principles of Harmony.)

GENERICAL NAME, in *Natural Hiftory*, the word ufed to fignify all the fpecies of natural bodies, which agree in certain effential and peculiar characters, and therefore all of the fame family or kind; fo that the word ufed as the generical name equally expreffes every one of them, and fome other words expreffive of the peculiar qualities or figures of each are added, in order to denote them fingly, and make up what is called the fpecific name. See BOTANY and NATURAL *Hiftory*.

GENESIS, the firft book of the Old Teftament, containing the hiftory of the creation, and the lives of the firft patriarchs.

The book of Genefis ftands at the head of the Pentateuch. Its author is held to be Mofes: it contains the relation of 2369 years, viz. from the beginning of the world to the death of Jofeph. The Jews are forbidden to read the beginning of Genefis, and the beginning of Ezekiel, before 30 years of age.

The Hebrews called this book *Berefchith*, becaufe it begins with that word, which in their language fignifies *in principio*, or "in the beginning." The Greeks gave it the name *Genefis*, Γενεσις, q. d. production, generation, becaufe it begins with the hiftory of the production or generation of all beings.

This book, befides the hiftory of the creation, contains an account of the original innocence and fall of man; the propagation of mankind; the rife of religion; the general defection and corruption of the world; the deluge; the reftoration of the world; the divifion and peopling of the earth; and the hiftory of the firft patriarchs to the death of Jofeph. It was eafy for Mofes to be fatisfied of the truth of what he delivers in this book, becaufe it came down to him through a few hands; for from Adam to Noah there was one man, viz. Methufelah, who lived fo long as to fee them both: in like manner Shem converfed with Noah and Abraham; Ifaac with Abraham and Jofeph, from whom the records of this book might eafily be conveyed to Mofes by Amram, who was contemporary with Jofeph.

GENESIS, in *Geometry*, denotes the formation of a line, plane, or folid, by the motion or flux of a point, line, or furface. See FLUXIONS.

The genefis or formation, *e. gr.* of a globe or fphere, is conceived by fuppofing a femicircle to revolve upon a right line, drawn from one extreme thereof to the other, called its axis, or axis of circumvolution: the motion or revolution of that femicircle is the genefis of the fphere, &c.

In the genefis of figures, &c. the line or furface that moves is called the *defcribent;* and the line round which, or, according to which, the revolution or motion is made, the *dirigent*.

GENET, GENNET, or *Jennet*, in the manege, denotes a fmall-fized well-proportioned Spanifh horfe.

To ride *à la genette*, is to ride after the Spanifh fafhion, fo fhort, that the fpurs bear upon the horfe's flank.

GENETHLIA, in antiquity, a folemnity kept in memory of fome perfon deceafed.

GENETHLIACI, in *Aftrology*, perfons who erect horofcopes, or pretend to foretel what fhall befal a man by means of the ftars which prefided at his nativity. The word is formed of the Greek γενεθλη, *origin, generation, nativity*.

The ancients called them *Chaldæi*, and by the general name *mathematici:* accordingly, the feveral civil and canon laws, which we find made againft the mathematicians, only refpect the *genethliaci* or aftrologers.

They were expelled Rome by a formal decree of the fenate; and yet found fo much protection from the credulity of the people, that they remained therein unmolefted. Hence an ancient author fpeaks of them as *hominum genus quod in civitate noftra femper et vetabitur et retinebitur*.

GENETTE, in *Zoology*. See VIVERRA, MAMMALIA *Index*.

GENEVA, a city of Switzerland, on the confines of France and Savoy, fituated in 6° E. Long. and 46° 12′ 9″ N. Lat. It ftands on the banks of the river Rhone, juft at the place where the latter iffues from the lake which takes its name from the city; and part of it is built on an ifland in the river. It is handfome, well fortified, and pretty large; the ftreets in general are clean and well paved, but the principal one is encumbered with a row of fhops on each fide between the carriage and foot-path. The latter is very wide, and protected from the weather by great wooden penthoufes projecting from the roofs; which, though very convenient, give the ftreet a dark and dull appearance. The houfes are generally conftructed of freeftone, with bafements of limeftone; the gutters, fpouts,

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ridges, and outward ornaments, being made of tinned iron. Some of them have arched walks or piazzas in front. The place called *Treille* is very agreeable, being planted with linden trees, and commanding a fine prospect of the lake, with several ranges of rocks rising behind one another, some covered with vineyards and herbage, and others with snow, having openings between them. Immediately below Geneva the Rhone is joined by the Arve, a cold and muddy stream rising among the Alps, and deriving a considerable part of its waters from the Glaciers. The Rhone is quite clear and transparent, so that the muddy water of the Arve is distinguishable from it even after they have flowed for several miles together. There are four bridges over the Rhone before it joins the Arve; and from it the city is supplied with water by means of an hydraulic machine, which raises it 100 Paris feet above its level. The principal buildings are, 1. The maison de ville, or townhouse, a plain ancient edifice, with large rooms, in which the councils assemble, and public entertainments are held; and in one of them a weekly concert is held by subscription during the winter. The ascent to the upper story is not by steps but a paved acclivity: which, however, is so gentle, that horses and mules can go up to the top. 2. The church of St Peter's, formerly the cathedral, is an ancient Gothic building, with a modern portico of seven large Corinthian columns of red and white marble from Roche. The only thing remarkable in the inside is the tomb of Henry duke of Rohan. 3. The arsenal is in good order, and supplied with arms sufficient for 12,000 men. There are many ancient suits of armour; and the scaling ladders, lanthorns, hatchets, &c. used by the Savoyards in their treacherous attempt on the city in the year 1602, to be afterwards noticed, are here preserved. The magazines contain 110 cannon, besides mortars. 4. The hospital is a large handsome building, by which and other charities near 4000 poor people are maintained. 5. The fortifications on the side of Savoy are of the modern construction, but are commanded by some neighbouring grounds. On the side of France they are old fashioned, and at any rate are rather calculated to prevent a surprise than to sustain a regular siege. There are three gates, towards France, Savoy, and Switzerland; and the access to the lake is guarded by a double jetty and chain.

The territory belonging to this city contains about seven square leagues, and is divided into nine parishes; the town is by far the most populous in Switzerland, having about 30,000 inhabitants, of whom, however, 5000 are generally supposed to be absent. It has a small district dependent on it, but this does not contain above 16,000. The adjacent country is extremely beautiful, and has many magnificent views arising from the different positions of the numerous hills and mountains with regard to the town and lake. The inhabitants were formerly distinguished into four classes, viz. citizens, burgesses, inhabitants, and natives; and since the revolution in 1782, a fifth class named *domicilius*, has been added, who annually receive permission from the magistrates to reside in the city. The citizens and burgesses alone, however, are admitted to a share in the government; those called *inhabitants* are strangers allowed to settle in the town with certain privileges; and the *natives* are the sons of those inhabitants, who possess additional advantages. The people are very active and industrious, carrying on an extensive commerce.

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1 State of learning in Geneva.

This city is remarkable for the number of learned men it has produced. The reformed doctrines of religion were very early received in it, being preached there in 1533 by William Farel and Peter Viret of Orbe, and afterwards finally established by the celebrated John Calvin. Of this reformer Voltaire observes, that he gave his name to the religious doctrines first broached by others, in the same manner that Americus Vesputius gave name to the continent of America, which had formerly been discovered by Columbus. It was by the assiduity of this celebrated reformer, and the influence that he acquired among the citizens, that a public academy was first established in the city, where he, Theodore Beza, and some of the more eminent first reformers, read lectures with uncommon success. The intolerant spirit of Calvin is well known; but little of it now appears in the government of Geneva: on the contrary, it is the most tolerating of all the estates in Switzerland, being the only one of them which permits the public exercise of the Lutheran religion. The advantages of the academy at Geneva are very conspicuous among the citizens at this day, even the lower class of them being exceedingly well informed; so that, according to Mr Coxe, there is not a city in Europe where learning is so generally diffused. "I received great satisfaction (says he) in conversing even with several tradesmen upon topics both of literature and politics; and was astonished to find in this class of men so uncommon a share of knowledge; but the wonder ceases when we are told that all of them were educated at the public academy." In this seminary the industry and emulation of the students are excited by the annual distribution of prizes to those who distinguish themselves in each class. The prizes consist of small medals, but are conferred with such solemnity as cannot fail to produce a striking effect on the minds of youth. There is also a public library to which the citizens have access, and which undoubtedly tends greatly to that universal diffusion of learning so remarkable among the inhabitants. It was founded by Bonnivard, remarkable for his sufferings in the cause of the liberties of his country. Having been a great antagonist of the dukes of Savoy, against whom he asserted the independence of Geneva, he had the misfortune at last to be taken prisoner, and was imprisoned for six years in a dungeon below the level of the lake, in the castle of Chillon, which stands on a rock in the lake, and is connected with the land by a drawbridge. In 1536 this castle was taken from Charles III. of Savoy by the canton of Berne, assisted by the Genevans, who furnished a frigate (their whole naval force) to besiege it by water. Bonnivard was now taken from his dungeon, where by constant walking backward and forward, his only amusement, he had worn a hollow in the floor which consisted of solid rock. Bonnivard considered the hardships he had endured as ties which endeared him to the city, and became a principal promoter of the reformation by the mild methods of persuasion and instruction. He closed his benefactions by the gift of his books and manuscripts, and bequeathing his fortune towards the establishment and support of the seminary. His works, which chiefly relate to the hiſtory of Geneva, are ſtill preſerved with great care and reverence. The library contains 25,000 volumes, with many curious manuſcripts, of which an account has been publiſhed by the reverend M. Sennebier the librarian, who has likewiſe diſtinguiſhed himſelf by ſeveral literary works. Meſſrs Bonnet, Sauſſure, Mallet, and De Luc, are the other moſt diſtinguiſhed literary geniuſes of which Geneva can boaſt. The laſt is particularly remarkable for the perfection to which he has brought the barometer, and which is now ſo great, that very little ſeems poſſible to be done by any body elſe.

2
Account of De Luc's cabinet.

His cabinet merits the attention of naturaliſts, as containing many rare and curious ſpecimens of foſſils, which ſerve to illuſtrate the theory of the globe. It may be divided into three parts: 1. Such as enable the naturaliſt to compare the petrifactions of animals and vegetables with the ſame bodies wich are ſtill known to exiſt in our parts of the globe. 2. To compare theſe petrifactions of animals with the ſame bodies which are known to exiſt in different countries. 3. To conſider the petrifactions of thoſe bodies which are no longer known to exiſt. The ſecond part comprehends the ſtones under three points of view: 1. Thoſe of the primitive mountains, which contain no animal bodies; 2. Thoſe of the ſecondary mountains, which contain only marine bodies; 3. Thoſe which contain terreſtrial bodies. The third part contains the lavas and other volcanic productions; which are diſtinguiſhed into two claſſes: 1. Thoſe which come from volcanoes now actually burning; 2. Thoſe from extinguiſhed volcanoes.

3
Hiſtory and government of Geneva.

In the time of Charles the Great, the city and territory of Geneva made part of his empire; and, under his ſucceſſors, it became ſubject to the German emperors. By reaſon of the imbecility of theſe princes, however, the biſhops of Geneva acquired ſuch authority over the inhabitants, that the emperor had no other means of counterbalancing it than by augmenting the privileges of the people. In theſe barbarous ages alſo the biſhops and counts had conſtant diſputes, of which the people took the advantage; and by ſiding ſometimes with one, and ſometimes with the other, they obtained an extenſion of their privileges from both. The houſe of Savoy at length purchaſed the territory, and ſucceeded the counts with additional power: againſt them therefore the biſhops and people united in order to reſiſt their encroachments; and, during this period, the government was ſtrangely complicated, by reaſon of the various pretenſions of the three parties. The counts of Savoy, however, had at laſt the addreſs to diſſolve the union between the biſhops and citizens, by procuring the epiſcopal ſee for their brothers, and even their illegitimate children; by which means their power became gradually ſo extenſive, that towards the commencement of the 16th century, Charles III. of Savoy (though the government was accounted entirely republican) obtained an almoſt abſolute authority over the people, and exerciſed it in a moſt unjuſt and arbitrary manner. Thus violent commotions took place; and the citizens became divided into two parties, one of which, viz. the patriots, were ſtyled *Eidgenoſſen* or *confederates; the* partiſans of Savoy being diſgraced by the appellation of *Mamelucs* or *ſlaves*. The true period of Genevan liberty may therefore be conſidered as commencing with the treaty concluded with Berne and Friburg in the year 1526; in conſequence of which the duke was in a ſhort time deprived of his authority, the biſhop driven from the city, and the reformed religion and a republican form of government introduced. A long war commenced with Savoy on this account; but the Genevans proved an overmatch for their enemies by their own bravery and the aſſiſtance of the inhabitants of Berne. In 1584, the republic concluded a treaty with Zurich and Berne, by which it is allied to the Swiſs cantons. The houſe of Savoy made their laſt attempt againſt Geneva in 1602, when the city was treacherouſly attacked in the night time during a profound peace. Two hundred ſoldiers had ſcaled the walls, and got into the town before any alarm was given; but they were repulſed by the deſperate valour of a few citizens, who periſhed in the encounter. A petard had been faſtened to one of the gates by the Savoyards; but the gunner was killed before it could be diſcharged. The war occaſioned by this treachery was next year concluded by a ſolemn treaty, which has ever ſince been obſerved on both ſides: though the independence of Geneva was not formally acknowledged by the king of Sardinia till the year 1754.

The reſtoration of tranquillity from without in conſequence of the above treaty, was however ſoon followed by the flames of internal diſcord, ſo common in popular governments; ſo that during the whole of the laſt century the hiſtory of Geneva affords little more than an account of the ſtruggles betwixt the ariſtocratical and popular parties. About the beginning of the preſent century the power of the grand council was become almoſt abſolute; but in order to reſtrain its authority, an edict was procured in 1707 by the popular party, enacting, that every five years a general council of the citizens and burghers ſhould be ſummoned to deliberate upon the affairs of the republic. In conſequence of this law a general aſſembly was convened in 1712; and the very firſt act of that aſſembly was to aboliſh the edict by which they had been convened. A proceeding ſo extraordinary can ſcarcely be accounted for on the principles of popular fickleneſs and inconſtancy. Rouſſeau, in his Miſcellaneous Works, aſcribes it to the artifices of the magiſtrates, and the equivocal terms marked upon the billets then in uſe. For the queſtion being put, "Whether the opinion of the councils for aboliſhing the periodical aſſemblies ſhould paſs into a law?" the words *approbation* or *rejection*, put upon the billets by which the votes were given, might be interpreted either way. Thus, if the billet was choſen on which the word *approbation* was written, the opinion of the councils which rejected the aſſemblies was approved; and by the word *rejection*, the periodical aſſembly was rejected of courſe. Hence ſeveral of the citizens complained that they had been deceived, and that they never meant to reject the general aſſembly, but only the opinion of the councils.

In conſequence of the abolition of the general aſſemblies, the power of the ariſtocratical party was greatly augmented; till at length the inhabitants exerting themſelves with uncommon ſpirit and perſeverance, found means to limit the power of the magiſtrates, and enlarge their own rights. In 1776, as Mr Cox informs us, the government might be conſidered as a mean betwixt

Geneva.

4 Sketch of the government in 1776.

twixt that of the ariſtocratical and popular cantons of Switzerland. The members of the ſenate, or little council of 25, enjoyed in their corporate capacity ſeveral very conſiderable prerogatives. By them half the members of the great council were named; the principal magiſtrates were ſupplied from their own body; they convoked the great and general councils, deliberating previouſly upon every queſtion which was to be brought before theſe councils. They were veſted alſo with the chief executive power, the adminiſtration of finances, and had in a certain degree the juriſdiction in civil and criminal cauſes. Moſt of the ſmaller poſts were likewiſe filled by them; and they enjoyed the ſole privilege of conferring the burgherſhip. Theſe, and other prerogatives, however, were balanced by thoſe of the great council and the privileges of the general council. The former had a right to chooſe the members of the ſenate from their own body; receiving appeals in all cauſes above a certain value, pardoning criminals, &c. beſides which they had the important privilege of approving or rejecting whatever was propoſed by the ſenate to be laid before the people.

The general council or aſſembly of the people is compoſed of the citizens and burghers of the town; their number in general amounting to 1500, though uſually not more than 1200 were preſent; the remainder reſiding in foreign countries, or being otherwiſe abſent. It meets twice a-year, chooſes the principal magiſtrates, approves or rejects the laws and regulations propoſed by the other councils, impoſes taxes, contracts alliances, declares war or peace, and nominates half the members of the great council, &c. But the principal check to the power of the ſenate aroſe from the right of *re-election*, or the power of annually expelling four members from the ſenate at the nomination of the *ſyndics* or principal magiſtrates, and from the right of repreſentation. The ſyndics are four in number, choſen annually from the ſenate by the general council; and three years elapſe before the ſame members can be again appointed. In chooſing theſe magiſtrates, the ſenate appointed from its own body eight candidates, from whom the four ſyndics were to be choſen by the general council. The latter, however, had it in their power to reject not only the firſt eight candidates, but alſo the whole body of ſenators in ſucceſſion: in which caſe, four members of the ſenate retired into the great council: and their places were filled by an equal number from that council. With regard to the power of repreſentation, every citizen or burgher has the privilege of applying to the ſenate in order to procure a new regulation in this reſpect, or of remonſtrating againſt any act of the magiſtracy. To theſe remonſtrances the magiſtrates were obliged to give an explicit anſwer; for if a ſatisfactory anſwer was not given to one, a ſecond was immediately preſented. The repreſentation was made by a greater or ſmaller number of citizens according to the importance of the point in queſtion.

5 Account of the revolution in 1782.

Since the 1776, however, ſeveral changes have taken place. This right of *re-election*, which the ariſtocratical party were obliged to yield to the people in 1768, ſoon proved very diſagreeable, being conſidered by the former as a kind of oſtraciſm; for which reaſon they catched at every opportunity of procuring its abolition. They were now diſtinguiſhed by the title of *negatives*, while the popular party had that of *repreſentants*; and the point in diſpute was the compilation of a new code of laws. This meaſure the negatives oppoſed, as ſuppoſing that it would tend to reduce their prerogatives; while, on the other hand, the repreſentants uſed their utmoſt endeavours to promote it, in hopes of having their privileges augmented by this means. At laſt in the month of January 1777, the negatives were obliged to comply with the demands of their antagoniſts; and a committee for forming a new code of laws was appointed by the concurrence of the little, great, and general councils. The committee was to laſt for two years, and the code to be laid before the three councils for their joint approbation or rejection. A ſketch of the firſt part of the code was preſented to the little and great councils on the firſt of September 1779, that they might profit by their obſervations before it was preſented to the general council. Great diſputes aroſe; and at length it was carried by the negatives that the code ſhould be rejected and the committee diſſolved. The oppoſite party complained of this as unconſtitutional, and violent diſputes enſued; the iſſue of which was, that the great council offered to compile the code, and ſubmit it to the deciſion of the public. This did not give ſatisfaction to the popular party, who conſidered it as inſidious: the contentions revived with more fury than ever, until at length the negatives ſuppoſing, or pretending to ſuppoſe, that their country was in danger, applied to the guarantees, France, Zurich, and Berne, entreating them to protect the laws and conſtitution. This was productive of no good effect; ſo that the negatives found no other method of gaining their point than by ſowing diſſenſion among the different claſſes of inhabitants. The *natives* were diſcontented and jealous on account of many excluſive privileges enjoyed by that claſs named *citizens*: they were beſides exaſperated againſt them for having, in 1770, baniſhed eight of the principal natives, who pretended that the right of burgherſhip belonged to the natives as well as to the citizens, and demanded that this right ought to be gratuitouſly conferred inſtead of being purchaſed. The negatives, in hopes of making ſuch a conſiderable addition to their party, courted the natives by all the methods they could think of, promiſing by a public declaration that they were ready to confer upon them thoſe privileges of trade and commerce which had hitherto been confined excluſively to the citizens. The deſigns of the negatives were likewiſe openly favoured by the court of France, and deſpatches were even written to the French reſident at Geneva to be communicated to the principal natives who ſided with the ariſtocratic party. The attorney-general, conceiving this mode of interference to be highly unconſtitutional, preſented a ſpirited remonſtrance; by which the French court were ſo much diſpleaſed, that they procured his depoſition from his office; and thus their party was very conſiderably increaſed among the natives. The repreſentants were by no means negligent in their endeavours to conciliate the favour of the ſame party, and even promiſed what they had hitherto oppoſed in the ſtrongeſt manner, viz. to facilitate the acquiſition of the burgherſhip, and to beſtow it as the recompenſe of induſtry and good behaviour. Thus two parties were formed among the natives themſelves; and the diſſenſions becoming

Gemma.

course of his life had ever been disposed to render him friendly offices; and it was but a short time after Geminiani's arrival at Dublin that he was called upon to do him the last. It appears that Geminiani had spent many years in compiling an elaborate treatise on music, which he intended for publication; but soon after his arrival at Dublin, by the treachery of a female servant, who, it was said, was recommended to him for no other end than that she might steal it, it was conveyed away, and could not be recovered. The greatness of this loss, and his inability to repair it, made a deep impression on his mind; and, as it is conjectured, hastened his end; at least he survived it but a short time, ending his days on the 17th of September 1762. The following list comprises the whole of his publications, except two or three articles of small account: Twelve solos for a violin, *opera prima;* six concertos in seven parts, *opera seconda;* six concertos in seven parts, *opera terza;* twelve solos for a violin, *opera quarta;* six solos for a violoncello, *opera quinta;* the same made into solos for a violin; six concertos from his *opera quarta;* six concertos in eight parts, *opera settima;* rules for playing in taste; a treatise on good taste; the art of playing the violin; 12 sonatas from his first solos, *opera undecima;* Ripieno parts to ditto; lessons for the harpsichord; *Guida Armonica;* supplement to ditto; the art of accompaniment, two books; his first two operas of concertos in score; and the Enchanted Forest.—Of his solos the *opera prima* is esteemed the best. Of his concertos some are excellent, others of them scarce pass the bounds of mediocrity. The sixth of the third opera not only surpasses all the rest, but, in the opinion of the best judges of harmony, is the finest instrumental composition extant.

GEMMA, or Bud, in *Botany:* a compendium or epitome of a plant, seated upon the stem and branches, and covered with scales, in order to defend the tender rudiments enclosed from cold and other external injuries, till, their parts being unfolded, they acquire strength, and render any further protection unnecessary.

Buds, together with bulbs, which are a species of buds generally seated upon or near the root, constitute that part of the herb called by Linnæus *hybernacula;* that is, the winter quarters of the future vegetable: a very proper appellation, as it is during that severe season that the tender rudiments are protected in the manner just mentioned.

Plants, considered in analogy to animals, may properly enough be reckoned both viviparous and oviparous. Seeds are the vegetable eggs; buds, living fetuses, or infant plants, which renew the species as certainly as the seeds.

Buds are placed at the extremity of the young shoots, and along the branches, being fixed by a short footstalk upon a kind of brackets, the remainder of the leaves, in the wings or angles of which the buds in question were formed the preceding year. They are sometimes placed single; sometimes two by two, and those either opposite or alternate; sometimes collected in greater numbers in whirls or rings.

With respect to their construction, buds are composed of several parts artificially arranged. Externally, we find a number of scales that are pretty hard, frequently armed with hairs, hollowed like a spoon, and placed over each other like tiles. These scales are fixed into the inner plates of the bark, of which they appear to be a prolongation. Their use is to defend the internal parts of the bud; which, being unfolded, will produce, some, flowers, leaves, and stipulæ; others, footstalks and scales. All these parts, while they remain in the bud, are tender, delicate, folded over each other, and covered with a thick clammy juice, which is sometimes resinous and odoriferous, as in the tacamahac tree. This juice serves not only to defend the more tender parts of the embryo plant from cold, the assaults of insects, and other external injuries; but likewise from excessive perspiration, which, in its young and infant state, would be very destructive. It is conspicuous in the buds of horse chesnut, poplar, and willow trees.

In general, we may distinguish three kinds of buds; that containing the flower, that containing the leaves, and that containing both flower and leaves.

The first, termed *gemma florifera*, and by the French *bouton à fleur* or *à fruit*, contains the rudiments of one or several flowers, folded over each other, and surrounded with scales. In several trees, this kind of bud is commonly found at the extremity of certain small branches, which are shorter, rougher, and less garnished with leaves, than the rest. The external scales of this species of bud are harder than the internal; both are furnished with hairs, and in general more swelled than those of the second sort. The bud containing the flower too is commonly thicker, shorter, almost square, less uniform, and less pointed; being generally terminated obtusely. It is called by Pliny *oculus gemmæ*; and is employed in that species of grafting called *inoculation*, or *budding*.

The second species of bud, viz. that containing the leaves, termed *gemma folifera*, and by the French *bouton à feuilles* or *à bois*, contains the rudiments of several leaves, which are variously folded over each other, and outwardly surrounded by scales, from which the small stipulæ that are seated at the foot of the young branches are chiefly produced. These buds are commonly more pointed than the former sort. In the hazel nut, however, they are perfectly round; and in horse chesnut, very thick.

The third sort of bud is smaller than either of the preceding; and produces both flowers and leaves, though not always in the same manner. Sometimes the flowers and leaves are unfolded at the same time. This mode of the flower and leaf bud is termed by Linnæus *gemma folifera et florifera.* Sometimes the leaves proceed or emerge out of this kind of bud upon a small branch, which afterwards produces flowers. This mode of the flower and leaf bud is termed by Linnæus *gemma folifera florifera*, and is the most common bud of any.

Such buds as produce branches adorned only with leaves, are called *barren;* such as contain both leaves and flowers, *fertile.* From the bulk of the bud we may often with ease foretel whether it contains leaves only, or leaves and flowers together, as in cherry and pear trees.

Neither the buds produced on or near the root, called by some authors *turiones*, nor those produced on the trunk, and from the angles or wings of the leaves, contain, in strict propriety, an entire delineation of the plant; since the roots are wanting; and in various buds,

buds, as we have seen, shoots are contained with leaves only, and not with flowers: but as a branch may be considered as a part similar to the whole plant, and, if planted, would in process of revegetation exhibit or produce roots and flowers, we may in general allow, that the bud contains the whole plant, or the principles of the whole plant, which may be unfolded *ad libitum;* and thus resembles the seed, in containing a delineation of the future plant in embryo: for although the bud wants a radicle, or plumula, of which the seed is possessed, yet it would undoubtedly form one, if planted in the earth. But as the medullary part adhering to the bud is too tender, and by the abundance of juice flowing into it from the earth would be disposed to putrefaction, the buds are not planted in the soil, but generally inserted within the bark of another tree; yet placed so that the production of the marrow, or pith, adhering to them, may be inserted into the pith of the branch in which the fissure or cleft is made; by which means there is a large communication of juice. This propagation by gems or buds, called *inoculation*, is commonly practised with the first sort of buds above described.

From the obvious uses of the buds, we may collect the reason why the Supreme Author of nature has granted this sort of protection to most of the trees that are natives of cold climates: and, on the other hand, denied it to such as, enjoying a warm benign atmosphere, have not the tender parts of their embryo shoots exposed to injuries and depredations from the severities of the weather. Of this latter kind are the plants of the following list; some of them very large trees; others smaller woody vegetables, of the shrub and under-shrub kind: Citron, orange, lemon, cassava, mock orange, blad apple, shrubby swallow-wort, alaternus, shrubby geraniums, berry-bearing alder, Christ's thorn, Syrian mallow, boabab or Ethiopian sour gourd, justicia, mild sena, the acacias and sensitive plant, coral tree, stinking bean trefoil, medicago, oleander, viburnum, sumach, ivy, tamarisk, heath, Barbadoes cherry, lavatera, rue, shrubby nightshades, Guinea henweed, cypress, lignum vitæ, and savine, a species of juniper.

On annual plants, whose root as well as stalk perishes after a year, true buds are never produced; in their stead, however, are produced small branches, like a little feather, from the wings of the leaves, which wither without any farther expansion if the plants climb and have no lateral branches; but if, either by their own nature or from abundance of sap, the plants become branched, the ramuli just mentioned obtain an increase similar to that of the whole plant.

The same appearance obtains in the trees of warm countries, such as those enumerated in the above list, in which a plumula, or small feather, sends forth branches without a scaly covering; as, in such countries, this tender part requires no defence or protection from cold. A scaly covering then is peculiar to buds, as it protects the tender embryo enclosed from all external injuries. When we therefore speak of trees having buds that are naked or without scales, our meaning is the same as if we had said that they have no buds at all.

The buds that are to be unfolded the following year, break forth from the evolved buds of the present year, in such a manner as to put on the appearance of small eminences in the wings or angles of the leaves. These eminences or knots grow but little during the summer; as, in that season, the sap is expended on the increase of the parts of the plant: but in autumn, when the leaves begin to wither and fall off, the buds, placed on the wings, increase; and the embryo plant contained in the bud is so expanded, that the leaves and flowers, the parts to be evolved the following year, are distinctly visible. Thus in horse chesnut the leaves, and in cornel tree the flowers, are each to be observed in their respective buds.

As each bud contains the rudiments of a plant, and would, if separated from its parent vegetable, become every way similar to it; Linnæus, to show the wonderful fertility of nature, has made a calculation, by which it appears, that, in a trunk scarce exceeding a span in breadth, 10,000 buds (that is, herbs) may be produced. What an infinite number, then, of plants might be raised from a very large tree!

GEMMATIO, from *gemma*, "a bud;" a term used by Linnæus, expressive of the form of the buds, their origin, and their contents. It includes both those properly called *buds*, and those which are seated at the roots, styled *bulbs*.

As to the origin of buds, they are formed either of the footstalks of the leaves, of stipulæ, or of scales of the bark. Their contents have been already discovered, in the preceding article, to be either flowers, leaves, or both.

GEMONIÆ SCALÆ, or *Gradus* GEMONII, among the Romans, was much the same as gallows or gibbet in England.—Some say they were thus denominated from the person who raised them; others, from the first criminals that suffered on them; and others, from the verb *gemo*, "I sigh or groan."

The *gradus gemonii*, according to Publius Victor or Sextus Rufus, was a place raised on several steps, from whence they precipitated their criminals; others represent it as a place whereon offenders were executed, and afterwards exposed to public view. The *gemoniæ scalæ* were in the tenth region of the city, near the temple of Juno. Camillus first appropriated the place to this use, in the year of Rome 358.

GENDARMES, or GENS D'ARMES, in the French armies, a denomination given to a select body of horse, on account of their succeeding the ancient gendarmes, who were thus called from their being completely clothed in armour; (see *Scots* GENDARMES, *infra*.) These troops were commanded by captain lieutenants, the king and the princes of the blood being their captains; the king's troop, besides a captain-lieutenant, had two sublieutenants, three ensigns, and three guidons.

Grand GENDARMES, latterly were a troop composed of 250 gentlemen; the king himself was their captain, and one of the first peers their captain-lieutenant, who had under him two lieutenants, three ensigns, three guidons, and other officers.

Small GENDARMES, were the Scots gendarmes, the queen's, the dauphin's, the gendarmes of Anjou, Burgundy, the English and Flemish gendarmes, having each a captain lieutenant, sub-lieutenant, ensign, guidon, and quarter-master.

Scots GENDARMES, were originally instituted by Charles VII. of France, about the middle of the 15th century, Gender, Genealogy.

Stuart's Constit. of Scotland.

century, and formed a part of his guard; in which station also they acted under other princes. It was their prerogative to take precedence of all the companies of the gendarmerie of France; and, on particular occasions, they even preceded the two companies of the king's mousquetaires. The sons of the Scottish monarchs were the usual captains of this company; and, after Mary's accession to the throne, its command belonged to them as a right. It was thence that James VI. made a claim of it for his son Prince Henry. This honour, and its emoluments, were also enjoyed by Charles I. and the next in command to this prince was Louis Stuart duke of Lennox. George Gordon marquis of Huntly succeeded the duke of Lennox in the year 1624, and took the title of captain or commander in chief when Charles I. mounted the English throne. It is not certain whether Charles II. was ever captain of this company; but it was conferred on his brother the duke of York, who was captain of the Scots gendarmes till the year 1667, when he resigned his commission into the hands of the French king. Since that time no native of Great Britain has enjoyed this command. See *Scots Guards*.

All the different gendarmeries are now abolished, in consequence of the reforming systems that have lately taken place in France.

GENDER, among grammarians, a division of nouns, or names, to distinguish the two sexes.

This was the original intention of gender: but afterwards other words, which had no proper relation either to one sex or the other, had genders assigned them, rather out of caprice than reason; which is at length established by custom. Hence genders vary according to the languages, or even according to the words introduced from one language into another. Thus, *arbor* in Latin is feminine, but *arbre* in French is masculine; and *dens* in Latin is masculine, but *dent* in French is feminine.

The oriental languages frequently neglect the use of genders, and the Persian language has none at all.

The Latins, Greeks, &c. generally content themselves to express the different genders by different terminations; as *bonus equus*, "a good horse;" *bona equa*, "a good mare," &c. But in English we frequently go further, and express the difference of sex by different words: as boar, sow; boy, girl; buck, doe; bull, cow; cock, hen; dog, bitch, &c.—We have only about 24 feminines, distinguished from the males, by the variation of the termination of the male into *ess*; of which number are abbot, abbess; count, countess; actor, actress; heir, heiress; prince, princess, &c. which is all that our language knows of any thing like genders.

The Greek and Latin, besides the masculine and feminine, have the neuter, common, and the doubtful gender; and likewise the epicene, or promiscuous, which under one single gender and termination includes both the kinds.

GENEALOGY, an enumeration of a series of ancestors; or a summary account of the relations and alliances of a person or family, both in the direct and collateral line.

The word is Greek, γενεαλογια; which is formed of γενος, "race or lineage," and λογος, "discourse."

In divers chapters and military orders, it is required, that the candidates produce their genealogy, to show that they are noble by so many descents.

Genealogica, General.

GENEALOGICA arbor, or *Tree of Consanguinity*, signifies a genealogy or lineage drawn out under the figure of a tree, with its root, stock, branches, &c. The genealogical degrees are usually represented in circles, ranged over, under, and aside each other. This the Greeks called *stemmata*, a word signifying crown, garland, or the like. See the articles Consanguinity and Descent, and the plates there referred to.

GENEP, a strong town of Germany, in the circle of Westphalia, subject to the king of Prussia. E. Long. 4. 29. N. Lat. 51. 42.

GENERAL, an appellation given to whatever belongs to a whole genus.

General Assembly. See Assembly.

General Charge, in *Law*. See *Charge to enter Heir*.

General Terms, among logicians, those which are made the signs of general ideas. See Logic and Metaphysics.

General Warrant. See Warrant.

General of an Army, in the art of War, he who commands in chief. See the article War, where his office and duties are particularly explained.

General of the Artillery. See Ordnance.

General of Horse, and *General of Foot*, are posts next under the general of the army, and these have upon all occasions an absolute authority over all the horse and foot in the army.

Adjutant General, one who attends the general, assists in council, and carries the general's orders to the army. He distributes the daily orders to the majors of brigade. He is likewise charged with the general detail of the duty of the army. The majors of brigade send every morning to the adjutant general an exact return, by battalion and company, of the men of his brigade. In a day of battle the adjutant general sees the infantry drawn up; after which, he places himself by the general, to receive any orders which may regard the corps of which he has the detail. In a siege, he orders the number of workmen demanded, and signs the warrant for their payment. He receives the guards of the trenches at their rendezvous, and examines their condition; he gives and signs all orders for parties. He has an orderly serjeant from each brigade of infantry in the line, to carry such orders as he may have occasion to send from the general.

Lieutenant General, is the next in command after the general; and provided he should die or be killed, the order is, that the oldest lieutenant general shall take the command. This office is the first military dignity after that of general. One part of their function is, to assist the general with their council: they ought therefore, if possible, to possess the same qualities with the general himself; and the more, as they often command armies in chief.

The number of lieutenant generals has been multiplied of late in Europe, in proportion as the armies have become numerous. They serve either in the field, or in sieges, according to the dates of their commissions. In battle, the oldest commands the right wing of the army, the second the left wing, the third the centre,

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the fourth the right wing of the second line, the fifth the left wing, the sixth the centre; and so on. In sieges, the lieutenant generals always command the right of the principal attack, and order what they judge proper for the advancement of the siege during the 24 hours they are in the trenches: except the attacks, which they are not to make without an order from the general in chief.

Lieutenant GENERAL *of the Ordnance*. See ORDNANCE.

Lieutenant GENERAL *of Artillery*, is, or ought to be, a very great mathematician, and an able engineer; to know all the powers of artillery; to understand the attack and defence of fortified places, in all its different branches; how to dispose of the artillery in the day of battle to the best advantage; to conduct its march and retreat; as also to be well acquainted with all the numerous apparatus belonging to the train, and to the laboratory, &c.

Major GENERAL, the next officer to the lieutenant general. His chief business is to receive orders from the general, or in his absence from the lieutenant general of the day; which he is to distribute to the brigade majors, with whom he is to regulate the guards, convoys, detachments, &c. On him rests the whole fatigue and detail of duty of the army roll. It is the major general of the day who is charged with the encampment of the army, who places himself at the head of it when they march, who marks out the ground of the camp to the quartermaster general, and who places the new guards for the safety of the camp.

The day the army is to march, he dictates to the field officers the order of the march, which he has received from the general, and on other days gives them the parole.

In a fixed camp he is charged with the foraging, with reconnoitring the ground for it, and posting the escorts, &c.

In sieges, if there are two separate attack, the second belongs to him; but if there is but one, he takes, either from the right or left of the attack, that which the lieutenant general has not chosen.

When the army is under arms, he assists the lieutenant general, whose orders he executes.

If the army marches to an engagement, his post is at the head of the guards of the army, until they are near enough to the enemy to rejoin their different corps; after which he retires to his own proper post: for the major generals are disposed on the order of battle as the lieutenant generals are; to whom, however, they are subordinate, for the command of their divisions. The major general has one aid-de-camp, paid for executing his orders.

GENERAL is also used for a particular march, or beat of drum; being the first which gives notice, commonly in the morning early, for the infantry to be in readiness to march.

GENERAL is likewise an appellation by which officers in law, in the revenues, &c. are distinguished; as, *attorney general*, *solicitor general*, &c. *receiver general*, *comptroller general*, &c. See ATTORNEY, &c.

GENERAL is also used for the chief of an order of monks, or of all the houses and congregations established under the same rule. Thus we say, the general of the Franciscans, Cistertians, &c.

GENERALISSIMO, called also *captain general*, and simply *general*, is an officer who commands all the military powers of a nation; who gives orders to all the other general officers; and receives no orders himself but from the king.

M. Balzac observes, that the cardinal de Richelieu first coined this word, of his own absolute authority, upon his going to command the French army in Italy.

GENERATE, in *Music*, is used to signify the operation of that mechanical power in nature, which every sound has in producing one or more different sounds. Thus any given sound, however simple, produces along with itself, its octave, and two other sounds extremely sharp, viz. its twelfth above, that is to say, the octave of its fifth; and the other the seventeenth above, or, in other words, the double octave of its third major.

Whether we suppose this procreation of sounds to result from an aptitude in the texture and magnitude of certain particles in the air, for conveying to our ears vibrations that bear those proportions, one to another, as being determined at once by the partial and total oscillations of any musical string; or from whatever economy of nature we choose to trace it; the power of one sound thus to produce another, when in action, is said to *generate*. The same word is applied, by Signior Tartini and his followers, to any two sounds which, simultaneously heard, produce a third.

GENERATED, or GENITED, is used, by some mathematical writers, for whatever is produced, either in arithmetic, by the multiplication, division, or extraction of roots; or in geometry, by the invention of the contents, areas, and sides; or of extreme and mean proportionals, without arithmetical addition and subtraction.

GENERATING LINE, or FIGURE, in *Geometry*, is that which, by its motion of revolution, produces any other figure, plane or solid. See GENESIS.

GENERATION, in *Physiology*, the act of procreating and producing a being similar to the parent. See ANATOMY, N° 157.

GENERATION *of Fishes*. See COMPARATIVE *Anatomy*, N° 304, and ICHTHYOLOGY.

GENERATION *of Plants*. See BOTANY.

GENERATION *of Insects*. See COMPARATIVE *Anatomy*, p. 312, and ENTOMOLOGY, p. 234.

Parts of GENERATION. See ANATOMY, N° 157.

GENERATION, in *Mathematics*, is used for formation or production. Thus we meet with the generation of equations, curves, solids, &c.

GENERATION, in *Theology*. The Father is said by some divines to have produced his Word or Son from all eternity, by way of generation; on which occasion the word *generation* raises a peculiar idea: that procession, which is really effected in the way of understanding, is called *generation*, because in virtue thereof, the Word becomes like to him from whom he takes this original; or, as St Paul expresses it, is the figure or image of his substance, i. e. of his being and nature. And hence it is, they say, that the second Person in the Trinity is called the Son.

GENERATION is also used, though somewhat improperly, for genealogy, or the series of children issued from the same stock. Thus the gospel of St Matthew commences with the book of the generation of Jesus Christ,

Christ, &c. The latter and more accurate translators, instead of *generation* use the word *genealogy*.

Generation is also used to signify a people, race, or nation, especially in the literal translations of the Scripture, where the word generally occurs wherever the Latin has *generatio*, and the Greek γενεσις. Thus, "A wicked and perverse generation seeketh a sign," &c. "One generation passes away, and another cometh," &c.

Generation is also used in the sense of an age, or the ordinary period of man's life. Thus we say, "to the third and fourth generation." In this sense historians usually reckon a generation the space of 33 years or thereabouts. See Age.

Herodotus makes three generations in a hundred years; which computation appears from the latter authors of political arithmetic to be pretty just.

GENERATOR, in *Music*, signifies the principal sound or sounds by which others are produced. Thus the lowest C for the treble of the harpsichord, besides its octave, will strike an attentive ear with its twelfth above, or G in alt, and with its seventeenth above, or E in alt. The C, therefore, is called their *generator*, the G and E its products or harmonics. But in the approximation of chords, for G, its octave below is substituted, which constitutes a fifth from the generator, or lowest C; and for E, is likewise substituted its fifteenth below, which, with the above-mentioned C, forms a third major. To the lowest notes, therefore, exchanged for those in alt by substitution, the denominations of products or harmonics are likewise given, whilst the C retains the name of their *generator*. But still according to the system of Tartini, two notes in concord, which when sounded produce a third, may be termed the *concurring generators* of that third. (See *Generation Harmonique, per M. Rameau;* see also that delineation of Tartini's system called The Power and Principles of Harmony.)

GENERICAL name, in *Natural History*, the word used to signify all the species of natural bodies, which agree in certain essential and peculiar characters, and therefore all of the same family or kind; so that the word used as the generical name equally expresses every one of them, and some other words expressive of the peculiar qualities or figures of each are added, in order to denote them singly, and make up what is called the specific name. See Botany and *Natural History*.

GENESIS, the first book of the Old Testament, containing the history of the creation, and the lives of the first patriarchs.

The book of Genesis stands at the head of the Pentateuch. Its author is held to be Moses: it contains the relation of 2369 years, viz. from the beginning of the world to the death of Joseph. The Jews are forbidden to read the beginning of Genesis, and the beginning of Ezekiel, before 30 years of age.

The Hebrews called this book *Bereschith*, because it begins with that word, which in their language signifies *in principio*, or "in the beginning." The Greeks gave it the name *Genesis*, Γενεσις, q. d. production, generation, because it begins with the history of the production or generation of all beings.

This book, besides the history of the creation, contains an account of the original innocence and fall of man; the propagation of mankind; the rise of religion; the general defection and corruption of the world; the deluge; the restoration of the world; the division and peopling of the earth; and the history of the first patriarchs to the death of Joseph. It was easy for Moses to be satisfied of the truth of what he delivers in this book, because it came down to him through a few hands; for from Adam to Noah there was one man, viz. Methuselah, who lived so long as to see them both: in like manner Shem conversed with Noah and Abraham; Isaac with Abraham and Joseph, from whom the records of this book might easily be conveyed to Moses by Amram, who was contemporary with Joseph.

Genesis, in *Geometry*, denotes the formation of a line, plane, or solid, by the motion or flux of a point, line, or surface. See Fluxions.

The genesis or formation, *e. gr.* of a globe or sphere, is conceived by supposing a semicircle to revolve upon a right line, drawn from one extreme thereof to the other, called its axis, or axis of circumvolution: the motion or revolution of that semicircle is the genesis of the sphere, &c.

In the genesis of figures, &c. the line or surface that moves is called the *describent;* and the line round which, or, according to which, the revolution or motion is made, the *dirigent*.

GENET, Gennet, or *Jennet*, in the manege, denotes a small-sized well-proportioned Spanish horse.

To ride *à la genette*, is to ride after the Spanish fashion, so short, that the spurs bear upon the horse's flank.

GENETHLIA, in antiquity, a solemnity kept in memory of some person deceased.

GENETHLIACI, in *Astrology*, persons who erect horoscopes, or pretend to foretel what shall befal a man by means of the stars which presided at his nativity. The word is formed of the Greek γενεθλη, *origin*, *generation*, *nativity*.

The ancients called them *Chaldæi*, and by the general name *mathematici:* accordingly, the several civil and canon laws, which we find made against the mathematicians, only respect the *genethliaci* or astrologers.

They were expelled Rome by a formal decree of the senate; and yet found so much protection from the credulity of the people, that they remained therein unmolested. Hence an ancient author speaks of them as *hominum genus quod in civitate nostra semper et vetabitur et retinebitur*.

GENETTE, in *Zoology*. See Viverra, Mammalia *Index*.

GENEVA, a city of Switzerland, on the confines of France and Savoy, situated in 6° E. Long. and 46° 12′ 9″ N. Lat. It stands on the banks of the river Rhone, just at the place where the latter issues from the lake which takes its name from the city; and part of it is built on an island in the river. It is handsome, well fortified, and pretty large; the streets in general are clean and well paved, but the principal one is encumbered with a row of shops on each side between the carriage and foot-path. The latter is very wide, and protected from the weather by great wooden penthouses projecting from the roofs; which, though very convenient, give the street a dark and dull appearance. The houses are generally constructed of freestone, with basements of limestone; the gutters, spouts, ridges,

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ridges, and outward ornaments, being made of tinned iron. Some of them have arched walks or piazzas in front. The place called *Treille* is very agreeable, being planted with linden trees, and commanding a fine profpect of the lake, with feveral ranges of rocks rifing behind one another, fome covered with vineyards and herbage, and others with fnow, having openings between them. Immediately below Geneva the Rhone is joined by the Arve, a cold and muddy ftream rifing among the Alps, and deriving a confiderable part of its waters from the Glaciers. The Rhone is quite clear and tranfparent, fo that the muddy water of the Arve is diftinguifhable from it even after they have flowed for feveral miles together. There are four bridges over the Rhone before it joins the Arve; and from it the city is fupplied with water by means of an hydraulic machine, which raifes it 100 Paris feet above its level. The principal buildings are, 1. The maifon de ville, or townhoufe, a plain ancient edifice, with large rooms, in which the councils affemble, and public entertainments are held; and in one of them a weekly concert is held by fubfcription during the winter. The afcent to the upper ftory is not by fteps but a paved acclivity: which, however, is fo gentle, that horfes and mules can go up to the top. 2. The church of St Peter's, formerly the cathedral, is an ancient Gothic building, with a modern portico of feven large Corinthian columns of red and white marble from Roche. The only thing remarkable in the infide is the tomb of Henry duke of Rohan. 3. The arfenal is in good order, and fupplied with arms fufficient for 12,000 men. There are many ancient fuits of armour; and the fcaling ladders, lanthorns, hatchets, &c. ufed by the Savoyards in their treacherous attempt on the city in the year 1602, to be afterwards noticed, are here preferved. The magazines contain 110 cannon, befides mortars. 4. The hofpital is a large handfome building, by which and other charities near 4000 poor people are maintained. 5. The fortifications on the fide of Savoy are of the modern conftruction, but are commanded by fome neighbouring grounds. On the fide of France they are old fafhioned, and at any rate are rather calculated to prevent a furprife than to fuftain a regular fiege. There are three gates, towards France, Savoy, and Switzerland; and the accefs to the lake is guarded by a double jetty and chain.

The territory belonging to this city contains about feven fquare leagues, and is divided into nine parifhes; the town is by far the moft populous in Switzerland, having about 30,000 inhabitants, of whom, however, 5000 are generally fuppofed to be abfent. It has a fmall diftrict dependent on it, but this does not contain above 16,000. The adjacent country is extremely beautiful, and has many magnificent views arifing from the different pofitions of the numerous hills and mountains with regard to the town and lake. The inhabitants were formerly diftinguifhed into four claffes, viz. citizens, burgeffes, inhabitants, and natives; and fince the revolution in 1782, a fifth clafs named *domicilius*, has been added, who annually receive permiffion from the magiftrates to refide in the city. The citizens and burgeffes alone, however, are admitted to a fhare in the government; thofe called *inhabitants* are ftrangers allowed to fettle in the town with certain privileges; and the *natives* are the fons of thofe inhabitants, who poffefs additional advantages. The people are very active and induftrious, carrying on an extenfive commerce.

1
State of learning in Geneva.

This city is remarkable for the number of learned men it has produced. The reformed doctrines of religion were very early received in it, being preached there in 1533 by William Farel and Peter Viret of Orbe, and afterwards finally eftablifhed by the celebrated John Calvin. Of this reformer Voltaire obferves, that he gave his name to the religious doctrines firft broached by others, in the fame manner that Americus Vefputius gave name to the continent of America, which had formerly been difcovered by Columbus. It was by the affiduity of this celebrated reformer, and the influence that he acquired among the citizens, that a public academy was firft eftablifhed in the city, where he, Theodore Beza, and fome of the more eminent firft reformers, read lectures with uncommon fuccefs. The intolerant fpirit of Calvin is well known; but little of it now appears in the government of Geneva: on the contrary, it is the moft tolerating of all the eftates in Switzerland, being the only one of them which permits the public exercife of the Lutheran religion. The advantages of the academy at Geneva are very confpicuous among the citizens at this day, even the lower clafs of them being exceedingly well informed; fo that, according to Mr Coxe, there is not a city in Europe where learning is fo generally diffufed. "I received great fatisfaction (fays he) in converfing even with feveral tradefmen upon topics both of literature and politics; and was aftonifhed to find in this clafs of men fo uncommon a fhare of knowledge; but the wonder ceafes when we are told that all of them were educated at the public academy." In this feminary the induftry and emulation of the ftudents are excited by the annual diftribution of prizes to thofe who diftinguifh themfelves in each clafs. The prizes confift of fmall medals, but are conferred with fuch folemnity as cannot fail to produce a ftriking effect on the minds of youth. There is alfo a public library to which the citizens have accefs, and which undoubtedly tends greatly to that univerfal diffufion of learning fo remarkable among the inhabitants. It was founded by Bonnivard, remarkable for his fufferings in the caufe of the liberties of his country. Having been a great antagonift of the dukes of Savoy, againft whom he afferted the independence of Geneva, he had the misfortune at laft to be taken prifoner, and was imprifoned for fix years in a dungeon below the level of the lake, in the caftle of Chillon, which ftands on a rock in the lake, and is connected with the land by a drawbridge. In 1536 this caftle was taken from Charles III. of Savoy by the canton of Berne, affifted by the Genevans, who furnifhed a frigate (their whole naval force) to befiege it by water. Bonnivard was now taken from his dungeon, where by conftant walking backward and forward, his only amufement, he had worn a hollow in the floor which confifted of folid rock. Bonnivard confidered the hardfhips he had endured as ties which endeared him to the city, and became a principal promoter of the reformation by the mild methods of perfuafion and inftruction. He clofed his benefactions by the gift of his books and manufcripts, and bequeathing his fortune towards the eftablifhment and fupport of the feminary. His works, which chiefly relate to the

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hiftory of Geneva, are ftill preferved with great care and reverence. The library contains 25,000 volumes, with many curious manufcripts, of which an account has been publifhed by the reverend M. Sennebier the librarian, who has likewife diftinguifhed himfelf by feveral literary works. Meffrs Bonnet, Sauffure, Mallet, and De Luc, are the other moft diftinguifhed literary geniufes of which Geneva can boaft. The laft is particularly remarkable for the perfection to which he has brought the barometer, and which is now fo great, that very little feems poffible to be done by any body elfe. His cabinet merits the attention of naturalifts, as containing many rare and curious fpecimens of foffils, which ferve to illuftrate the theory of the globe. It may be divided into three parts: 1. Such as enable the naturalift to compare the petrifactions of animals and vegetables with the fame bodies wich are ftill known to exift in our parts of the globe. 2. To compare thefe petrifactions of animals with the fame bodies which are known to exift in different countries. 3. To confider the petrifactions of thofe bodies which are no longer known to exift. The fecond part comprehends the ftones under three points of view: 1. Thofe of the primitive mountains, which contain no animal bodies; 2. Thofe of the fecondary mountains, which contain only marine bodies; 3. Thofe which contain terreftrial bodies. The third part contains the lavas and other volcanic productions; which are diftinguifhed into two claffes: 1. Thofe which come from volcanoes now actually burning; 2. Thofe from extinguifhed volcanoes.

2 Account of De Luc's cabinet.

3 Hiftory and government of Geneva.

In the time of Charles the Great, the city and territory of Geneva made part of his empire; and, under his fucceffors, it became fubject to the German emperors. By reafon of the imbecility of thefe princes, however, the bifhops of Geneva acquired fuch authority over the inhabitants, that the emperor had no other means of counterbalancing it than by augmenting the privileges of the people. In thefe barbarous ages alfo the bifhops and counts had conftant difputes, of which the people took the advantage; and by fiding fometimes with one, and fometimes with the other, they obtained an extenfion of their privileges from both. The houfe of Savoy at length purchafed the territory, and fucceeded the counts with additional power: againft them therefore the bifhops and people united in order to refift their encroachments; and, during this period, the government was ftrangely complicated, by reafon of the various pretenfions of the three parties. The counts of Savoy, however, had at laft the addrefs to diffolve the union between the bifhops and citizens, by procuring the epifcopal fee for their brothers, and even their illegitimate children; by which means their power became gradually fo extenfive, that towards the commencement of the 16th century, Charles III. of Savoy (though the government was accounted entirely republican) obtained an almoft abfolute authority over the people, and exercifed it in a moft unjuft and arbitrary manner. Thus violent commotions took place; and the citizens became divided into two parties, one of which, viz. the patriots, were ftyled *Eidgenoffen* or *confederates; the* partifans of Savoy being difgraced by the appellation of *Mamelucs* or *flaves*. The true period of Genevan liberty may therefore be confidered as commencing with the treaty concluded with Berne and Friburg in the year 1526; in confequence of which the duke was in a fhort time deprived of his authority, the bifhop driven from the city, and the reformed religion and a republican form of government introduced. A long war commenced with Savoy on this account; but the Genevans proved an overmatch for their enemies by their own bravery and the affiftance of the inhabitants of Berne. In 1584, the republic concluded a treaty with Zurich and Berne, by which it is allied to the Swifs cantons. The houfe of Savoy made their laft attempt againft Geneva in 1602, when the city was treacheroufly attacked in the night time during a profound peace. Two hundred foldiers had fcaled the walls, and got into the town before any alarm was given; but they were repulfed by the defperate valour of a few citizens, who perifhed in the encounter. A petard had been faftened to one of the gates by the Savoyards; but the gunner was killed before it could be difcharged. The war occafioned by this treachery was next year concluded by a folemn treaty, which has ever fince been obferved on both fides: though the independence of Geneva was not formally acknowledged by the king of Sardinia till the year 1754.

The reftoration of tranquillity from without in confequence of the above treaty, was however foon followed by the flames of internal difcord, fo common in popular governments; fo that during the whole of the laft century the hiftory of Geneva affords little more than an account of the ftruggles betwixt the ariftocratical and popular parties. About the beginning of the prefent century the power of the grand council was become almoft abfolute; but in order to reftrain its authority, an edict was procured in 1707 by the popular party, enacting, that every five years a general council of the citizens and burghers fhould be fummoned to deliberate upon the affairs of the republic. In confequence of this law a general affembly was convened in 1712; and the very firft act of that affembly was to abolifh the edict by which they had been convened. A proceeding fo extraordinary can fcarcely be accounted for on the principles of popular ficklenefs and inconftancy. Rouffeau, in his Mifcellaneous Works, afcribes it to the artifices of the magiftrates, and the equivocal terms marked upon the billets then in ufe. For the queftion being put, "Whether the opinion of the councils for abolifhing the periodical affemblies fhould pafs into a law?" the words *approbation* or *rejection*, put upon the billets by which the votes were given, might be interpreted either way. Thus, if the billet was chofen on which the word *approbation* was written, the opinion of the councils which rejected the affemblies was approved; and by the word *rejection*, the periodical affembly was rejected of courfe. Hence feveral of the citizens complained that they had been deceived, and that they never meant to reject the general affembly, but only the opinion of the councils.

In confequence of the abolition of the general affemblies, the power of the ariftocratical party was greatly augmented; till at length the inhabitants exerting themfelves with uncommon fpirit and perfeverance, found means to limit the power of the magiftrates, and enlarge their own rights. In 1776, as Mr Cox informs us, the government might be confidered as a mean betwixt

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twixt that of the ariſtocratical and popular cantons of Switzerland. The members of the ſenate, or little council of 25, enjoyed in their corporate capacity ſeveral very conſiderable prerogatives. By them half the members of the great council were named; the principal magiſtrates were ſupplied from their own body; they convoked the great and general councils, deliberating previouſly upon every queſtion which was to be brought before theſe councils. They were veſted alſo with the chief executive power, the adminiſtration of finances, and had in a certain degree the juriſdiction in civil and criminal cauſes. Moſt of the ſmaller poſts were likewiſe filled by them; and they enjoyed the ſole privilege of conferring the burgherſhip. Theſe, and other prerogatives, however, were balanced by thoſe of the great council and the privileges of the general council. The former had a right to chooſe the members of the ſenate from their own body; receiving appeals in all cauſes above a certain value, pardoning criminals, &c. beſides which they had the important privilege of approving or rejecting whatever was propoſed by the ſenate to be laid before the people.

4 Sketch of the government in 1776.

The general council or aſſembly of the people is compoſed of the citizens and burghers of the town; their number in general amounting to 1500, though uſually not more than 1200 were preſent; the remainder reſiding in foreign countries, or being otherwiſe abſent. It meets twice a-year, chooſes the principal magiſtrates, approves or rejects the laws and regulations propoſed by the other councils, impoſes taxes, contracts alliances, declares war or peace, and nominates half the members of the great council, &c. But the principal check to the power of the ſenate aroſe from the right of *re-election*, or the power of annually expelling four members from the ſenate at the nomination of the *ſyndics* or principal magiſtrates, and from the right of repreſentation. The ſyndics are four in number, choſen annually from the ſenate by the general council; and three years elapſe before the ſame members can be again appointed. In chooſing theſe magiſtrates, the ſenate appointed from its own body eight candidates, from whom the four ſyndics were to be choſen by the general council. The latter, however, had it in their power to reject not only the firſt eight candidates, but alſo the whole body of ſenators in ſucceſſion: in which caſe, four members of the ſenate retired into the great council: and their places were filled by an equal number from that council. With regard to the power of repreſentation, every citizen or burgher has the privilege of applying to the ſenate in order to procure a new regulation in this reſpect, or of remonſtrating againſt any act of the magiſtracy. To theſe remonſtrances the magiſtrates were obliged to give an explicit anſwer; for if a ſatisfactory anſwer was not given to one, a ſecond was immediately preſented. The repreſentation was made by a greater or ſmaller number of citizens according to the importance of the point in queſtion.

5 Account of the revolution in 1782.

Since the 1776, however, ſeveral changes have taken place. This right of *re-election*, which the ariſtocratical party were obliged to yield to the people in 1768, ſoon proved very diſagreeable, being conſidered by the former as a kind of oſtraciſm; for which reaſon they catched at every opportunity of procuring its abolition. They were now diſtinguiſhed by the title of *negatives*, while the popular party had that of *repreſentants*; and the point in diſpute was the compilation of a new code of laws. This meaſure the negatives oppoſed, as ſuppoſing that it would tend to reduce their prerogatives; while, on the other hand, the repreſentants uſed their utmoſt endeavours to promote it, in hopes of having their privileges augmented by this means. At laſt in the month of January 1777, the negatives were obliged to comply with the demands of their antagoniſts; and a committee for forming a new code of laws was appointed by the concurrence of the little, great, and general councils. The committee was to laſt for two years, and the code to be laid before the three councils for their joint approbation or rejection. A ſketch of the firſt part of the code was preſented to the little and great councils on the firſt of September 1779, that they might profit by their obſervations before it was preſented to the general council. Great diſputes aroſe; and at length it was carried by the negatives that the code ſhould be rejected and the committee diſſolved. The oppoſite party complained of this as unconſtitutional, and violent diſputes enſued; the iſſue of which was, that the great council offered to compile the code, and ſubmit it to the deciſion of the public. This did not give ſatisfaction to the popular party, who conſidered it as inſidious: the contentions revived with more fury than ever, until at length the negatives ſuppoſing, or pretending to ſuppoſe, that their country was in danger, applied to the guarantees, France, Zurich, and Berne, entreating them to protect the laws and conſtitution. This was productive of no good effect; ſo that the negatives found no other method of gaining their point than by ſowing diſſenſion among the different claſſes of inhabitants. The *natives* were diſcontented and jealous on account of many excluſive privileges enjoyed by that claſs named *citizens*: they were beſides exaſperated againſt them for having, in 1770, baniſhed eight of the principal natives, who pretended that the right of burgherſhip belonged to the natives as well as to the citizens, and demanded that this right ought to be gratuitouſly conferred inſtead of being purchaſed. The negatives, in hopes of making ſuch a conſiderable addition to their party, courted the natives by all the methods they could think of, promiſing by a public declaration that they were ready to confer upon them thoſe privileges of trade and commerce which had hitherto been confined excluſively to the citizens. The deſigns of the negatives were likewiſe openly favoured by the court of France, and deſpatches were even written to the French reſident at Geneva to be communicated to the principal natives who ſided with the ariſtocratic party. The attorney-general, conceiving this mode of interference to be highly unconſtitutional, preſented a ſpirited remonſtrance; by which the French court were ſo much diſpleaſed, that they procured his depoſition from his office; and thus their party was very conſiderably increaſed among the natives. The repreſentants were by no means negligent in their endeavours to conciliate the favour of the ſame party, and even promiſed what they had hitherto oppoſed in the ſtrongeſt manner, viz. to facilitate the acquiſition of the burgherſhip, and to beſtow it as the recompenſe of induſtry and good behaviour. Thus two parties were formed among the natives themſelves; and the diſſenſions becoming

Geneva.

Geneva. coming every day worſe and worſe, a general inſurrection took place on the 5th of February 1781. A diſpute, accompanied with violent reproaches, having commenced betwixt two neighbouring and oppoſite parties of natives, a battle would have immediately taken place, had it not been for the interpoſition of the ſyndics on the one ſide, and the chiefs of the repreſentants on the other. The tumult was beginning to ſubſide, when a diſcharge of muſquetry was heard from the arſenal. Some young men who ſided with the negatives, having taken poſſeſſion of the arſenal, had fired by miſtake upon ſeveral natives of their own party, and had killed one and wounded another. This was conſidered by the repreſentants as the ſignal for a general inſurrection, on which they inſtantly took up arms and marched in three columns to the arſenal; but finding there only a few young men who had raſhly fired without orders, they permitted the reſt to retire without moleſtation. In the opinion of ſome people, however, this affair was preconcerted, and the repreſentants are ſaid to have been the firſt aggreſſors.

The repreſentants having thus taken up arms, were in no haſte to lay them down. They took poſſeſſion of all the avenues to the city; and their committee being ſummoned next morning by the natives to fulfil their engagements with reſpect to the burgherſhip, they held ſeveral meetings with the principal negatives on that ſubject, but without any ſucceſs: for though the latter readily agreed to an augmentation of the commercial privileges of the natives, they abſolutely refuſed to facilitate the acquiſition of the burgherſhip. The committee, however, embarraſſed and alarmed at the number and threats of the natives, determined to abide by what they had promiſed; drew up an edict permitting the natives to carry on trade, and to hold the rank of officers in the military aſſociations; and conferred the burgherſhip on more than 100 perſons taken from the natives and inhabitants, and even from the peaſants of the territory. This was approved by the three councils; the negatives, dreading the power of their adverſaries, who had made themſelves maſters of the city, not daring to make their appearance.

Thus the popular party imagined that they had got a complete victory; but they ſoon found themſelves deceived. They were prevailed upon by the deputies from Zurich and Berne (who had been ſent to conciliate the differences) to lay down their arms; and this was no ſooner done, than the ſame deputies declared the edict in favour of the natives to be null and illegal. The ſenate declared themſelves of the ſame opinion; and maintained, that the aſſent of the councils had been obtained only through fear of the repreſentants who were under arms, and whom none at that time durſt oppoſe. The repreſentants, exaſperated by this proceeding, preſented another remonſtrance on the 18th of March 1782, ſummoning the magiſtrates once more to confirm the edict; but a month afterwards received the laconic anſwer, that "government was neither willing nor able to confirm it." The natives, now finding themſelves diſappointed in their favourite object at the very time they had ſuch ſtrong hopes of obtaining it, behaved at firſt like frantic people; and theſe tranſports having ſubſided, an univerſal tumult took place. The moſt moderate of the popular party endeavoured in vain to allay their fury, by diſperſing themſelves in different quarters of the city; and the citizens, finding themſelves at laſt obliged either to abandon the party of the natives or to join them openly, haſtily adopted the latter meaſure; after which, as none could now oppoſe them, the officers of the repreſentants took poſſeſſion of the town, and quelled the inſurrection. Various negotiations were carried on with the negatives in order to prevail upon them to ratify the edict, but without ſucceſs: on which a few of the magiſtrates were confined by the popular party along with the principal negatives; and as they juſtly expected the interference of France on account of what they had done, they reſolved to prolong the confinement of the priſoners, that they might anſwer the purpoſe of hoſtages for their own ſafety. In the mean time the body of citizens, deceived by the pretences of the popular party, acted as if their power was already eſtabliſhed and permanent. In conſequence of this, they depoſed ſeveral members of the great and little councils, appointing in their room an equal number of perſons who were favourable to the cauſe of the repreſentants. The great council thus new modelled, executed the edict for conferring the burgherſhip upon a number of the natives; and appointed a committee of ſafety, compoſed of eleven members, with very conſiderable authority. By this committee the public tranquillity was re-eſtabliſhed; after which, the fortifications were ordered to be repaired; and the people were buoyed up by the moſt dangerous notions of their own proweſs, and a confidence that France either durſt not attack them or did not incline to do ſo. In conſequence of this fatal error, they refuſed every offer of reconciliation which was made them from the other party; until at laſt troops were diſpatched againſt them by the king of Sardinia and the canton of Berne; and their reſpective generals, Meſſrs de la Marmora and Lentulus, were ordered to act in concert with the French commander, M. de Jaucourt, who had advanced to the frontiers with a conſiderable detachment. The Genevans, however, vainly puffed up by a confidence in their own abilities, continued to repair their fortifications with indefatigable labour; the peaſants repaired from all quarters to the city, offering to mount guard and work at the fortifications without any pay; women of all ranks crowded to the walls as to a place of amuſement, encouraging the men, and even aſſiſting them in their labour. The beſiegers, however, advanced in ſuch force, that every perſon of diſcernment foreſaw that all reſiſtance would be vain. The French general Jaucourt, on the 29th of June 1782, deſpatched a meſſage to the ſyndics; in which he inſiſted on the following humiliating conditions: 1. That no perſon ſhould appear on the ſtreets under pain of military puniſhment. 2. That a certain number of citizens, among whom were all the chiefs of the repreſentants, ſhould quit the place in 24 hours. 3. That all arms ſhould be delivered to the three generals. 4. That the depoſed magiſtrates ſhould be inſtantly re-eſtabliſhed: And, laſtly, That an anſwer ſhould be returned in two hours. By this meſſage the people were thrown into the utmoſt deſpair; and all without exception reſolved to periſh rather than to accept of terms ſo very diſgraceful. They inſtantly hurried to the ramparts with a view of putting their reſolution in

Geneva. in force; but in the mean time the syndics found means to obtain from the generals a delay of 24 hours. During this interval, not only men of all ages prepared for the approaching danger, but even women and children tore the pavement from the streets, carrying the stones up to the tops of the houses, with a view of rolling them down upon the enemy in case they should force their way into the town. About 80 women and girls, dressed in uniforms, offered to form themselves into a company for the defence of their country. The committee of safety accepted their services, and placed them in a barrack secured from the cannon of the besiegers. The negatives were greatly alarmed at this appearance of desperate resistance; and some of the most moderate among them endeavoured, but without success, to effect a reconciliation. At the hour in which it was expected that the attack would begin, the ramparts were filled with defenders; and though the most zealous of the popular party had calculated only on 3000, upwards of 5000 appeared in the public cause. The French general, however, justly alarmed for the prisoners, who were now in imminent danger, again prolonged the period proposed for the capitulation. By these repeated delays the ardour of the defendants began to abate. The women first began to figure to themselves the horrors of a town taken by assault, and given up to an enraged and licentious soldiery; many timid persons found means not only to disguise their own fears, but to inspire others with them under the pretence of prudence and caution: at last the committee of safety themselves, who had so strenuously declared for hostilities, entirely changed their mind. Being well apprized, however, that it would be dangerous for them to propose surrendering in the present temper of the people, they assembled the citizens in their respective circles, representing, that if the city should be attacked in the night, it would be no longer possible to convene them: for which reason they recommended to them that each circle should nominate several deputies with full authority to decide in their stead; adding, that they ought rather to appoint those persons who from their age and respectable character were capable of assisting their country by their advice, while others were defending it by their valour. Thus a new council, composed of about 100 citizens, was formed; in which the chiefs, by various manœuvres, first intimidating, and then endeavouring to persuade the members of the necessity of surrendering, at last found means to take the thoughts of the people entirely off the defence of the city, and engage them in a scheme of general emigration. A declaration was drawn up to be delivered to the syndics with the keys of the city, the chiefs summoned the principal officers from their posts, ordered the cannon of several batteries to be rendered unfit for service, and at last took care of themselves by quitting the town. The people were in the utmost despair; and left the town in such multitudes, that when the Sardinians entered it in the morning, they found it almost deserted.' This was followed by the restoration of the former magistrates, a complete subjection of the popular party, and the establishment of a military government.

6
New constitution established.

The changes which took place on this occasion were as follow: 1. An abolition of the right of re-election. 2. The abolition of that right by which the general council nominated half the vacancies in the great council. 3. The right of remonstrating was taken from the citizens at large, and vested in 36 adjuncts, who might be present in the great council the first Monday of every month. They enjoyed a right of representation, and in consequence of that had a deliberative voice; but on the whole were so insignificant, that they were nicknamed *Les Images*, or "The shadows." 4. The introduction of the grabeau, or annual confirmation of the members of the senate and of the great council, vested entirely in the latter. By this law part of the authority both of the senate and general council was transferred to the great council; and by subjecting the senate to this annual revision, its power was greatly lessened, and it was made in fact dependent upon the general councils. 5. The circles or clubs in which it was customary to convene the citizens, and all public assemblies whatever, were prohibited; and so rigorously was this carried into execution, that the society of arts was prohibited from meeting. 6. The militia were abolished; firing at marks, even with bows and arrows, was prohibited; and the town, instead of being guarded by the citizens, was now put under the care of 1000 foreign soldiers, whose colonel and major were both to be foreigners. These troops were to take an oath of fidelity to the republic, and of obedience to the great council and the committee of war: but were under the immediate command and inspection of the latter, and subject to the superior controul of the former. 7. No person was permitted to bear arms, whether citizen, native, or inhabitant. 8. Several taxes were imposed without the consent of the general council; but in time to come it was provided, that every change or augmentation of the revenue should be submitted to that body. 9. Several privileges with regard to trade and commerce, formerly possessed by the citizens alone, were now granted both to citizens and inhabitants.

It is not to be supposed that this revolution would be agreeable to people who had such a strong sense of liberty, and had been accustomed to put such a value upon it, as the Genevans. From what has been already related, it might seem reasonable to conclude, that an almost universal emigration would have taken place: but after their resentment had time to subside, most of those who fled at first, thought proper to return; and, in the opinion of Mr Coxe, not more than 600 finally left their country on account of the revolution in 1782. The emigrants principally settled at Brussels and Constance, where they introduced the arts of printing linens and watchmaking. Soon after the revolution, indeed, a memorial, signed by above 1000 persons of both sexes, all of them either possessed of some property or versed in trade or manufactures, was presented to the earl of Temple, then lord lieutenant of Ireland, expressing a desire to settle in that kingdom. 7

Scheme of settling a number of Genevans in Ireland.

The proposal met with general approbation; the Irish parliament voted 50,000l. towards defraying the expences of their journey, and affording them a proper settlement in the island. Lands were purchased for 8000l. in a convenient situation near Waterford; part of New Geneva was actually completed at the expence of 10,000l.; a charter was granted with very considerable privileges; the standard of gold was altered

Geneva. ed for the accommodation of the watch manufactures; and the foundation of an academy laid upon an useful and liberal plan. Seven Genevans landed in Ireland in the month of July 1783: but when the nation had expended near 30,000l. on the scheme, it was suddenly abandoned. This seems principally to have been owing to the delays necessarily occasioned in the execution of such a complicated plan; and in some degree also by the high demands of the Genevan commissioners, who required many privileges inconsistent with the laws of Ireland. By these delays the Genevans, whose character seems not to be *perseverance*, were induced to abandon the scheme, and return to their former place of residence. Even the few who had already landed, though maintained at the public expence, were discontented at not finding the new town prepared for their reception; and as those among the proposed emigrants who possessed the greatest share of property had already withdrawn their names, the remainder did not choose to remain in a country where they had not capital sufficient to carry on any considerable trade or manufacture. A petition was then presented by the Genevan commissioners, requesting that 10,000l. of the 50,000l. voted might be appropriated to the forming a capital: but as this had been voted for other purposes, the petition was of course rejected; in consequence of which, the Genevans relinquished the settlement by an address, and soon after quitted the island.

3 New revolution in 1789.

The people of Old Geneva, though returned to their former place of abode, were far from being inclined to submit to the yoke with patience. They were obliged to pay heavy taxes for maintaining a military force expressly calculated to keep themselves in subjection: and so intolerable did this appear, that in a few years every thing seemed ready for another revolution. The success of this seemed more probable than that of the former, as France was not now in a condition to interfere as formerly. The general ferment soon rose to such a height, that government was obliged to call in the aid of the military to quell a tumult which happened in the theatre. This produced only a temporary tranquillity; another tumult took place on the 26th of January 1789, on account of the publication of an edict raising the price of bread a farthing per pound. On this the people instantly rose, plundered the bakers shops: and next day a carriage loaded with bread and escorted by soldiers was plundered in its way to the distribution office. The soldiers fired on the populace, by which one man was killed and another wounded: but the tumult still increasing, the soldiers were driven away; and the body of the deceased was carried in a kind of procession before the town house, as a monument of the violence and oppression of the aristocratic party. The magistrates in the mean time spent their time in deliberation, instead of taking any effectual method of quelling the insurrection. The people made the best use of the time afforded them by this delay of the magistrates; they attacked and carried two of the gates, dangerously wounding the commanding officer as he attempted to allay the fury of both parties. At last the magistrates despatched against them a considerable body of troops, whom they thought the insurgents would not have the courage to resist; but in this they found themselves deceived. The people had formed a strong barricade, behind which they played off two fire pumps filled with boiling water and soap lyes against the extremities of two bridges which the military had to cross before they could attack them. The commanding officer was killed and several of his men wounded by the discharge of small arms from windows; and the pavement was carried up to the tops of houses in order to be thrown down upon the troops if they should force the barricades and penetrate into the streets. The tumult in the mean time continued to increase, and was in danger of becoming universal; when the magistrates, finding it would be impossible to quell the insurgents without a great effusion of blood, were reduced to the necessity of complying with their demands. One of the principal magistrates repaired in person to the quarter of St Gervais, proclaimed an edict for lowering the price of bread, granted a general amnesty, and released all the insurgents who had been taken into custody. Thus a momentary calm was produced; but the leaders of the insurrection, sensible that the magistrates were either unable or unwilling to employ a sufficient force against them, resolved to take advantage of the present opportunity to procure a new change of government. A new insurrection, therefore, took place on the 29th of the month, in which the soldiers were driven from their posts, disarmed, and the gates seized by the people. The magistrates then, convinced that all opposition was fruitless, determined to comply with the demands of their antagonists in their full extent; and the aristocratical party suddenly changing their sentiments, renounced in a moment that system to which they had hitherto so obstinately adhered. On the application of the solicitor general, therefore, for the recovery of the ancient liberties of the people, the permission of bearing arms, re-establishment of the militia, and of their circles or political clubs, the removal of the garrison from the barracks, and the recal of the representants who were banished in 1782; these moderate demands were received with complacency, and even satisfaction. The preliminaries were settled without difficulty, and a new edict of pacification was published under the title of *Modifications à l'Edition de* 1782, and approved by the senate, great council, and general council. So great was the unanimity on this occasion, that the modifications were received by a majority of 1321 against 52. The pacification was instantly followed by marks of friendship betwixt the two parties which had never been experienced before; the sons of the principal negatives frequented the circles of the burghers; the magistrates obtained the confidence of the people; and no monument of the military force so odious to the people will be allowed to remain. "The barracks of the town house (says Mr Coxe) are already evacuated, and will be converted into a public library; the new barracks, built at an enormous expence, and more calculated for the garrison of a powerful and despotic kingdom than for a small and free commonwealth, will be converted into a building for the university. The reformation of the studies, which have scarcely received any alteration since the time of Calvin, is now in agitation. In a word, all things seem at present to conspire for the general good; and it is to be hoped that both parties, shocked at the recollection of past troubles, will continue on as friendly terms, Geneva. terms as the jealous nature of a free conſtitution will admit."

Geneva, as well as the whole of Switzerland fell a victim to French rapacity in 1802. The following obſervations, made by a traveller on the ſpot, afford us ſome information of the conſequences of this event to Geneva, of its degraded ſtate, and of the manners of the inhabitants.

"The population of Geneva is about 24,000: moreover it contains at preſent between 1200 and 1400 French troops: the parties intermix but little, and have had no diſputes, although they certainly regard each other with an eye of jealouſy. The Genevans do the French ſoldiers the juſtice to ſay, that they have demeaned themſelves in a very becoming manner during their reſidence here: they acknowledge themſelves to be a conquered people, and dare not open their mouths, except to an Engliſhman, againſt the treacherous invaders of their country, and deſtroyers of their liberties.

"You are too well verſed in the hiſtory of this people to require being told, that, notwithſtanding their preſent humiliated condition, Freedom is the goddeſs they worſhip; and that, had there been any poſſibility of ſecuring her from violation, they would gladly have bled before her altars. However various has been their ſucceſs, in the different revolutions which have agitated this ſecluded ſtate, the Genevans have uniformly evinced a courage which awed their enemies, and a determined bravery in defence of their rights, which in ſhewing that they prized them highly, gave proof that they were worthy to enjoy them.

"The territory of Geneva is comprehended in the *Department du Leman*, which department contains about 16 ſquare leagues of land; its population is eſtimated at 609,000 perſons. It is divided into three cantons or hundreds, the largeſt of which has Geneva for its capital, and contains about 75,000 ſouls, of which 10,000 only are Genevans, 20,000 are French, and the remainder are Savoyards. The prefet, as in all the other departments, is appointed by the Firſt Conſul, *durante beneplacito.* The care of the high roads and public walks, public finances, executive juſtice, military affairs, and paſſports, are under his immediate direction. All military appointments are given to Frenchmen: one general commands the town, and another the country. At the firſt moment of the revolution all the old magiſtrates were diſplaced, and ſince that time the civil officers have been elected by the citizens at large, conſequently ſome are Frenchmen, and ſome Genevans: the preſent mayor is one of the latter: he is a gentleman of great reſpectability, and is much eſteemed by both parties. Whenever a new code of laws ſhall be eſtabliſhed in France, its operations will be extended over the territory of Geneva; but at preſent the people here retain their old laws with ſome trifling alterations only, rather the form than the ſubſtance: thus, the guillotine is now ſubſtituted for the gallows, and the puniſhments in general, without varying the degree, are inflicted according to the French manner.

"In their treaty with France, the Genevans ſtipulated, that their hoſpital ſhould not be obliged to receive French ſoldiers: this hoſpital was founded in the early part of the laſt century, by ſome of the richeſt citizens, and is ſo well ſupported by legacies, and by annual ſubſcriptions, that the fund enables the directors to expend Geneva. two thouſand louis a year. In contempt of his treaty, Bonaparte has inſiſted on the admiſſion of French ſoldiers, for whoſe accommodation, however, he promiſed to pay a certain ſum *per diem*: in contempt of his promiſe, again, he has withheld the payment! An hoſpital, however, is now preparing at Carouge, a village in Savoy, between Geneva and Grange Colonge, for Frenchmen, to which, it is expected, the ſoldiers will be removed in May or June. Here is alſo a general hoſpital, once the nunnery of St Clair; it was founded, together with many other uſeful inſtitutions, by that celebrated reformer, John Calvin, who fled from the perſecution of Francis I. and found an aſylum in Geneva. The revenue ariſing from the eſtates of this hoſpital has, till within theſe laſt few years, been commenſurate with its expences; but, for ſome time back, it has been found neceſſary to collect almoſt an additional fourth, in order to ſupply its diſburſements: twice in the year the treaſurer goes round to every houſe, and ſolicits the charitable contribution of its inmates.

"Prior to the laſt revolution, I learn, that 600,000 French livres, diſcharged all the public expences: with this very trifling ſum were paid the ſalaries of the magiſtrates, of the maſter of the town, of the maſter of the country, the expences of the academy, of repairing the roads, of cleaning and lighting the town; in ſhort, theſe 600,000 livres were ſufficient to defray all the ordinary expences of the government. Since that too-memorable event, the citizens of Geneva have been aſſeſſed to the amount of 1,500,000 livres, the ſalaries of the inferior magiſtrates are in arrears, the roads are not kept in good repair, the town is very dimly lighted, and the ſtreets, a few of the principal ones excepted, are left with all their dirty honours thick upon them! The inhabitants go ſo far as to aſſert, that, in conſequence of the neglect which the public drains have ſuffered, they have been affected with fevers and other illneſſes to which they had hitherto been ſtrangers.

"I underſtand, that the revenue of Geneva, ſince it has been annexed to the republic of France, ariſes chiefly from the following ſources.—An exciſe duty is laid on all proviſions (wheat excepted), on wine and merchandiſe of every deſcription, which is brought into Geneva: the annual produce of this tax is about 120,000 French livres; a land tax; a tax on doors and windows; a tax on the ſale of eſtates; a heavy tax on the collateral inheritance of an eſtate—where the inheritance is lineal and immediate, the tax is moderate. To theſe taxes or contributions, as they are called, muſt be added *la contribution mobilière*, which is a ſmall tax on perſonal property, and produces annually about 75,000 livres. The collectors of theſe taxes are appointed by the Firſt Conſul, and are paid very highly for their trouble: the prefet, and all the principal public officers, are very regularly paid, but thoſe in a ſubordinate ſituation ſeldom get above one-third of their ſtipends.

"Divorces ſeem to be obtained here with too much facility. But, in the firſt place, as to marriages, they muſt be celebrated, according to the French law, before the municipality, at the maiſon de ville. Marriage in France, you know, is merely a civil ceremony, the parties being obliged to ſwear before an appointed magiſtrate, that they are of age, and that they have conſented

consented to become man and wife. The Genevans, however, do not consider this ceremony as sufficient: but, as our Gretna Green couples, on their return to Britain, think it necessary, after the fervour of passion is abated, and the mercury is fallen, in the animal thermometer, something lower than *blood heat*, to have the holy rites performed with the solemnity prescribed by law; so the Genevans, in addition to the civil ceremony prescribed by the laws of the republic of France, voluntarily conform to the religious ordinance of their own church. That a man should be able to obtain a divorce from the wife who is unfaithful to his bed, is highly reasonable: but here, if a woman leaves her husband, and refuses to return to his habitation, after being summoned by him for that purpose, he can repudiate her for disobedience. This doubtless was grounded on the presumption, that, if a woman fled from her husband, and resisted his solicitation to return, it could only be for the purpose of cohabiting with some other man: but an advantage is taken of this presumption; and now, when the parties, for whatever reasons, are desirous of being divorced, the wife, with the knowledge and consent of her husband, generally goes into Switzerland, where she remains six months, during which time the husband summons her to return, she refuses, and at the end of that term a divorce is declared between them."*

* *Month. Mag.* 1802.

Geneva *Lake*. This lake is in the shape of a crescent; along the concave side of which Mr Coxe travelled 54 miles. Switzerland forms the hollow, and Savoy the convex part; the greatest breadth being about 12 miles. The country on the side of Savoy is full of high and craggy mountains; but from Geneva to the environs of Lausanne it slopes to the margin of the lake, and is very rich and fertile. The banks rise considerably in the neighbourhood of Lausanne, and form a most beautiful terrace, with a rapid descent a few miles beyond the town. A plain begins in the neighbourhood of Vevay, which continues for a great way beyond the end of the lake, but contracting towards the water by the approach of the mountains. The lake itself appears at a distance of a beautiful blue colour, and the water is very clear and transparent. Near Geneva the coast of the lake abounds with pebbles; between that city and Lausanne it is sandy; from thence to Chilon it is bounded by hard calcareous rocks; and the extremity of the shore is a marsh formed by mud collected from the river Rhone. The greatest depth of this lake found by M. de Luc is 160 fathoms. Here the birds called *tippet grebes* make their appearance in December, and retire in February to other places where they breed. They make floating nests of reeds; but as the lake of Geneva affords none of these, they are obliged to migrate to other places where they grow. Their skins are much esteemed, and sell for 12s. or 14s. each. The lake of Geneva, like all others situated between mountains, is subject to sudden storms.

Geneva, or *Gin*, among distillers, an ordinary malt spirit, distilled a second time, with the addition of some juniper berries.

Originally, the berries were added to the malt in the grinding; so that the spirit thus obtained was flavoured with the berries from the first, and exceeded all that could be made by any other method. At present, they leave out the berries entirely, and give their spirits a flavour by distilling them with a proper quantity of oil of turpentine; which, though it nearly resembles the flavour of juniper berries, has none of their valuable virtues.

GENEVIEVE, fathers or religious of; the name of a congregation of regular canons of the order of St Augustine, established in France.

The congregation of St Genevieve is a reform of the Augustine canons. It was begun by St Charles Faure, in the abbey of St Vincent de Senlis, of which he was a member, in the year 1618.

In the year 1634, the abbey was made elective; and a general chapter, composed of the superiors of 15 houses who had now received the reform, chose F. Faure coadjutor of the abbey of St Genevieve, and general of the whole congregation. Such were its beginnings.

It has since increased very much, and it now consists of above a hundred monasteries; in some whereof the religious are employed in the administration of the parishes and hospitals: and in others, in the celebration of divine service, and the instruction of ecclesiastics in seminaries for the purpose.

The congregation takes its name from the abbey of St Genevieve, which is the chief of the order, and whose abbot is the general thereof. The abbey itself took its name from St Genevieve, the patroness of the city of Paris, who died in the year 512. Five years after her death, Clovis erected the church of St Genevieve, under the name and invocation of St Peter, where her relicks are still, or were till lately preserved, her shrine visited, and her image carried with great processions and ceremonies upon extraordinary occasions, as when some great favour is to be entreated of heaven.

GENGIS KHAN, the renowned sovereign of the Moguls, a barbarous and bloody conqueror. See Jenghiz Khan, and (*History* of the) Moguls.

GENIAL, an epithet given by the Pagans to certain gods who were supposed to preside over generation.

The genial gods, says Festus, were earth, air, fire, and water. The twelve signs, together with the sun and moon, were sometimes also ranked in the number.

GENII, a sort of intermediate beings, by the Mahometans believed to exist between men and angels. They are of a grosser fabric than the latter, but much more active and powerful than the former. Some of them are good, others bad, and they are capable of future salvation or damnation like men. The orientals pretend that these genii inhabited the world many thousand years before the creation of Adam, under the reigns of several princes, who all bore the common name of Solomon; that falling at length into an almost general corruption, Eblis was sent to drive them into a remote part of the earth, there to be confined; and that some of that generation still remaining were by Tahmurath, one of the ancient kings of Persia, forced to retreat into the famous mountain of *Kaf*; of whose successions and wars they have many fabulous and romantic stories. They also made several ranks and degrees among this kind of beings (if they are not rather different

different species); some being absolutely called *Jin*; some *Peri*, or fairies; some *Div*, or giants; and others *Tacwins*, or fates.

GENIOGLOSSI, in *Anatomy*. See ANATOMY, *Table of the Muscles*.

GENIOHYOIDÆUS, in *Anatomy*. *Ibid*.

GENIOSTOMA, a genus of plants, belonging to the pentandria class. See BOTANY *Index*.

GENIPPA, a genus of plants, belonging to the pentandria class, and in the natural method ranking under the 30th order, *Contortæ*. See BOTANY *Index*.

GENISTA, BROOM, or DYERS WEED, a genus of plants, belonging to the diadelphia class; and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

GENITAL, an appellation given to whatever belongs to the parts of generation. See ANATOMY, N° 107, 108.

GENITES, among the Hebrews, those descended from Abraham, without any mixture of foreign blood.

The Greeks distinguished by the name of *genites* such of the Jews as were issued from parents, who, during the Babylonish captivity, had not allied with any gentile family.

GENITIVE, in *Grammar*, the second case of the declension of nouns. The relation of one thing considered as belonging in some manner to another, has occasioned a peculiar termination of nouns called the *genitive case*; but in the vulgar tongues they make use of a sign to express the relation of this case. In English they prefix the particle *of*, in French *de* or *du*, &c. Though in strictness there are no cases in either of these languages; inasmuch as they do not express the different relations of things by different terminations, but by additional prepositions, which is otherwise in the Latin.

GENIUS, a good or evil spirit or dæmon, whom the ancients supposed set over each person, to direct his birth, accompany him in life, and to be his guard. See DÆMON.

Among the Romans, Festus observes, the name *genius* was given to the god who had the power of doing all things, *deum qui vim obtineret rerum omnium gerendarum;* which Vossius, *de Idol.* rather chooses to read *genendarum*, who has the power of producing all things; by reason Censorinus frequently uses *gerere* for *gignere*.

Accordingly St Augustin, *de Civitate Dei*, relates, from Varro, that the genius was a god who had the power of generating all things; and presided over them when produced.

Festus adds, that Aufustius spake of the genius as the Son of God, and the Father of men, who gave them life; others, however, represented the genius as the peculiar or tutelary god of each place; and it is certain, the last is the most usual meaning of the word. The ancients had their *genii* of nations, of cities, of provinces, &c. Nothing is more common than the following inscription on medals, GENIUS POPULI ROM. "the genius of the Roman people;" or GENIO POP. ROM. "to the genius of the Roman people. In this sense *genius* and *lar* were the same thing; as, in effect, Censorinus and Apulius affirm they were. See LARES and PENATES.

The Platonists, and other eastern philosophers, supposed the *genii* to inhabit the vast region or extent of air between earth and heaven. They were a sort of intermediate powers, who did the office of mediators between gods and men. They were the interpreters and agents of the gods; communicated the wills of the deities to men; and the prayers and vows of men to the gods. As it was unbecoming the majesty of the gods to enter into such trifling concerns, this became the lot of the *genii*, whose nature was a mean between the two; who derived immortality from the one, and passions from the other; and who had a body framed of an aerial matter. Most of the philosophers, however, held, that the genii of particular men were born with them, and died; and Plutarch attributes the ceasing of oracles partly to the death of the genii.—See ORACLE.

The heathens, who considered the genii as the guardians of particular persons, believed that they rejoiced and were afflicted at all the good and ill fortune that befel their wards. They never, or very rarely, appeared to them; and then only in favour of some person of extraordinary virtue or dignity. They likewise held a great difference between the genii of different men; and that some were much more powerful than others: on which principle it was, that a wizzard in *Appian* bids Antony keep at a distance from Octavius, by reason Antony's genius was inferior to and stood in awe of that of Octavius. There were also evil genii, who took a pleasure in persecuting men, and bringing them evil tidings: such was that mentioned by Plutarch which appeared to Brutus the night before the battle of Philippi. These were also called *larvæ* and *lemures*. See LARVÆ and LEMURES.

GENIUS, in matters of literature, &c. a natural talent or disposition to do one thing more than another; or the aptitude a man has received from nature to perform well and easily that which others can do but indifferently and with a great deal of pains.

To know the bent of nature is the most important concern. Men come into the world with a genius determined not only to a certain art, but to certain parts of that art, in which alone they are capable of success. If they quit their sphere, they fall even below mediocrity in their profession. Art and industry add much to natural endowments, but cannot supply them where they are wanting. Every thing depends on genius. A painter often pleases without observing rules; whilst another displeases though he observes them, because he has not the happiness of being born with a genius for painting.

A man born with a genius for commanding an army, and capable of becoming a great general by the help of experience, is one whose organical conformation is such, that his valour is no obstruction to his presence of mind, and his presence of mind makes no abatement of his valour. Such a disposition of mind cannot be acquired by art: it can be possessed only by a person who has brought it with him into the world. What has been said of these two arts may be equally applied to all other professions. The administration of great concerns, the art of putting people to those employments for which they are naturally formed, the study of physic, and even gaming itself, all require a genius. Nature has thought fit to make a distribution of her talents

Genius, Genoa.

talents among men, in order to render them neceſſary to one another; the wants of men being the very firſt link of ſociety: ſhe has therefore pitched upon particular perſons, to give them aptitude to perform rightly ſome things which ſhe has rendered impoſſible to others; and the latter have a greater facility granted them for other things, which facility has been refuſed to the former. Nature indeed has made an unequal diſtribution of her bleſſings among her children; yet ſhe has diſinherited none; and a man diveſted of all kinds of abilities, is as great a phenomenon as an univerſal genius.

From the diverſity of genius the difference of inclination ariſes in men, whom nature has had the precaution of leading to the employments for which ſhe deſigns them, with more or leſs impetuoſity in proportion to the greater or leſſer number of obſtacles they have to ſurmount in order to render themſelves capable of anſwering this vocation. Thus the inclinations of men are ſo very different, becauſe they follow the ſame mover, that is, the impulſe of their genius. This, as with the painter, is what renders one poet pleaſing, even when he treſpaſſes againſt rules; while others are diſagreeable, notwithſtanding their ſtrict regularity.

The genius of theſe arts, according to the abbé du Bos, conſiſts in a happy arrangement of the organs of the brain; in a juſt conformation of each of theſe organs; as alſo in the quality of the blood, which diſpoſes it to ferment, during exerciſe, ſo as to furniſh plenty of ſpirits to the ſprings employed in the functions of the imagination. Here he ſuppoſes that the compoſer's blood is heated; for that painters and poets cannot invent in cool blood; nay, that it is evident they muſt be rapt into a kind of enthuſiaſm when they produce their ideas. Ariſtotle mentions a poet who never wrote ſo well as when his poetic fury hurried him into a kind of frenzy. The admirable pictures we have in Taſſo of Armida and Clorinda were drawn at the expence of a diſpoſition he had to real madneſs, into which he fell before he died. "Do you imagine (ſays Cicero), that Pacuvius wrote in cold blood? No, it was impoſſible. He muſt have been inſpired with a kind of fury, to be able to write ſuch admirable verſes."

GENOA, a city of Italy, and formerly capital of a republic of the ſame name, ſituated in E. Long. 9. 30. N. Lat. 44. 30.—By the Latin authors it is very frequently, though corruptly called *Janua;* and its preſent territories made part of the ancient Liguria. The era of its foundation is not known. In the time of the ſecond Punic war it was a celebrated emporium; and having declared for the Romans, was plundered and burnt by Mago the Carthaginian. It was afterwards rebuilt by the Romans; and with the reſt of Italy continued under their dominion till the decline of the weſtern empire in 476. Soon after, it fell under the power of Theodoric the Oſtrogoth; who having defeated the uſurper Odoacer, became king of Italy. This happened in the year 498; and in a ſhort time, the Goths being almoſt entirely ſubdued by Beliſarius the emperor Juſtinian's general, Genoa was reannexed to the Roman empire. In 638, it was plundered and burnt by the Lombards, whoſe king Protharis erected it into a provincial dukedom.

Genoa.

The Lombards continued maſters of Genoa till the year 774, when they were conquered by Charles the Great, ſon to Pepin king of France. He reduced Liguria to the ancient bounds ſettled by Auguſtus, and erected it into a marquiſate: appointing his relation *Audemarus* the firſt count or margrave. Genoa at this time being diſtinguiſhed for its wealth and populouſneſs, began to give its name to the whole coaſt; and continued under the dominion of theſe counts for about 100 years, till the race of the Pepins became entirely extinct in Italy, and the empire was transferred to the German princes.—In the year 935 or 936, while the Genoeſe forces were abſent on ſome expedition, the Saracens ſurpriſed the city, which they plundered and burnt, putting to death a great number of the inhabitants, and carrying others into captivity. Having embarked their captives, together with an immenſe booty, they ſet ſail for Africa; but the Genoeſe immediately returning, purſued the invaders; and having entirely defeated them, recovered all the captives and booty, and took a great many of the enemy's ſhips.

About the year 950, the Franks having loſt all authority in Italy, the Genoeſe began to form themſelves into a republic, and to be governed by their own magiſtrates, who were freely elected, and took the name of *Conſuls.* In order to ſupport their independence, they applied themſelves with great aſſiduity to commerce and navigation; and being apprehenſive that ſome of the German emperors, who frequently entered Italy as invaders, might renew their pretenſions to their ſtate, they conſented to acknowledge Berengarius III. duke of Friuli, who had been elected emperor by a party of Italian nobles. Berengarius, who had much ado to maintain himſelf in his new dignity, endeavoured by his conceſſions to enlarge the number of his friends and adherents; and accordingly made no difficulty to confirm the new republic in all its rights and privileges. After this the Genoeſe began to extend their commerce from Spain to Syria, and from Egypt to Conſtantinople; their veſſels, according to the cuſtom of theſe times, being fitted for fighting as well as merchandiſe. Having thus acquired great reputation, they were invited in 1017, by the Piſans, who had likewiſe formed themſelves into a republic, to join with them in an expedition againſt Sardinia, which had been conquered by the Moors. In this expedition they were ſucceſsful; the iſland was reduced; but from this time an enmity commenced between the two republics, which did not end but with the ruin of the Piſans.

The firſt war with Piſa commenced about 30 years after the Sardinian expedition, and laſted 18 years; when the two contending parties having concluded a treaty of peace, jointly ſent their forces againſt the Moors in Africa, of whom they are ſaid to have killed 100,000. The Genoeſe were very active in the time of the cruſades, and had a principal ſhare in the taking of Jeruſalem. They alſo waged conſiderable wars with the Moors in Spain, of whom they generally got the better. They alſo prevailed againſt the neighbouring ſtates; and, in 1220, had enlarged their territories beyond the ſkirts of the Apennines, ſo that the reſt of Italy looked upon them with a jealous eye: but in 1311 the factions which had for a long time reigned in the city, notwithſtanding all its wealth and power, induced

Genoa. induced the inhabitants to ſubmit themſelves for 20 years to the dominion of Henry VII. emperor of Germany. That emperor, however, died in Auguſt 1312; and the vicar he had left ſoon after went to Piſa, upon which the diſſenſions in Genoa revived with greater fury than ever. In 1317, a quarrel happened between the families of Spinola and Doria; which came to ſuch a height, that both parties fought in the ſtreets for 24 days without intermiſſion, raiſed battering engines againſt each other's houſes, and filled the city with blood. At laſt the Spinolæ quitted the city, and retired to their territories in the Apennine mountains. The civil war continued till the year 1331; when, by the mediation of the king of Naples, it was concluded, that all exiles ſhould return to the city; that the republic ſhould be governed by the king's vicar; and all the offices of the ſtate be equally divided between the Guelfs and the Gibellines, the two contending parties.

By this ruinous war, the coaſt of Genoa, formerly adorned with palaces and vineyards, was now reduced to the appearance of a barren waſte. So great was the general deſolation, that, according to Petrarch, the ſpectators who ſailed along were ſtruck with aſtoniſhment and horror. Villani, a cotemporary author, relates, that it was ſuppoſed by the learned, that greater exploits had not been performed at the ſiege of Troy; and that the loſſes each party had ſuſtained would have been ſufficient to have purchaſed a kingdom, the Genoeſe republic being in his time the richeſt and moſt powerful ſtate in Chriſtendom. The annaliſt Stella informs us, that, before the war, the moſt extravagant profuſion and luxury prevailed among the Genoeſe: but that, towards the end, many noble families were reduced to indigence and poverty; ſo that, about 100 years after, it became faſhionable for the nobles to live in a plain manner, without any ſhow or magnificence.

In 1336, both parties, ſuſpending their mutual animoſities, ſent two fleets of 20 galleys each into the German ocean, to the aſſiſtance of the king of France, who was engaged in a war with Edward III. king of England. This naval expedition proved the cauſe of a moſt remarkable revolution in the Genoeſe government. The ſailors of the fleet, thinking themſelves injured by their officers, whom they accuſed of defrauding them of their pay, proceeded to an open mutiny; and, having expelled the admiral, and other commanders, ſeized the galleys. The king of France being choſen arbitrator, decided in favour of the officers, and impriſoned 16 of the chiefs of the mutineers. Upon this ſeveral of the ſailors left the fleet, and returned to Genoa; where they went round the coaſts, repeating their mutinous complaints, which were greatly hearkened to, upon a falſe report that the mutineers who had been impriſoned were broke upon the wheel. The factious ſpirit increaſed; and at laſt the Genoeſe inſiſted in a tumultuous manner for having an abbot of their own chooſing, and 20 of the people with the conſent of the captains of the republic aſſembled for that purpoſe. While the mob were impatiently expecting their deciſion, a mechanic, generally accounted a fool, mounted a wooden bench, and called out that one Simon Bucanigree ſhould be choſen abbot. This being inſtantly echoed by the populace, he was firſt declared *abbot*, then *lord*, and at laſt *duke* of Genoa.

This new expedient did not at all anſwer the purpoſe. The diſſenſions continued as violent as ever, notwithſtanding the power of the new magiſtrates; and by theſe perpetual diviſions the republic was at laſt ſo much weakened, that in 1390 the king of France was declared lord of Genoa. Under the French government, however, they ſoon became exceedingly impatient; and, in 1422, the duke of Milan obtained the ſovereignty. With this ſituation they were equally diſpleaſed, and therefore revolted in 1436. Twenty-two years after, finding themſelves preſſed by a powerful fleet and army ſent by Alphonſo king of Naples, they again conferred the ſovereignty of their ſtate upon the king of France. In 1460, they revolted from the French; and, four years after, put themſelves again under the protection of the duke of Milan: from whom they revolted in 1478. He was again declared ſovereign of the republic in 1488; and, 11 years after, the city and territories of Genoa were conquered by Louis XII. of France.

The almoſt unparalleled fickleneſs of the Genoeſe diſpoſition was not to be corrected by this misfortune. They revolted in 1506; but next year were again ſubdued by Louis. Six years after, they again revolted; and in 1516, the city was taken and plundered by the Spaniards. In 1528, Andrew Doria, a Genoeſe admiral in the ſervice of the French, undertook to reſcue his country from the dominion of foreign princes, and reſtore it to its liberty. Knowing well the fickle diſpoſition of his countrymen, he took all occaſions of exciting diſcontents among them againſt the government. He perſuaded them, that the French (who had again obtained the ſovereignty) had left them only a ſhadow of liberty, while they pretended to protect them from their enemies. To the nobility he repreſented the diſgrace of ſuffering the government to be veſted in the hands of foreigners leſs worthy of authority than themſelves. Thus he ſoon formed a ſtrong faction, and formed his plan; for the execution of which he took the moſt proper time, namely, when almoſt three-fourths of the French garriſon had been carried off by the plague. He advanced with 500 men; and his friends having opened the gates of the city to him, he ſeized the principal poſts, and thus became maſter of it without drawing his ſword. The garriſon retired to the forts, where they ſoon after capitulated, and being driven out of the city, Doria reeſtabliſhed the ancient form of government. See DORIA.

The republic hath ſince continued to preſerve her liberty, though greatly fallen from her ancient ſplendour, and now become a very inconſiderable ſtate. In 1684, the Genoeſe had the misfortune to fall under the reſentment of Louis XIV. at which time the city was almoſt deſtroyed by a formidable bombardment. In the year 1688, it was bombarded by Admiral Byng, and forced to capitulate; but there were at that time no views of making a permanent conqueſt of the city. In 1730, the iſland of Corſica revolted from the Genoeſe, and could never afterwards be reduced by them; for which reaſon it was ſold to the French, who in the year 1770 totally reduced it.

The

Genoa.

The Genoese territories extend along that part of the Mediterranean sea, commonly called the *gulf of Genoa*, about 152 miles; but their breadth is very unequal, being from eight to about 20 miles. Where they are not bounded by the sea, the following states and countries, taking them from west to east, are their boundaries, viz. Piedmont, Montferrat, Milan, Placentia, Parma, the dukedom of Tuscany, and the republic of Lucca. This tract, though a great part of it is mountainous, and some of that barren enough, yet produces plenty of excellent fruit, good pasture, wood, garden stuff, and mulberry trees, with some wine and oil, but little corn. What they want of the last, they have either from Lombardy, Sicily, or Naples.

Genoa stands on the coast of the Mediterranean sea, at the bottom of a little gulf, partly on the flat, and partly on the declivity, of a pleasant hill; in consequence of which, it appears to great advantage from the sea. It is defended on the land side by a double wall, which in circumference is about ten Italian miles. Two of the streets consist entirely of a double straight row of magnificent palaces. The others, though clean and well paved, are crooked and narrow. The palaces of the nobility are almost all of marble, and many of them are painted on the outside. That there should be such a profusion of marble here, is not to be wondered at, as the neighbouring hills abound with it. The city contains a vast number of palaces, churches, and convents, and several hospitals. The palace where the doge resides, and where the great and little council, and the two colleges of the procuratori and governatori assemble, is a large stone building in the centre of the city: but it contains some fine paintings in fresco; two statues of Andrew and John Doria in white marble; and an arsenal, in which are said to be arms for thirty-four thousand men, with a shield, containing one hundred and twenty pistol barrels, and thirty-three coats of mail, which, it is pretended, were worn by as many Genoese heroines in a croisade. Of the churches, the finest are those of the Annunciation, St Mary Carignan, St Dominic, and St Martha. In the cathedral is a dish made of a single emerald. All the inhabitants here, except the principal ladies, who are carried in chairs, walk on foot, on account of the narrowness or steepness of the streets. The fortifications of the city, towards the sea, are remarkably strong. There are two fine stone bridges over the rivers Bonzerva and Bisagno, the first whereof washes the west, and the other the east side of the city, within which there is also a surprising stone bridge joining two hills. The harbour, though large, is far from being safe; but no care or expence have been spared to render it as safe and commodious as possible. The wind to which it is most exposed, is that called *Labeccio*, or the south-west. The place where the republic's galleys lie, is called the Darsena, where are a great number of Turkish slaves. On a rock, on the west side of the harbour, is the fanal or lighthouse, a high tower, on the top of which is a lanthorn, containing thirty-six lamps. The trade of Genoa is chiefly in velvets, damasks, plush, and other silks, brocades, lace, gloves, sweetmeats, fruits, oil, Parmesan cheese, anchovies, and medicinal drugs from the Levant; but the badness of the harbour, and the high price of commodities, greatly checks the commerce. In 1751, Genoa was declared a free port for ten years, under certain restrictions: in that called *Porto Franco*, any merchant may have a warehouse, and import or export goods duty free; but such as are disposed of in the city, or on the continent, are taxed pretty high. The nobility are allowed to trade in the wholesale way; to carry on velvet, silk, and cloth manufactures; and to have shares in merchant ships: and some of them, as the Palavicini, are actually the greatest merchants in Genoa. Another very profitable article of trade carried on by them is banking, and dealing in bills of exchange. A new academy of painting, sculpture, civil and military architecture, was instituted here in 1751. One may walk the streets of Genoa in the night with the greatest safety, which is more than can be said of many cities in Italy. Excessive splendour and luxury are, in several respects, restrained by salutary laws. No beggars are permitted to ask alms in Genoa, and the inns are better than those at Turin. When a single person is buried, a kind of garland of all sorts of artificial flowers is placed on the coffin. The Genoese in general are esteemed crafty, industrious, and inured to labour above the other Italians.

Amidst the political convulsions which agitated Europe, in consequence of the unexampled French revolution, it was scarcely to be expected that Genoa would escape the shock. Accordingly in the year 1798, by the force and intrigues of the French republicans, its political constitution was totally subverted, and changed into what was afterwards denominated the *Ligurian Republic*, which was to be governed in a manner similar to that of their own, and the country also was divided into departments. As the preceding campaign had terminated in favour of the combined powers, and left them in the possession of every important place in Italy, this only excepted, the capture of it became an object of the utmost consequence to the contending parties. To regain it was the highest ambition of the house of Austria, while the retaining of it was matter of solicitude to the French republic. The reason is obvious. The conquest of it restored to the emperor of Germany the possession of all Italy, gave him the means of resuming his former positions in the Maritime Alps, and reinforcing his former position on the Rhine. To the French it was a place of the utmost consequence, because while they were enabled to retain it in their own hands, they could easily favour the operations of their army in Switzerland, or their entrance into Italy by the defiles of Piedmont.

As the allies were fully determined on its conquest for the reasons already assigned, as well as for others of an inferior nature and magnitude, it is but candid to admit that the general by whom it was defended had innumerable difficulties to struggle with, and obstacles to surmount. When Massena succeeded Championet, the army was reduced to the most melancholy situation. Confined during the winter season to the bleak summits of the Apennines, it was reduced in numbers more than one half, and a constant prey to famine and disease. To add to the difficulties which everywhere presented themselves to Massena, the higher classes of the Genoese looked upon the French only as the destroyers of their rank, commerce, and political importance; in consequence of which they secretly aided every measure by which they might be driven from the country. Instead of of 60,000 men which he was promifed, Maffena had no more than 20,000 after all his unwearied exertions, and with thefe he had to defend an extent of country from Mount Cenis to the frontiers of Tufcany. He wifely difmiffed all the former generals, independent of their merit, becaufe the foldiers affociated with them the idea of former mifery and difgrace. In addition to the fuperior ftrength of the Auftrian army, Maffena found a formidable infurrection raifed againft him in the eaftern territory of the Genoefe republic. The paffage by fea was obftructed by the Britifh fleet, and his expected fuccours from Marfeilles only reached him in part. As he could not meet the army in the field by which he was blockaded, his only alternative was to remain in Genoa, every moment in dread of perifhing by famine, if not fpeedily relieved.

In the mean time, the Auftrian army had nothing to do during the winter but to remain in a ftate of obfervation; the diftrefs to which the republican general was reduced was unfpeakably great. After enduring a number of hardfhips with the moft undaunted fortitude, and finding the city no longer tenable, a principle of humanity for his diftreffed army and the ftarving inhabitants induced him to furrender.

In the progrefs of fubfequent hoftilities the French again obtained poffeffion of it, and it is now (1806) fubject to the dominion of a brother of Bonaparte's, who has affumed the title of king of Italy.

GENSING. See Panax, Botany *Index*.

GENTIANA, Gentian, a genus of plants belonging to the pentandria clafs; and in the natural method ranking under the 20th order, *Rotaceæ*. See Botany *Index*.

GENTILE, in matters of religion, a Pagan, or worfhipper of falfe gods.

The origin of this word is deduced from the Jews, who called all thofe who were not of their name גוים *gojim*, i. e. *gentes*, which in the Greek tranflations of the Old Teftament is rendered τα εθνα; in which fenfe it frequently occurs in the New Teftament; as in Matth. vi. 32. "All thefe things the nations or Gentiles feek." Whence the Latin church alfo ufed *gentes* in the fame fenfe as our *Gentiles*, efpecially in the New Teftament. But the word *gentes* foon got another fignification, and no longer meant all fuch as were not Jews; but thofe only who were neither Jews nor Chriftians, but followed the fuperftitions of the Greeks and Romans, &c. In this fenfe it continued among the Chriftian writers, till their manner of fpeech, together with their religion, was publicly and by authority received in the empire; when *gentiles*, from *gentes*, came into ufe: and then both words had two fignifications, viz. in treatifes or laws concerning religion, they fignified Pagans, neither Jews nor Chriftians; and in civil affairs, they were ufed for all fuch as were not Romans.

Gentile, in the Roman law and hiftory, a name which fometimes expreffes what the Romans otherwife called *barbarians*, whether they were allies of Rome or not: but this word was ufed in a more particular fenfe for all ftrangers and foreigners not fubject to the Roman empire.

GENTILESCHI, Horatio, an Italian painter, was born at Pifa in 1563. After having made himfelf famous at Florence, Rome, Genoa, and other parts of Italy, he removed to Savoy; from whence he went to France, and at laft, upon the invitation of Charles I. came over to England. He was well received by that king, who appointed him lodgings in his court, together with a confiderable falary; and employed him in his palace at Greenwich, and other public places. The moft remarkable of his performances in England, were the ceilings of Greenwich and York houfe. He did alfo a Madona, a Magdalen, and Lot with his two daughters, for King Charles; all which he performed admirably well. After the death of the king, when his collection was expofed to fale, nine pictures of Gentilefchi were fold for 600l. and are now faid to be the ornaments of the hall in Marlborough houfe. His moft efteemed piece abroad was the portico of Cardinal Bentivoglio's palace at Rome. He made feveral attempts in face painting, but with little fuccefs; his talent lying altogether in hiftories, with figures as big as the life. He was much in favour with the duke of Buckingham, and many others of the nobility. After 12 years continuance in England, he died here at 84 years of age, and was buried in the queen's chapel at Somerfet-houfe. His print is among the heads of Vandyke, he having been drawn by that great mafter. He left behind him a daughter, *Artemifia Gentilefchi*, who was but little inferior to her father in hiftory painting, and excelled him in portraits.

GENTILIS, Albericus, profeffor of civil law at Oxford; an Italian by birth. He had quitted Italy with his father, on account of religion. He wrote feveral works; three books, in particular, *De jure belli*, which have not been unferviceable to Grotius. He died at London in 1608.

Gentilis, *Scipio*, brother to the former, and as celebrated a civilian as he, forfook his native country that he might openly profefs the Proteftant religion. He was counfellor of the city of Nuremberg, and profeffor of law with uncommon reputation. He was a great humanift; and in his lectures, as well as books, mixed the flowers of polite learning with the thorns of the law. He died in 1616.

GENTLEMAN. Under this denomination are comprehended all above the rank of yeomen † whereby noblemen are truly called *gentlemen*.

† See *Commonalty*.

A gentleman is ufually defined to be one, who, without any title, bears a coat of arms, or whofe anceftors have been freemen: and by the coat that a gentleman giveth, he is known to be, or not to be, defcended from thofe of his name that lived many hundred years fince.

The word is formed of the French *gentilhomme;* or rather of *gentil*, "fine, fafhionable, or becoming;" and the Saxon *man*, q. d. *honeftus*, or *honefto loco natus*.—The fame fignification has the Italian *gentilhuomo*, and the Spanifh *hidalgo*, or *hijo dalgo*, that is, the fon of fomebody, or a perfon of note.—If we go farther back, we fhall find *gentleman* originally derived from the Latin *gentilis homo;* which was ufed among the Romans for a race of noble perfons of the fame name, born of free or ingenuous parents, and whofe anceftors had never been flaves or put to death by law. Thus Cicero in his *Topics*, "*Gentiles funt, qui inter fe eodem funt nomine, ab ingenuis oriundi, quorum majorum nemo fervitutem fervivit, qui capite non funt diminuti*, &c.

—Some

—Some hold that it was formed from *gentile*, i. e. pagan; and that the ancient Franks, who conquered Gaul, which was then converted to Chriſtianity, were called *gentiles* by the natives, as being yet heathens.—Others relate, that towards the declenſion of the Roman empire, as recorded by Ammianus Marcellinus, there were two companies of brave ſoldiers, the one called *gentiles*, and the other *ſcutarii*; and that it was hence we derive the names *gentleman* and *eſquire*. See Esquire.—This ſentiment is confirmed by Paſquire, who ſuppoſes the appellation *gentiles* and *ecuyers* to have been tranſmitted to us from the Roman ſoldiery; it being to the *gentiles* and *ſcutarii*, who were the braveſt of the ſoldiery, that the principal benefices and portions of lands were aſſigned. See Benefice.—The Gauls obſerving, that during the empire of the Romans, the *ſcutarii* and *gentiles* had the beſt tenements or appointments of all the ſoldiers on the frontiers of the provinces, became inſenſibly accuſtomed to apply the ſame names, *gentilhommes* and *ecuyers*, to ſuch as they found their kings gave the beſt proviſions or appointments to.

Gentleman Uſher of the Black Rod. See Rod.

Gentlemen of the Chapel; officers whoſe duty and attendance is in the royal chapel, being in number 32. Twelve of them are prieſts; the other 20, commonly called *clerks of the chapel*, aſſiſt in the performance of divine ſervice. One of the firſt 12 is choſen for confeſſor of the houſehold; whoſe office is to read prayers every morning to the houſehold ſervants, to viſit the ſick, examine and prepare communicants, and adminiſter the ſacrament. One of 20 clerks, well verſed in muſic, is choſen firſt organiſt, who is maſter of the children, to inſtruct them in muſic, and whatever elſe is neceſſary for the ſervice of the chapel; a ſecond is likewiſe an organiſt; a third, a lutaniſt; and a fourth a violiſt. There are likewiſe three vergers, ſo called from the ſilver rods they carry in their hands; being a ſerjeant, a yeoman, and groom of the veſtry; the firſt attends the dean and ſubdean, and finds ſurplices and other neceſſaries for the chapel; the ſecond has the whole care of the chapel, keeps the pews, and ſeats the nobility and gentry; the groom has his attendance within the chapel door, and looks after it.

GENTOOS, in modern hiſtory, according to the common acceptation of the term, denote the profeſſors of the religion of the bramins or brachmans, who inhabit the country called *Hindoſtan*, in the Eaſt Indies, from the word *ſtan*, a "region," and *hind* or *hindoo*; which Feriſhtah, as we learn from Colonel Dow's tranſlation of his hiſtory, ſuppoſes to have been a ſon of Ham the ſon of Noah. It is obſerved, however, that Hindoo is not the name by which the inhabitants originally ſtyled themſelves; but according to the idiom of the *Shanſcrit* which they uſe, *jumbodeep*, from *jumboo*, a "jackall," an animal common in their country; and *deep*, a large portion of land ſurrounded by the ſea; or *bhertekhunt*, from *khunt*, i. e. "a continent," and *bherrhut*, the name of one of the firſt Indian rajahs. It is alſo to be obſerved, that they have aſſumed the name of *Hindoos* only ſince the era of the Tartar government, to diſtinguiſh themſelves from their conquerors the Muſſulmans. The term *Gentoo* or *Gent*, in the Shanſcrit dialect, denotes *animal* in general, and in its more confined ſenſe *mankind*, and is never appropriated particularly to ſuch as follow the doctrines of Brama. Theſe are divided into four great tribes, each of which has its own ſeparate appellation; but they have no common or collective term that comprehends the whole nation under the idea affixed by the Europeans to the word *Gentoo*. Mr Halhed, in the preface to his tranſlation of the Code of Gentoo Laws, conjectures, that the Portugueſe, on their firſt arrival in India, hearing the word frequently in the mouths of the natives, as applied to mankind in general, might adopt it for the domeſtic appellation of the Indians themſelves, or perhaps their bigotry might force from the word *Gentoo* a fanciful alluſion to gentile or Pagan. The Hindoos, or Gentoos, vie with the Chineſe as to the antiquity of their nation. They reckon the duration of the world by four jogues, or diſtinct ages; the firſt the Suttee jogue, or age of purity, which is ſaid to have laſted about 3,200,000 years; during which the life of man was 100,000 years, and his ſtature 21 cubits: the ſecond, the Tirtah jogue, or the age in which one-third of mankind were reprobate; which conſiſted of 2,400,000 years, when men lived to the age of 10,000 years: the third, the Dwaper jogue, in which half of the human race became depraved, which endured to 600,000 years, when men's lives were reduced to 1000 years: and fourthly, the Collee jogue, in which all mankind were corrupted, or rather diminiſhed, which the word *collee* imports. This is the preſent era, which they ſuppoſe will ſubſiſt for 400,000 years, of which near 5000 are already paſt; and man's life in this period is limited to 100 years. It is ſuppoſed by many authors, that moſt of the Gentoo *ſhaſters*, or ſcriptures, were compoſed about the beginning of the Collee jogue: but an objection occurs againſt this ſuppoſition, viz. that the ſhaſters take no notice of the deluge; to which the bramins reply, that all their ſcriptures were written before the time of Noah, and the deluge never extended to Hindoſtan. Neverthelefs, it appears from the ſhaſters themſelves, that they claim a much higher antiquity than this; inſtances of which are recited by Mr Halhed.

The doctrine of tranſmigration is one of the diſtinguiſhing tenets of the Gentoos. With regard to this ſubject, it is their opinion, according to Mr Holwell, that thoſe ſouls which have attained to a certain degree of purity, either by the innocence of their manners or the ſeverity of their mortifications, are removed to regions of happineſs proportioned to their reſpective merits; but that thoſe who cannot ſo far ſurmount the prevalence of bad example, and the powerful degeneracy of the times, as to deſerve ſuch a promotion, are condemned to undergo continual puniſhment in the animation of ſucceſſive animal forms, until, at the ſtated period, another renovation of the four jogues ſhall commence, upon the diſſolution of the preſent. They imagine ſix different ſpheres above this earth; the higheſt of which called *ſuttee*, is the reſidence of Brama, and his particular favourites. This ſphere is alſo the habitation of thoſe men who never uttered a falſehood, and of thoſe women who have voluntarily burned themſelves with their huſbands; the propriety of which practice is expreſly enjoined in the code of the Gentoo laws. This code, printed by the Eaſt India Company in 1776, is a very curious collection of Hin-

Gentoos, Genuflexion.

doo jurifprudence, which was felected by the moft experienced pundits or lawyers from curious originals in the Shanfcrit language, who were employed for this purpofe from May 1773 to February 1775; afterwards tranflated into the Perfian idiom, and then into the Englifh language by Mr Halhed.

The feveral inftitutes contained in this collection are interwoven with the religion of the Gentoos, and revered as of the higheft authority. The curious reader will difcover an aftonifhing fimilarity between the inftitutes of this code and many of the ordinances of the Jewifh law: between the character of the bramins or priefts, and the Levites; and between the ceremony of the fcape goat under the Mofaic difpenfation, and a Gentoo ceremony called the *afhummed jug*, in which a horfe anfwers the purpofe of the goat. Many obfolete cuftoms and ufages alluded to in many parts of the Old Teftament, may alfo receive illuftrations from the inftitutes of this code. It appears from the code, that the bramins, who are the priefts and legiflators of the country, have refigned all the fecular and executive power into the hands of another caft or tribe; and no bramin has been properly capable of the magiftracy fince the time of the futtee jogue. The only privilege of importance which they have appropriated to themfelves, is an exemption from all capital punifhment: they may be degraded, branded, imprifoned for life, or fent into perpetual exile; but it is everywhere exprefsly ordained, that a bramin fhall not be put to death on any account whatfoever.

We have already obferved, that the Hindoos are divided into four great and original tribes, which according to the Gentoo theology, proceeded from the four different members of Brama, the fuppofed immediate agent of the creation under the fpirit of the Almighty. Thefe tribes are the Bramins, which proceeded from his mouth, and whofe office is to pray, read, and inftruct; the Chehteree, which proceed from his arms, whofe office is to draw the bow, to fight, and to govern; the Bice, proceeding from the belly or thighs, who are to provide the neceffaries of life by agriculture and traffic; and the Soonder, from the feet, which are ordained to labour, ferve, and travel.

Few Chriftians, fays the tranflator of the Gentoo code, have expreffed themfelves with a more becoming reverence of the grand and impartial defigns of Providence, in all its wroks, or with a more extenfive charity towards all their fellow creatures of every profeffion, than the Gentoos. It is indeed an article of faith among the Bramins, that God's all merciful power would not have permitted fuch a number of different religions, if he had not found a pleafure in beholding their varieties.

GENUFLEXION, (of *genu*, "knee," and *flecto* "I bend,") the act of bowing or bending the knee; or rather of kneeling down.

The Jefuit Rofweyd, in his Onomafticon, fhows, that genuflexion, or kneeling, has been a very ancient cuftom in the church, and even under the Old Teftament difpenfation; and that this practice was obferved throughout all the year, excepting on Sundays, and during the time from Eafter to Whitfuntide, when kneeling was forbidden by the council of Nice.

Others have fhown, that the cuftom of not kneeling on Sundays had obtained from the time of the apoftles, as appears from St Irenæus, and Tertullian; and the Ethiopic church, fcrupuloufly attached to the ancient ceremonies, ftill retains that of not kneeling at divine fervice. The Ruffians efteem it an indecent pofture to worfhip God on the knees. Add, that the Jews ufually prayed ftanding. Rofweyd gives the reafons of the prohibition of genuflexion on Sundays, &c. from St Bafil, Anaftafius, St Juftin, &c.

Baronius is of opinion, that genuflexion was not eftablifhed in the year of Chrift 58, from that paffage in Acts xx. 36. where St Paul is exprefsly mentioned to kneel down at prayer; but Saurin fhows, that nothing can be thence concluded. The fame author remarks, alfo, that the primitive Chriftians carried the practice of genuflexion fo far, that fome of them had worn cavities in the floor where they prayed: and St Jerome relates of St James, that he had contracted a hardnefs on his knees equal to that of camels.

Genus.

GENUS, among metaphyficians and logicians, denotes a number of beings which agree in certain general properties common to them all: fo that a genus is nothing elfe but an abftract idea, expreffed by fome general name or term. See LOGIC and METAPHYSICS.

GENUS, is alfo ufed for a character or manner applicable to every thing of a certain nature or condition: in which fenfe it ferves to make capital divifions in divers fciences, as medicine, natural hiftory, &c.

GENUS, in *Rhetoric*. Authors diftinguifh the art of rhetoric, as alfo oration or difcourfes produced thereby, into three genera or kinds, demonftrative, deliberative, and judiciary. To the demonftrative kind belong panegyrics, genethliacons, epithalamiums, funeral harangues, &c. To the deliberative belong perfuafions, diffuafions, commendations, &c. To the judiciary kind belong defences and accufations.

GENUS, in *Medicine*. See MEDICINE, under the *Nofology*.

GENUS, in *Natural Hiftory*, a fubdivifion of any clafs or order of natural beings, whether of the animal, vegetable, or mineral kingdoms, which agree in certain common characters. See NATURAL *Hiftory*.

GENUS, in *Mufic*, by the ancients called *genus melodiæ*, is a certain manner of dividing and fubdividing the principles of melody; that is, the confonant and diffonant intervals, into their concinnous parts.

The moderns confidering the octave as the moft perfect of intervals, and that whereon all the concords depend, in the prefent theory of mufic, the divifion of that interval is confidered as containing the true divifion of the whole fcale.

But the ancients went to work fomewhat differently: the diateffaron, or fourth, was the leaft interval which they admitted as concord; and therefore they fought firft how that might be moft conveniently divided; from whence they conftituted the diapente and diapafon.

The diateffaron being thus, as it were, the root and foundation of the fcale, what they called the *genera*, or kinds, arofe from its various divifions; and hence they defined the *genus modulandi* to be the manner of dividing the tetrachord and difpofing its four founds as to fucceffion.

The genera of mufic were three, the enharmonic, chromatic, and diatonic. The two firft were varioufly fubdivided;

Geocentric || Geoffroy. subdivided; and even the last, though that is commonly reckoned to be without any species, yet different authors have proposed different divisions under that name, without giving any particular names to the species as was done to the other two.

For the characters, &c. of these several genera, see ENHARMONIC, CHROMATIC, and DIATONIC.

GEOCENTRIC, in *Astronomy*, is applied to a planet, or its orbit, to denote it concentric with the earth, or as having the earth for its centre, or the same centre with the earth.

GEOFFRÆA, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY and MATERIA MEDICA *Index*.

GEOFFREY of MONMOUTH, bishop of St Asaph, called by our ancient biographers *Gallofridus Monumentensis*. Leland conjectures that he was educated in a Benedictine convent at Monmouth, where he was born; and that he became a monk of that order. Bale, and after him Pits, call him archdeacon of Monmouth; and it is generally asserted that he was made bishop of St Asaph in the year 1151 or 1152, in the reign of King Stephen. His history was probably finished after the year 1138. It contains a fabulous account of British kings, from the Trojan Brutus to the reign of Cadwallader in the year 690. But Geoffrey, whatever censure he may deserve for his credulity, was not the inventor of the stories he relates. It is a translation from a manuscript written in the British language, and brought to England from Armorica by his friend Gualter, archdeacon of Oxford. But the achievements of King Arthur, Merlin's prophecies, many speeches and letters, were chiefly his own addition. In excuse for this historian, Mr Wharton judiciously observes, that fabulous histories were then the fashion, and popular traditions a recommendation to his book.

GEOFFROY, STEPHEN-FRANCIS, a physician eminent for his chemical and botanical knowledge, was born at Paris in the year 1672, where his father kept an apothecary's shop, and had been several times in the magistracy. He received a liberal education; and, while prosecuting the study of medicine, he had conferences at his father's house with Cassini, du Verney, Homberg, and other men of distinguished eminence. At Montpellier he attended the lectures of the most able professors of physic, and afterwards visited the south of France, carefully viewing every object deserving of his attention. He accompanied count de Tallard to England in 1698, where he became acquainted with the chief men of science, and was made a member of the Royal Society. He next went into Holland, and in 1700 he attended the abbe de Louvois in a tour to Italy. He was, on his return, made bachelor of medicine in 1702, and, in two years after, he was created M. D. One of his theses was on the question, "*An hominis primordia vermis?*" which was translated into French for the sake of some ladies of exalted rank, by whom it was deemed interesting.

Geoffroy, Geographical.

Geoffroy did not hastily commence the practice of medicine, continuing the prosecution of his studies in retirement for some years. He never appeared anxious to push himself forward, although his knowledge made him be often consulted by several gentlemen of the faculty. He was so concerned for the recovery of his patients, that it gave him an air of melancholy, which at first alarmed them, till they became acquainted with the cause. He was, in 1709, made professor of physic by the king to the Royal College, vacant by the death of the celebrated Tournefort. He began with lectures on materia medica; and in 1712, M. Fagon resigned to him the chemical chair: on both which topics Geoffroy lectured with unwearied assiduity. He was twice chosen to the office of dean by the faculty of Paris, and he filled a place in the Royal Academy of Sciences, from the year 1699. His health at last yielded to his toils, and he died in January, 1731. He is known to the chemical world by his table of affinities, far superior to any which had appeared before his time. His greatest work was his History of the Materia Medica, which, in an unfinished state, was published after his death in the year 1741, in 3 vols 8vo.

GEOGRAPHICAL MILE, the same with the sea mile; being one minute, or the 60th part of a degree of a great circle on the earth's surface.

GEOGRAPHY.

INTRODUCTION.

1 Definition. GEOGRAPHY is that part of knowledge which describes the surface of the earth; its divisions, extent, and boundaries; the relative position of the several countries and places on the globe, and the manners, customs, and political relations of their inhabitants. The word is Greek, γεωγραφια, from γῆ or γεα, *terra*, "the earth," and γραφω, *scribo*, "I write." As every thing that immediately contributes to the ascertaining of the situation and limits of countries and places on the surface of the earth, is within the province of geography, this science includes the description and use of globes, maps, and charts, with the methods of constructing them.

This science has been divided into GEOGRAPHY properly so called, or a description of the *lands* of the globe, and HYDROGRAPHY, or a description of the waters; but this division is of little consequence, and is now seldom employed. Geography has also been divided into *general* and *particular*, terms which are variously understood by different writers on the subject. By Varenius, one of the oldest and best modern writers on general geography, general or universal geography is used to denote that part of the subject which considers the earth in general, and explains its affections as a terrestrial globe, without attending to its arbitrary division into different regions; and by particular or special geography, this writer understands the description of the particular regions of the earth: and he divides this latter into two parts; *chorography*, describing some considerable 2 Division of geography.

Introduction.

ſiderable parts of the earth, as of the quarters, and *topography*, deſcribing a particular province or diſtrict.

Geography may be conveniently divided into *deſcriptive* geography, or that part of the ſcience which deſcribes the form, limits, extent, and variety of ſurface of different countries, with the manners and cuſtoms of their inhabitants; and *phyſical* geography, or that part which teaches how to determine the ſituations of different places on the globe, and to lay down and delineate their poſitions for the information of others. Deſcriptive geography is the more popular and entertaining part of the ſubject. It is uſually divided into ancient or claſſical geography, geography of the middle ages, and modern geography. The firſt branch of the ſubject conſiders the ſtate of the earth ſo far as it was known or diſcovered at different periods, previous to the ſixth century of the Chriſtian era. The geography of the middle ages extends from the ſixth to the fifteenth century, and modern geography from the fifteenth century to the preſent time. One of the moſt uſeful ſubdiviſions of deſcriptive geography is that employed by Mr Pinkerton, who conſiders the geography of the ſeveral countries which he deſcribes under four different heads. 1. *Hiſtorical* or *progreſſive geography*; in which he treats of the names, extent, original population, progreſſive geographical improvements, hiſtorical epochs and antiquities of the countries. 2. *Political geography*; under which he deſcribes the religion and eccleſiaſtic inſtitutions, government, laws, population, colonies, military force, revenue, and political relations. 3. *Civil geography*, comprehending manners and cuſtoms, language, literature, and the arts, education, cities and towns, principal edifices, roads, manufactures and commerce. And, 4. *Natural geography*, comprehending an account of the climate and ſeaſons, face of the country, its ſoil, and ſtate of agriculture, its rivers, lakes, mountains, and foreſts, and an enumeration of the natural productions and natural curioſities, which are uſually found within each diſtrict*. Deſcriptive geography is ſometimes ſtyled *political* geography, while phyſical or general geography is called *natural* geography.

* Vid. *Pinkerton's Geography*, vol. 1. p. 3.

Among the other departments of this ſtudy we may mention ſacred geography, or that which illuſtrates the ſacred writings; and eccleſiaſtic geography, which deſcribes the diviſion of a country according to its church government, as into archbiſhoprics, biſhoprics, &c.

Many writers of treatiſes or ſyſtems of geography give a detailed account of the hiſtorical events and commercial concerns of the ſeveral countries which they deſcribe; but we conſider this as unneceſſary in a pure geographical work, as theſe departments belong rather to HISTORY and *POLITICAL Economy*.

Some ſyſtematic writers on geography conſidering the term in a very comprehenſive view, as including a deſcription of the internal ſtructure of the earth, as well as of its ſurface, have thought it neceſſary to enter into diſcuſſions reſpecting the original formation of the earth, and the minerals of which it is compoſed. How far they are right in this we ſhall not pretend to determine. In this work, theſe ſubjects will be treated of under the articles GEOLOGY and MINERALOGY.

Another ſubject relative to the affections of the earth, reſpects the phyſical and chemical changes that take place in its atmoſphere. Theſe properly belong to the ſcience of METEOROLOGY, and will be found under that article.

3 Object of this treatiſe.

We propoſe in this article to offer only an introductory outline of deſcriptive geography, as the ſeveral quarters of the globe, and their ſubdiviſions into empires, kingdoms, and ſtates, are deſcribed as particularly as is compatible with the limits of this work, under the ſeveral articles to which they belong in the general alphabet.

Our attention will be chiefly directed to phyſical geography, eſpecially that part of it which deſcribes the conſtruction and uſe of globes, maps, and charts.

4 Of phyſical geography.

Phyſical geography is properly a branch of mixed mathematics, and its principles depend on geometry, and its kindred ſciences, trigonometry and perſpective. It is intimately connected with aſtronomy; and as theſe two ſciences mutually illuſtrate each other, they are commonly taught at the ſame time. The phyſical changes that take place on the earth, as far as it is conſidered in its general character of an individual of the ſolar ſyſtem, have been already explained under ASTRONOMY; and we ſhall have little here to add reſpecting them, except as they are modified by the ſituation of the obſerver on different parts of the earth's ſurface.

The principles and practice of phyſical geography, though ſtrictly dependent on pure mathematics, may be, for the moſt part, explained in a popular way, ſo as to be underſtood by the generality of readers. This popular view of the ſubject we ſhall attempt in the preſent article, throwing every thing that is purely mathematical into the form of notes. It muſt be evident, however, that a reader who is converſant with mathematics will ſtudy phyſical geography to more advantage; and for this purpoſe, it will be ſufficient to poſſeſs a moderate acquaintance with arithmetic, the elements of geometry, plane trigonometry, ſpherics, and perſpective.

5 Importance of geography.

It is ſcarcely neceſſary to enlarge on the importance or utility of geography. It is one of thoſe ſciences, the knowledge of which is almoſt conſtantly required. Without an acquaintance with the geography of the countries that are the ſcenes of the actions which he relates, the hiſtorian muſt either be extremely conciſe, or his narration muſt be obſcure and unintelligible. Geography affords the beſt illuſtration of hiſtory, and is equally neceſſary to the hiſtorian and his reader. To the traveller, under which denomination we may claſs the ſoldier, the ſailor, the merchant, as well as thoſe who travel for pleaſure or curioſity, a previous knowledge of the countries, through which he is to paſs, is always uſeful, and often indiſpenſable. To the politician a comprehenſive knowledge of geography is of the higheſt importance. If he is ignorant of the extent, form, boundaries, appearances, climate, &c. of the country with which he is at war, he will plan his hoſtile expeditions without effect, and will ſend his invading armies only to periſh among the defiles of the enemy, or to meet a more inglorious and deplorable fate from the diſeaſes of the climate.

Even, if we conſider geography as a ſtudy of mere amuſement and curioſity, it forms one of the moſt rational and intereſting ſtudies in which we can engage. Nothing can be more gratifying to the obſerver of mankind than to ſurvey the manners and cuſtoms of various

History. rious nations, and to compare the relative ſtate of civilization and improvement in countries widely remote from each other. The ſtudent of geography can ſit in his cloſet, and accompany the adventurous traveller in his toilſome journey, through

——————— "antres vaſt, and deſerts wild,
Rough quarries, rocks, and hills, whoſe heads touch heav'n!"

trace his progreſs over the boundleſs ocean, and draw from his narration a delightful fund of inſtruction and amuſement, free (except in imagination) from thoſe perils and hardſhips, which the writer had undergone. History.

At the end of this article, we ſhall offer a few remarks on the beſt method of teaching and learning geography. We muſt now take a brief view of the origin and progreſs of the ſcience.

PART I. HISTORY AND PRESENT STATE OF GEOGRAPHY.

6 History of geography.

AN hiſtorical account of geography would be extremely intereſting, as it would include, not only the progreſſive improvements of the ſcience, conſidered as a branch of mixed mathematics, but an account of the ſucceſſive diſcoveries of different parts of the earth that have been made by the more civilized communities. Such an account in detail, however, cannot be expected here; and we ſhall confine ourſelves principally to a curſory view of the geographical diſcoveries of ancient and modern nations, reſerving the progreſſive improvements of phyſical geography for thoſe parts of the article to which they properly belong; as they would neither be ſo intereſting nor ſo intelligible to a general reader, before he has been made acquainted with the principles of the ſcience.

7 Origin.

As ſoon as mankind had formed themſelves into ſocieties, and begun to eſtabliſh connexions with their neighbours, they would find it neceſſary to inform themſelves of the poſition of the countries which bordered on their own; and very ſoon their curioſity would lead them to deſire to form an acquaintance with the extent of the country in which they lived, and with many particulars reſpecting thoſe which were remote from them. Thus, we ſee that ſcarcely had the ſciences ariſen among the Greeks, before their philoſophers began to occupy themſelves in geographical purſuits. We are told that Anaximander exhibited to his countrymen a plan of Greece and the neighbouring countries, and in this he was imitated by his countryman Hecateus of Miletus. Of the nature of theſe ancient plans or maps, and their progreſſive improvements, we ſhall ſpeak more at large hereafter.

8 Diſcoveries of the Phœnicians.

Commerce, and the taſte for adventures, which uſually accompanies it, were doubtleſs among the firſt cauſes of geographical reſearches; but the Phœnicians are the earlieſt commercial people of whoſe diſcoveries we have any correct accounts. This people ſeem firſt to have inveſtigated the coaſts on the Mediterranean; and their navigators, extending their voyages beyond this ſea, through the narrow channel which is now called the Straits of Gibraltar, entered the Atlantic ocean, and planted colonies in Iberia, a part of Spain, in the country of Tharſhiſh, which is probably the modern Andaluſia, and upon the weſtern ſhores of Africa.

The learned Bochart, led by the analogy between the Phœnician tongue, and the oriental languages, has followed the tracks of the Phœnicians, both along the ſhores of the Mediterranean, and thoſe of the Atlantic. Theſe analogies are not always ſure guides; but we can ſcarcely doubt that the city of Cadiz was a Phœnician colony, and it is not likely that this was the only one formed by that enterpriſing people.

9 Situation of Ophir.

In the time of Solomon, Phœnician ſhips, employed by him, ſet ſail from a port in the Red ſea, called Azion-Gaber, and paſſing from that ſea through the ſtraits of Babelmandel, carried on their commerce in the Indian ocean. The country of Ophir, to which they ſailed, muſt have been at a conſiderable diſtance from the Red ſea, as we are told that a voyage thither required three years. "The king (ſays the author of the firſt book of Kings) had a navy of Tharſhiſh, with the navy of Hiram. Once in three years came the navy of Tharſhiſh, bringing gold and ſilver, ivory, and apes and peacocks." Some have placed Ophir upon the coaſt of Africa, where the modern Sofala is ſituated: Others ſuppoſe it was a port in the iſland of Ceylon, or in the iſland of Sumatra, in which latter iſland there is ſtill a place called Ophir. The gold duſt and ivory brought from thence, ſeem to ſhew that it was an African port. (See OPHIR.) M. Montucla ſuppoſes that the Phœnicians muſt even at this period have ſailed round the continent of Africa, and that Ophir was ſome place on the Gold Coaſt (A). * *Montucla Hiſt. de Mathem.* tom. iv. p. 590.

10 Carthaginians.

The Carthaginians, a Phœnician colony, imitated their predeceſſors. We know that they ſailed into the Atlantic ocean, as far as the coaſt of Cornwall in England, whence they procured large quantities of tin. The ſame people made ſeveral attempts towards a complete ſurvey of the weſtern coaſt of Africa. Of theſe we have an account only of one expedition, that of Hanno, of which we have already given an account under the article AFRICA.

The Carthaginian navigators, if we may believe the recital of Diodorus Siculus, (lib. xv.) diſcovered a country ſituated in the Atlantic ocean, which furniſhed all the neceſſaries and conveniences of life. Some pretend that this country was America, but it is much more probable that it was ſome one of the Cape de Verd iſlands.

(A) The moſt celebrated writers who have ſupported the opinion, that Ophir was a port in Africa, are Monteſquieu, Bruce, and d'Anville. Dr Prideaux and M. Goſſelin again contend, that Ophir was a port in Arabia Felix, and the ſame with *Sabéa* or Sheba; and their opinions have lately been ably ſupported by Dr Vincent. See *Vincent's Periplus of the Erythrean Sea*, Part II.

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islands. The Carthaginian senate, fearful that the relation of the sailors who had discovered such a country, might be the means of producing frequent emigrations, are said to have used every endeavour to stifle the memory of this expedition.

11
Circumnavigation of Africa.

History speaks of several voyages undertaken by order of the kings of Egypt and of Persia, for the purpose of ascertaining the extent of Africa; and Herodotus relates that Pharaoh Necho, king of Egypt, employed some Phœnician navigators to sail along the coast of Africa, for the purpose of taking a more exact survey of it. See AFRICA.

M. Gosselin, who has considered the geography of the ancients in a very learned dissertation, maintains, that the different passages of ancient writers, who have always declared that the Phœnicians and the Greeks circumnavigated Africa, are not sufficient to prove the certainty of such a voyage. The passage in Herodotus has been discussed by him at considerable length, and he seems to have proved his relation to be nothing more than a romance, founded on the historical knowledge of the Egyptians. M. Gosselin, however, admits, that many ancient voyages took place from those countries in which geography had arrived at some perfection; and there are numerous arguments, proving that all the shores of the old continent had been sailed round. See *Bailly's History of Astronomy*, p. 307. edit. 1775.

12
Voyage of Sataspes.

Xerxes king of Persia, according to Herodotus, gave a similar commission about the year before Christ 480, to one of his satraps named Sataspes, who had been condemned to die. Sataspes entered the Atlantic ocean through the straits of Gibraltar, and bending his course towards the south, he coasted the continent of Africa, till he doubled a cape which was called Syloco, and which Riccioli considers as the same with the Cape of Good Hope. He is said to have continued his course to the south for some time, and then to have returned home, assigning as a reason for not proceeding further, that he had encountered a sea so full of herbage, that his passage had been completely obstructed. This reason appeared so ridiculous to Xerxes, that he ordered Sataspes to be crucified; but in this sentence he appears to have been rather too precipitate, as it is certain that in some latitudes there grows such a quantity of sea weed, that a vessel can scarcely make way through it; as in that part of the sea which lies between the Cape de Verd islands, the Canaries, and the coast of Africa, and is called by the Portuguese the sea of Saragossa. This shews that the relation of Sataspes may have been correct, as he might think it dangerous to attempt proceeding where he found himself so much entangled.

13
Expedition of Scylax.

Herodotus has commemorated another marine expedition, undertaken by Scylax, by order of Darius the son of Hystaspes, and which probably took place about the year 422 B. C. Scylax embarked upon the river Indus, the course of which he followed to its mouth, from whence he sailed in the course of 30 months, either into the Arabian gulf, or the Red sea. This Scylax must not be confounded with a navigator of the same name, who, at a later period, made a voyage of investigation round the Red sea.

14
Geography improved by Alexander.

The conquests of Alexander the Great, if they added little to the happiness of mankind, had at least the advantage of throwing considerable light on the state of geography at that time, as they afforded to the Greeks a more perfect knowledge of the river Indus, and of many parts of that vast country which derives its name from that river. Alexander does not seem to have penetrated to the Ganges, though his expedition led the way to the knowledge of that river; for soon after he went as far as Palibothra, a town situated on the river Indus, at its confluence with another river coming from the west. The followers of Alexander went down the Indus, as far as its opening into the Indian ocean, where they witnessed for the first time the phenomenon of the flux and reflux of the sea,—a phenomenon which excited in them great astonishment and terror. It was after this that Alexander detached, about the year 327 before Christ, two of his captains, Nearchus and Onesicritus, to investigate the coast of the Indian sea. Nearchus was ordered to return by the Red sea, and this he effected. Some fragments of his voyage have come down to us, and upon these has been formed an excellent work by Dr Vincent, entitled the "Periplus of the Erythrean Sea." This learned and valuable work is just completed by the publication of the Second Part, and affords much additional illustration of the geographical information and commercial enterprises of the ancients.

Onesicritus sailed to the east, and if we may believe the account that is left of his voyage, he gave us the first exact information respecting the island of Ceylon. The measure given by Onesicritus, of the extent of the island which he investigated, viz. 7000 stadia, does not correspond to Ceylon, whether we consider the length or circumference of the island, (see CEYLON); and if we take it as the measure of the length, it more nearly corresponds to that of Sumatra. The relations of Nearchus and Onesicritus were extant in the time of Strabo, by whom the latter is said to exceed, in point of exaggeration, all the other historians of Alexander's expedition. At the same time, it must be acknowledged that there are many things related by Onesicritus, as quoted by Strabo, which sufficiently agree with what we know of India, and the productions of that country; for he speaks of the sugar cane, the cotton plant, the bamboo, &c.

15
By Ptolemy Philadelphus.

The kings of Egypt who succeeded Alexander, took considerable interest in the progress of geography. The second of these kings, Ptolemy Philadelphus, about the year 280 before Christ, sent into India two ambassadors, Megasthenes and Daimachus, accompanied by the mathematician Dionysius. Megasthenes was sent to the king of Palibothra on the banks of the Ganges, and Daimachus to another Indian potentate. No account remains of the proceedings of Dionysius and Daimachus, but Megasthenes left an account of his journey, which is frequently quoted by Strabo, by whom it is considered as a mixture of real adventures and improbable exaggerations. These quotations of Strabo are certainly all that remain of the relation of Megasthenes; for the work published under the name of Megasthenes is a literary imposture, similar to the works of Berosus, Manetho and Ctesius.

In the reign of Ptolemy Lathyrus, about 115 years 16
before Christ, other expeditions were undertaken, for the purpose of sailing round the continent of Africa.

Eudoxus and Cysicus having incurred the displeasure of Ptolemy, were sent on this voyage of discovery. They

History. They paſſed through the ſtraits of Gibraltar, and circumnavigating Africa, returned by the Red ſea. Laſtly, in the reign of Ptolemy, ſurnamed Alexander, about 90 years before Chriſt, Agatarchides, who had been the king's governor, was ſent to take a complete ſurvey of the Red ſea, and wrote an account of his voyage, of which, however, there remain only a few extracts that are preſerved by Photius, in his Bibliotheca, a work of ninth century.

17 Voyage of Pythias.

The extenſion of commerce ſeems always to have been one of the principal objects of theſe voyages of diſcovery. It is not ſurpriſing, therefore, that the inhabitants of Marſeilles, which was early celebrated as a commercial city, appear among the ancient navigators who laboured to extend geographical knowledge. Two voyagers, Pythias and Euthymenes, undertook an expedition about 320 years before the Chriſtian æra. Euthymenes entered the Atlantic through the ſtraits of Gibraltar, and turned towards the ſouth, for the purpoſe of taking a ſurvey of the coaſt of Africa. This is all that we know of his route; but Pythias ſteered northward, and after reconnoitring the coaſts of Spain and Gaul, ſailed round the iſland of Albion, and ſtretching ſtill farther to the north, diſcovered an iſland which is believed to be the modern Iceland, or the Thule of the ancients, *terrarum ultima Thule.* Perhaps, however, this was only one of the Ferro iſlands. Strabo, who appears to have been prejudiced againſt Pythias, treats his relation as fabulous, founding his opinion principally on the number of incredible circumſtances that occur in his narration. Taking theſe circumſtances, however, not according to their literal meaning, but in a figurative ſenſe, they repreſent pretty well the ſtate of the ſea and ſky in theſe countries which are ſo little favoured by nature. Pythias certainly ſeems to have been one of the firſt Greek navigators who entered the Baltic.

18 Ancient geographers.

We have thus traced the progreſs of geographical diſcoveries to very nearly the period which we aſſigned as the limit of ancient geography; and ſhall now notice very briefly ſome of the principal ſcientific geographers of antiquity, whoſe names or writings have deſcended to poſterity, and ſhall afterwards give a ſummary ſketch of the knowledge which the ancients ſeem to have poſſeſſed of the habitable globe.

As geography is a branch of knowledge intimately connected with geometry and aſtronomy, it became an object of conſideration with many of the ancient geometers and aſtronomers. We have already mentioned the names of Anaximander of Miletus, and his countryman Hecateus. Strabo alſo notices Democritus, Eudoxus of Cnidos, and Parmenides, to the laſt of whom he attributes the diviſion of the earth into zones. Theſe were followed by Eratoſthenes, who lived about 240 years before the Chriſtian æra, and Hipparchus, who flouriſhed about 80 years afterwards; Polybius, Geminus, and Poſſidonius. Eratoſthenes wrote three books on geography, of which Strabo criticiſes ſome paſſages, though he frequently defends him againſt Hipparchus, w[illegible] often affects an oppoſite opinion. Polybius wrote on geography as well as hiſtory, and as well as Geminus and Poſſidonius, is frequently quoted by Strabo. Polybius and Geminus argue with conſiderable acuteneſs for the poſſibility of the torrid zone being inhabited, a circumſtance which was generally diſbelieved by the ancients; and they even adduce arguments which are very plauſible, to prove that the climate of the countries under the equator is more temperate than that of thoſe which are ſituated nearer the tropics.

We muſt not here omit a geographer and mathematician who lived about the time of Alexander the Great. This was Dicearchus of Meſſina, the diſciple of Theophraſtus, who wrote a deſcription of Greece in iambic verſes, of which ſome fragments yet remain. What renders this work moſt remarkable is, that it contains the height of ſeveral mountains meaſured geometrically by Dicearchus. Thus, for inſtance, the height of Mount Cyllene is ſtated at 15 ſtadia, and that of Satabyce at about 14. Taking the ſtadium at 94½ toiſes, we have for the latter of theſe heights, at moſt 1400 toiſes, whereas many of the ancients aſſigned 300, 400, or even 500 ſtadia, as the height of ſome of their mountains.

With Dicearchus we may mention another geometer noticed by Plutarch in his life of Paulus Emilius; viz. Xenagoras, a diſciple of Ariſtotle, who alſo employed himſelf in meaſuring mountains, and has aſſigned only 15 ſtadia, which is equal to about 1417 toiſes, as the height of Mount Olympus. In ſome of the later periods previous to the Chriſtian æra, we find the names of ſeveral geographers, as Artemidorus of Epheſus, who wrote a geographical work in eleven books, of which nothing remains; Scymnus of Chio, author of a deſcription of the earth in iambic verſes, which remains in a very mutilated ſtate; Iſidorus of Charax, who left a deſcription of the Parthian empire, and Scylax of Caryades, author of a voyage round the Mediterranean ſea, which is ſtill extant. 19

Strabo.

The works of all theſe geographers, however, are trifling when compared with the geography of Strabo, a work in 16 books, which has come down to us entire. This is one of the moſt valuable works of antiquity, both from the ſpirit of diſcuſſion which runs through it, and the number of curious obſervations which the author has collected of different geographers and navigators who preceded him; and of whoſe works nothing remains except theſe extracts. Strabo lived in the reigns of Auguſtus and Tiberius, and was nearly cotemporary with Pomponius Mela. 20

Pomponius Mela.

This latter geographer wrote a work *de ſitu orbis*, which is little more than a bare ſummary, though it is valuable, as it gives us a ſketch of what was known in his time reſpecting the ſtate of the habitable globe. Pomponius Mela was followed by Julius Solenus, who has alſo treated of geography in his Polyhiſtor, a compilation which is ſufficiently valuable from the number of curious obſervations which are there collected. 21

Ptolemy.

Of all the ancient geographers, poſterity is moſt indebted to Ptolemy, who produced a work much more ſcientific than had ever before been written on this ſcience; a geography in eight books, which muſt ever be conſidered as one of the principal monuments of the labours of its author. In this work there appear, for the firſt time, an application of geometrical principles to the conſtruction of maps; the different projections of the ſphere, and a diſtribution of the ſeveral places on the earth, according to their latitudes and longitudes. This work muſt have been the reſult of a great many relations both hiſtorical and geographical, that had been collected by Ptolemy. It has paſſed through numerous editions.

22 Dionyſius the Periegetic.

Some time after Ptolemy lived, Dionyſius the African, commonly called the *Periegetic*, from the title of a work that he compoſed in verſe, containing a deſcription of the world, which may be conſidered as one of the moſt correct ſyſtems of ancient geography, and was by Pliny propoſed to himſelf as a pattern. This work was afterwards tranſlated into Latin verſes by Priſcian, and by Avienus, the latter of whom alſo wrote a deſcription of the maritime coaſts in iambic verſes, of which there remain about 700. Among the lateſt geographers of this period are reckoned Marcianus and Agathemares, of whom little is known, except that the latter was author of two books on geography.

23 Hudſon's collection.

The ſcattered works of moſt of theſe authors being difficult to procure, were collected by Hudſon into one work, and publiſhed by him in four volumes octavo, in the years 1698, 1702, and 1712, under the title of *Geographiæ veteris ſcriptores Greciæ minores*, together with a Latin tranſlation and notes and diſſertations on each by Dodwell. In this work we find the remains of Hanno, Scylax, Nearchus, Agatarchides, Arrian, Marcianus, Dicearchus, Iſidore of Charax, Scymnus, Agathemeres, Dionyſius the Periegetic, Artemidorus, Dionyſius of Biſance, Avienus, Priſcian, and ſome fragments of Strabo, of Plutarch, of Ptolemy, of Abulfeda, and of Ulug Beg. This is a moſt valuable collection, and as it had become extremely ſcarce, was a few years ago reprinted at Leipſic.

24

The above is a haſty ſketch of the names and characters of moſt of the geographical writers within the period which we have aſſigned to the ancient hiſtory of the ſcience. We ſhall have occaſion to make ſome further obſervations on the more eminent of theſe geographers in a future part of this article.

25 Geographical knowledge of the ancients.

With reſpect to the knowledge of the globe that was poſſeſſed by the ancients, there have been various opinions; ſome have conſidered them as very extenſively acquainted with almoſt every part of it, not excepting ſome portion of America; while others have confined their geographical knowledge within very narrow limits. The following obſervations are chiefly drawn from M. Montucla, an eminent judge in every thing that relates to the hiſtory of the mathematical ſciences.

26 Europe.

As to the knowledge which the ancients poſſeſſed of the habitable globe, it is certain that they were well acquainted with Europe, or at leaſt all that part of it which had been made ſubject to the Roman empire, as far as the banks of the Rhine and the Danube. They were tolerably well acquainted with Germany and Sarmatia. They had ſome knowledge of the Baltic ſea, as a fleet had been ſent by Auguſtus, which ſailed as far as the peninſula then called the Cimbrian Cherſoneſus, the modern Jutland. The Baltic was at that time celebrated for the production of ambergriſe. They had acquired a knowledge of the iſland of Britain, from the expeditions of Julius Cæſar, and Claudius; but the northern parts of this iſland, and the whole of Ireland, were to them nations of rude, uncivilized ſavages. The boundary of their knowledge of Europe to the north, was the Thule of Pythias, or Iceland; at leaſt if it is certain, as is the general opinion, that this iſland is the *ultima Thule*.

27 Aſia.

With reſpect to Aſia, they ſeem to have ſurveyed the country as far towards the eaſt as the river Ganges; and the immenſe extent of country comprehended between the Indus and the Ganges, was called by them *India on this ſide the Ganges*. Further on towards the north of China, in the neighbourhood of the mountains where theſe rivers derive their ſource, they placed ſeveral nations of people, of whom they related the moſt ridiculous fables. Beyond theſe, ſtill more towards the eaſt, they placed the Seres, and upon the coaſt of the gulf, which is now the bay of Cochin China, called by Ptolemy the Great Bay, were ſituated the Sinæ, ſo called by Ptolemy, though they are not mentioned by Strabo, Pomponius Mela, or Solinus. The Seres were probably the inhabitants of the northern parts of China, and the Sinæ, thoſe of the ſouthern parts of China, who very early occupied Cochin-China, Tonquin, &c. countries which in the ſequel they have entirely ſubjugated. They maintained a commerce by land with the Seres, and their route is pointed out in one of Ptolemy's maps. Beyond the Seres, according to Strabo and Pomponius Mela, lay between the Oriental ſea, though Ptolemy, for want of certain intelligence reſpecting that part of Aſia, conſiders the point as undecided, and places there ſeveral unknown countries. The ancients carried this extremity of Aſia much farther to the eaſt than it is found to extend by modern geographers; for, according to them, the Seres and the Sinæ were ſituated about the longitude of 180°, while the meridian of Pekin, or about the middle of the Chineſe empire, reaches no farther than to 134°, reckoning the longitude from the moſt diſtant of the Canary iſlands, as was done by Ptolemy. To the north of the Indus the ancient geographers placed the Scythians, and Hyperboreans (the Tartars and Samoides of more modern date) and ſome other nations to an indefinite extent, who were ſuppoſed to form on that ſide an inſurmountable barrier, having behind them an ocean of ice, which was believed to communicate with the Caſpian ſea, though this was at leaſt at the diſtance of 450 leagues.

The boundary of Aſia, aſſigned by the ancients to the ſouth, was the Indian ocean, and they were acquainted with its communication with the Red ſea, by means of a ſtrait, the figure of which is very ill expreſſed in their maps. This is alſo the caſe with the Perſian gulf, with which they were acquainted, but which in the ancient maps has nearly the form of a rhombus, one ſide of which, towards the mouths of the Indus, was pretty well known to them, but the ſide next the mouths of the Ganges is very inaccurately delineated, being continued nearly in a ſtraight line. It is even probable that the iſland which Ptolemy calls Taprobana, was only the peninſula of India very much disfigured in the delineation.

28 Situation of the iſland of Taprobane.

The ſituation of this iſland of Taprobana, ſo celebrated among the ancients, is a problem in geography that is yet unſolved. It is commonly ſuppoſed to be the modern iſland of Ceylon; but the dimenſions of it as laid down by ancient geographers, render this ſuppoſition doubtful, and there are ſome who rather believe it to be the modern Sumatra. The ancients had alſo ſome obſcure knowledge of the peninſula of Malacca, which they called the *Golden Cherſoneſus*, and they ſeem to have examined the gulf formed by that land, which is now the gulf of Cochin China, or commonly called the *gulf of Tonkin*. It is ſomewhat extraordinary that they do not ſeem to have been acquainted

quainted with Java, Borneo, and that numerous group of islands which form, in that quarter, the greatest Archipelago in the world. It is equally singular that the Maldives had escaped the observation of these navigators. This seems to prove that they never ventured out into the open sea, but kept close along the shore. Ptolemy indeed says, that his island of Taprobana was surrounded with many hundreds of smaller islands, to some of which he gives names; but all this is involved in impenetrable obscurity.

29 Africa.

Of Africa, the ancients knew only those parts which lay along the coast, and to a very small distance inland, if we except Egypt, with which they were well acquainted, at least as far as the cataracts of the Nile, and a little beyond them, as far as the island of Meroë, towards the 20th degree of north latitude. Their knowledge of the coasts of Africa on the side of the Red sea, extended no farther than the shores of that sea, except that part which was dependent on Egypt; the interior of the country being inhabited by ferocious and untractable people. They were still less acquainted with the countries which lay beyond the strait, and Ptolemy appears to have given no credit to the navigators who were said to have sailed round that part of the world, for he has left the continent of Africa imperfect towards the south. Strabo and Pomponius Mela were, however, decidedly of opinion that Africa was a peninsula, and that it was joined to the rest of the continent only by that narrow neck of land which is now called the isthmus of Suez. The ancients seem to have had no knowledge of that large and beautiful island of Madagascar, unless we suppose that Ptolemy had some imperfect acquaintance with it, under the name of the island *Menuthius*. The coast of Africa upon the Mediterranean sea, was once covered with towns, dependent on the Roman empire, flourishing and polished, while it presents at present nothing but a nest of pirates, whom the jealousy of the great commercial nations supports, to the disgrace and prejudice of civilized states. Proceeding from the straits of Gadez or Gibraltar, they had become acquainted with the coast as far as a cape which they called *Hesperion-Keras*, probably the modern Cape de Verd, or the cape that lies a little to the west of it, though in the maps of Ptolemy it is thrown a little back inland. The Fortunate islands, or the Hesperides, at present the Canaries, better known by fame than in reality, seem to have been the boundaries of ancient geography to the west, as the Seres and Sinæ were to the east. It appears, however, that the Cape de Verd islands were not entirely unknown to the ancients, and they are probably the same with what were then called the Gorgades or Gorgones, which were supposed to be two days sail to the west of Hesperion-Keras.

30

"There is little doubt (says Mr Patteson) concerning the names by which most of the principal countries of Europe were known to the ancients; nor is there any difficulty in disposing the chief nations, which ancient writers have enumerated in the south-west part of Asia or on the African coast of the Mediterranean; but with the north and north-east parts of Europe, about two thirds of Asia towards the same quarters, and nearly the same proportion of Africa towards the south, they appear to have been wholly unacquainted. Of America they did not even suspect the existence; and if it ever happened, as some writers have imagined, that Phœnician merchant ships were driven by storms across the Atlantic to the American shores, it does not appear that any of them returned from thence to report the discovery.

"The names of provinces, subdivisions, and petty tribes, mentioned by ancient authors, in those countries which were the chief scenes of Roman, Grecian, or Israelitish transactions, are almost as numerous as in a modern map of the same countries; and the situations of many of them can be very nearly assigned: but the limits of each, or indeed of the states or nations to which they belonged, can, in very few instances, be precisely fixed. Thus the southern boundaries of the Sarmatæ in Europe, cannot be ascertained within a degree at the nearest; and in France, neither the limits of the people called the Belgæ, Celtæ, and Aquitani; nor those of the Roman divisions, viz. Belgica, Lugdunensis, Aquitania, Narbonensis, and the Province, can be laid down, in many places, but by a hardy conjecture. The same observation may be justly applied to the Tarraconensis, Lusitania, and Betica of Spain; to the Cauci, Catti, Suevi, &c. of Germany; and, above all, to the Britannia prima et secunda, and other divisions of the Roman government in Britain: of which not only the limits, but the situations are still in dispute." *

* *Patteson's Atlas*, Part i. page 27.

31 Geography of the middle ages.

During the middle ages geography, as well as most other arts and sciences, seems rather to have gone backwards than advanced. The weakness of the Roman emperors, the relaxation of military discipline, the boundless passion for luxury and pleasure, and the continual incursions of the barbarous nations, while they contributed to hasten the fall of the western empire, also accelerated the ruin of the arts. It seems as if these destructive hordes of barbarians, the Goths, the Huns, and the Vandals, had enveloped the whole world in one profound and universal ignorance. This darkness, which overspread the whole of Europe, did not permit geography to make any advances for a very considerable time. There were indeed some navigators who investigated countries that were still little known, but they were so ignorant, that they afford us very little new light. There was one named Cosmas, who made a voyage to India, which procured him the name of Indo-Pleustes, and who gave an account of his voyage under the title of *Sacred Geography*. This man was so egregiously ignorant, as to believe that he had discovered that the earth was a plane, and that the diversity of the seasons, and the inequality of the days and nights, were owing to a very high mountain situated to the north, behind which the sun set to a greater or less depth.

32 Discoveries of the Arabians.

The voyages of the Arabians to the East Indies (see the history of COMMERCE), contributed to throw farther light on that extensive part of the globe. Conquerors of the countries on the Red sea, and enthusiastic propagators of their religion, they carried their arms as far as the extremity of India. We see them in the 9th century extending to China; and Renaudot has published two of their narrations, in which we can trace with tolerable accuracy, the places visited by their authors. The island of Serendib, so celebrated in their tales, is certainly the modern Ceylon; for *dib* or *dit*, in the Malay language, signifies *island*, so that Serendib, signifies the island of Seren or Selan. Farther, these relations

History. relations do not give us as favourable an idea of the Chinefe as we derive from their own hiftory; on the contrary, if we may believe thefe Arabian travellers, this people were, even at that time, in a ftate not very civilized.

33 Modern difcoveries. We are now arrived at the modern period of our hiftory, during which the moft important difcoveries have been made, and our knowledge of the habitable globe more than doubled. The difcoveries and improvements during this period are fo numerous, that it will be impoffible to give here any thing more than a chronological view of the moft remarkable, referring for a detailed account of them to the geographical and hiftorical articles in this work.

The tafte for voyages of difcovery began in Europe foon after the revival of literature in the 15th century, juft before the commencement of which, namely, in the reign of Henry III. king of Spain, about the year 1395, the Canary iflands were more fully furveyed than at any former period.

1415. Prince Henry III. fon of John king of Portugal, failed round the coaft of Africa.

1417. The Canary iflands were fubdued by Bethancourt, nephew of the admiral of France.

1420. The ifland of Madeira was examined by John Gonfalvo and Triftan Vaz, two Portuguefe.

1446. Cape de Verd was difcovered by Dennis Fernandez.

1487. The Cape of Good Hope was difcovered by Barthelemi Diaz. The difcovery of this cape led the way to that of the new world. This great event, which gave a new flight to the genius of mankind, is one of the moft important in the hiftory of geography. A particular account of this difcovery will be found under the article AMERICA. The following are the dates of the principal geographical difcoveries which have taken place between that of Columbus, and the voyages of our celebrated navigator Cook.

1496. Florida, by Sebaftian Gabot, an Englifhman.

1498. The Indies, by Vafco di Gama.

1499. The river of Amazons, by Yanez Pinçon.

1500. Brazil, by Alvarez Cabral, a Portuguefe.

1504. Newfoundland, by fome Normans.

1518. Mexico, by Ferdinand Cortes.

1519. The ftraits of Magellan, South fea, and Phillippine iflands, by Ferdinand Magellan.

1525. Canada, by Jean Verrazan, a Florentine, fent by Francis I. of France.—Peru, by F. Pizarro of Spain.

1527. New Guinea, by Alvaro de Salvedra.

1534. Chili, by Diego Almagro.

1535. California, by Ferdinand Cortes.

1567. The iflands of Solomon, by Alvaro de Mendoza.

1618. New Holland, by Zechaen.

1642. Van Dieman's land, by Abel Janfen Tafman.

1643. Brower's land.

1654. New Zealand.

1678. Louifiana, by Robert Cavelier de Lafalle, governor of Frontiniac.

1700. New Britain, by Dampier, an Englifhman.

1739. Cape Circumcifion, contefted between the French and Englifh. Said by Montucla to be difcovered by two French veffels

1767. The ifland of Taiti, by Wallis, an Englifhman.

1778. The Sandwich iflands, by Cook.

Within this period there are reckoned 25 voyages round the world, viz. thofe of Magellan, Drake, Cavendifh, Noort, Spilburg, Lemaire, L'Hermite, Clepington, Carreri, Shelvack, Dampier, Cowley, Woodes Rogers, Le Gentil, Anfon, Wallis, Roggewein, Bougainville, Sarville, Dixon, three voyages of Cook, La Peyroufe, Marchand, Vancouver, and Pages. 34 Number of voyages round the world.

Within thefe few years, very confiderable light has been thrown on the ftate of our geographical knowledge, by feveral valuable voyages and travels that have lately appeared. The difcoveries that have been fucceffively made in the great South fea, and in other parts of the world, efpecially the extenfive ifland of New Holland, are now fo fully eftablifhed, as to add confiderably to the certainty of our geographical knowledge; and the voyages of Cook, La Peyroufe, and Vancouver, have afforded us more exact furveys of the coafts of thefe countries than we could, fome years ago, have dared to hope for. The accounts of the late embaffies to China, Tibet and Ava, afford many authentic materials for a modern fyftem of geography, the place of which muft have been fupplied by more remote and doubtful information. From the latter of thefe accounts we are become familiarly acquainted with an empire (that of the Birmans), which a fhort time ago was fcarcely known (fee ASIA, 81—152.) Our knowledge of Hindoftan and the neighbouring countries has been greatly extended by the refearches of the Afiatic Society, and fome other late works; while our acquaintance with the interior of Africa has been rendered lefs imperfect by the exertions of the African Society, and by the travels of Park, Brown, and Barrow; and the northern boundaries of America, even as far as the fea which appears to furround the northern extremity of that vaft continent, have been more fully difclofed by the journeys of Hearne and Mackenzie. 35

The late voyage of Turnbull, however infignificant it may be in other refpects, has at leaft the merit of enlarging our knowledge of the manners and political tranfactions of the South fea iflanders, and of introducing to our acquaintance, in the perfon of Tamahama, the chief of Owhyhee, a fovereign, who, in ambition and defire of improvement, bids fair to vie with Peter the Great; and to transform a nation of favages, to a civilized people.

With all the advantages which geography has lately received, the fcience is ftill far from being perfect; and the exclamation which D'Anville is faid to have made in his old age, "Ah! mes amis, il y a bien d'erreurs dans la geographie"—*Ah! my friends, there are a great many errors in geography*, may ftill be applied with confiderable juftice. Many points in the fcience have been but very lately afcertained. Thus, the extent of the Mediterranean fea was almoft unknown at the beginning of the 17th century, although it is now almoft as exactly afcertained as that of any country in Europe. In a book publifhed by Gemma Frifius, *de orbis divifione*, in 1530, we find the difference of longitude between Cairo in Egypt and Toledo in Spain ftated at 53° inftead of 35°, and other meafures of extent are proportionally erroneous. Not many years ago there was an uncertainty with refpect to the extremity of the Black fea and the Cafpian, to the amount of 3° or 4°; and 36 Prefent defects of geography.

History.

and fo lately as the year 1769, the longitude of Gibraltar and of Cadiz was not known within half a degree.

Many parts of the geography of Europe are ftill very defective; Spain and Portugal have been but imperfectly explored, and European Turkey is ftill lefs known. It may appear extraordinary that we have yet no correct chart of the Britifh channel, though we are affured by Major Rennel that this is the cafe; and it has been proved by the trigonometrical furveys of Britain that have yet been publifhed, that there are many grofs errors in our beft county maps. We have had occafion to remark that geography has fometimes been retrogreffive, and there cannot be a greater proof of the truth of the obfervation, than that in a map of the Shetland iflands, publifhed not long ago, by Prefton, they are reprefented as too large by one third, both in length and breadth, and their relative pofitions are very inaccurate, though in the maps of the fame iflands publifhed before the year 1750, they are laid down with much greater accuracy, as appears from furveys made by order of the late king of France, and from the maps publifhed by Captain Donelly, and at Copenhagen, in the year 1787.

In Afia we are imperfectly acquainted with Tibet, and fome other central regions; and even Perfia, Arabia, and Afiatic Turkey, are but little known. Of Auftralafia, or New Holland, and New Guinea, almoft nothing is known except the coafts, and a great part of them towards the fouth has been but imperfectly explored. Of Polynefia, or the numerous iflands in the South Pacific ocean, we are alfo very ignorant; and in the Pacific ocean, particularly towards the fouth pole, many difcoveries probably remain to be made.

Our ignorance of the central parts of Africa is notorious, and the improvement of our geographical knowledge in that quarter has, for fome years, been a favourite object. It may admit of doubt, however, whether this object will be fpeedily attained, as the obftacles to inveftigation in thofe inhofpitable tracts, feem nearly infurmountable by human prudence and courage. Even the fhores of Africa have not been completely furveyed, efpecially thofe towards the fouth and eaft.

America has of late been much more fully explored than at any former period: but ftill the weftern parts of North America, and the central and fouthern regions of South America, are very little known; and the Spanifh fettlements towards the north are fcarcely known, except to their own inhabitants.

The fcience of geography will probably be never perfectly underftood, as, befides the numerous obftacles which oppofe the progrefs of the traveller, it is fcarcely poffible that exact trigonometrical furveys of every place and country, the only certain method of afcertaining their exact fituations and relative pofitions, can be made.

Political geography muft ever remain the moft uncertain part of the fcience. New changes are perpetually taking place in the relations of neighbouring ftates, according as ambition, tyranny, or commercial convenience dictates. Territory is transferred, by ceffion or by conqueft, from one nation to another. Whoever will compare the relations of the European ftates, as they appear in the prefent maps, and in thofe publifhed half a century ago, will fcarcely recognife the countries to be the fame. The great divifions indeed remain as before, but the boundaries of moft of them are entirely changed. A number of independent ftates, and in one inftance, a large kingdom, have been fwallowed up by the unjuftifiable ambition of their more powerful neighbours, and their names may be blotted from the map of Europe. The republics of Holland, of Switzerland, of Venice, are no more: the kingdoms of Poland and Sardinia have ceafed to exift; the fucceffor of St Peter, who once gave laws to princes, and governed Europe with unbounded fway, is now a wretched exile, and his dominions are doomed to increafe the already overgrown power of defpotic upftarts. Whether the prefent generation of emperors and kings, erected by the mighty Napoleon, will remain as long as did the ftates on whofe ruins they have been raifed, or are rather ephemeral productions, doomed to perifh at the fetting of that fun which now gives them life and vigour, is a queftion which future experience alone can determine.

37 The limits prefcribed to this article do not permit us to enter on a critical examination, or even a characteriftic fketch, of the geographical works that have appeared in the modern period of the hiftory of the fcience; and a bare enumeration of names would be equally tirefome and uninterefting. Some of the beft modern works will be mentioned in the fequel; at prefent we fhall conclude this Part in the words of an able judge of the prefent ftate of the fcience.

"The Spaniards and Italians (fays Mr Pinkerton) have been dormant in this fcience; the French works of La Croix and others are too brief; while the German compilations of Bufching, Fabri, Ebeling, &c. are of a moft tremendous prolixity, arranged in the moft taftelefs manner, and exceeding in dry names, and trifling details, even the minutenefs of our gazetteers. A defcription of Europe in 14 quarto volumes, may well be contrafted with Strabo's defcription of the world in one volume: and geography feems to be that branch of fcience, in which the ancients have eftablifhed a more claffical reputation than the moderns. Every great literary monument may be faid to be erected by compilation, from the time of Herodotus to that of Gibbon, and from the age of Homer to that of Shakefpeare; but in the ufe of the materials there is a wide difference between Strabo, Arrian, Ptolemy, Paufanias, Mela, Pliny, and other celebrated ancient names, and modern general geographers; all of whom, except d'Anville, feem under graduates in literature, without the diftinguifhed talents or reputation, which have accompanied almoft every other literary exertion. Yet it may fafely be affirmed, that a production of real value in univerfal geography requires a wider extent of various knowledge than any other literary department, as embracing topics of the moft multifarious defcription. There is, however, one name, that of d'Anville, peculiarly and juftly eminent in this fcience; but his reputation is chiefly derived from his maps, and from his illuftrations of various parts of ancient geography. In fpecial departments Goffelin, and other foreigners, have alfo been recently diftinguifhed; nor is it neceffary to remind the reader of the great merit of Rennell and Vincent in our own country *."

* *Pinkerton's Geography*, p. 8.

PART II. PRINCIPLES AND PRACTICE OF GEOGRAPHY.

38 CHAP. I. *Of the Surface, and General Diviſions of the Earth.*

IT has been ſuppoſed, by the leſs enlightened part of mankind in all ages, that the ſurface of the earth is nearly a plane, bounded on all ſides by the ſky. It was ſhewn, however, in the article ASTRONOMY, (N° 269—272) that the earth is of a ſpherical figure, and an account was there given of the manner in which the true form of it was determined. Independently of the conſiderations there detailed, the ſpherical figure of the earth may be inferred, in a popular view, from the following facts.

39 Proofs of the ſpherical form of the earth.

1. When we ſtand on the ſea-ſhore, while the ſea is perfectly calm, we eaſily perceive that the ſurface of the water is not quite plain, but convex or rounded; and if we are on one ſide of a broad river or arm of the ſea, as the frith of Forth, and with our eyes near the water, look towards the oppoſite coaſt, we ſhall plainly ſee the water elevated between our eyes and the oppoſite ſhore, ſo as to prevent our ſeeing the land near the edge of the water.

2. When we obſerve a ſhip leaving the ſhore, and going out to ſea, we firſt loſe ſight of the *hull*, then of the ſails and lower rigging, and laſtly of the upper part of the maſts. Again, when a ſhip is approaching the ſhore, the firſt part of her that is ſeen from the land is the topmaſt, then the ſails and rigging appear, and laſtly the hull comes gradually into view. Theſe appearances can ariſe only from the ſhip's ſailing on a convex ſurface; as, if the ſurface of the ſea was plain, a ſhip on its firſt appearance would be viſible, though very ſmall, in all its parts at the ſame time, or rather the hull would firſt appear, as being moſt diſtinguiſhable; and, in going out of ſight, it would in the ſame manner diſappear at once, or the hull would be the laſt part of which we ſhould loſe ſight.

3. Many navigators ſent on voyages of diſcovery, have, by keeping the ſame courſe, at length arrived at the port from which they ſet out, having literally ſailed round the globe. This could not happen if the ſea were a plain.

4. When we travel to a conſiderable diſtance, in a direction due north or due ſouth, a number of new ſtars ſucceſſively appear in the heavens, in the quarter to which we are travelling; while many of thoſe in the oppoſite quarter gradually and ſucceſſively diſappear, and are ſeen no more till we return in a contrary direction.

5. In an eclipſe of the moon, which has been ſhewn (ASTRONOMY, N° 199) to be owing to the obſcuration of the moon's ſurface by the ſhadow of the earth, the boundary of the obſcured part of the moon is always circular. Now, it is evident that no body, which is not ſpherical, can, in all ſituations, caſt a circular ſhadow.

40 Magnitude of the earth.

The diameter of the earth is generally computed at 7958 miles, though Mr Vince makes it 7930, nearer the medium derived from a compariſon of the polar with the equatorial axis. Taking this laſt, therefore, as the mean diameter, the circumference will be =24,912 miles, and conſequently the extent of the ſuperficies will be = 197,552,160 miles, of which it is computed that at leaſt two-thirds are covered with water.

In the above computation no account is taken of the mountains and other eminences on the ſurface of the globe; for, although theſe are of conſiderable conſequence in a geographical point of view, as they conſtitute the moſt natural and remarkable boundaries of countries, and by their influence on the ſoil and climate of the different regions, contribute in a great degree to form thoſe ſhades of diſtinction which diverſify the inhabitants of the ſeveral quarters of the earth, they are, however, too trifling, when compared with the diameter of ſo great a body, to make any ſenſible error in the calculation.

The ſurface of the earth is exceedingly diverſified, al- 41 Diviſions of the earth.
moſt everywhere riſing into hills and mountains, or ſinking into valleys; and plains of any great extent are extremely rare. Among the moſt extenſive plains, are the ſandy deſerts of Arabia and Africa, the internal part of European Ruſſia, and a tract of conſiderable extent in the late kingdom of Poland, now called Pruſſian Poland. But the moſt remarkable extent of level ground, is the vaſt platform of Tibet in Aſia, which forms an immenſe table, ſupported by mountains running in every direction, and is the moſt elevated tract of level country on the globe. The chief elevations or mountains that occur, with their elevation, &c. will be 42 Oceans.
mentioned under GEOLOGY. The greateſt concavities of the globe are thoſe which are occupied by the waters of the ſea, and of theſe by far the largeſt forms the bed of the Pacific ocean, which ſtretching from the eaſtern ſhores of New Holland to the weſtern coaſt of America, covers nearly half the globe. The concavity next in ſize and importance, is that which forms the bed of the Atlantic ocean, extending between the new and the old worlds; and a third concavity is filled by the Indian ocean. Smaller collections of water, though ſtill large enough to receive the name of oceans, fill up the remaining concavities, and take the names of Arctic and Antarctic oceans.

Smaller collections of water that communicate freely 43 Seas. Plate CCXXX.
with the oceans, are called *ſeas*, (vid. A; fig. 1), and of theſe the principal are the Mediterranean, the Baltic, the Black ſea, and the White ſea. Theſe ſeas ſometimes take their names from the country near which they flow; as the Iriſh ſea, and the German ocean. Some large bodies of water, which appear to have no immediate connexion with the great body of waters, being everywhere ſurrounded by land, are yet called *ſeas;* as the Caſpian ſea.

A part of the ſea running up within the land, ſo as 44 Bays or gulfs.
to form a hollow, if it be large, is called a *bay* or *gulf;* as the bay of Biſcay, gulf of Mexico: if ſmall, a *creek*, *road*, or *haven*.

When two large bodies of water communicate by a 45 Straits.
narrow paſs between two adjacent lands, this paſs is called

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called a *ſtrait* or *ſtraits* (C, fig. 1.) as the ſtraits of Gibraltar, the ſtraits of Dover, of Babelmandel, &c. The water uſually flows through a ſtrait with conſiderable

46 Currents.

force and velocity, forming what is called a current, and frequently this current always flows in the ſame direction. Thus, in the ſtraits of Gibraltar there is a conſtant current from the Atlantic into the Mediterranean, though the ſurface of the latter never ſeems to be elevated beyond its uſual level. There is always a current round Cape Finiſterre and Cape Ortegal, ſetting into the bay of Biſcay, and it has been diſcovered by Major Rennel, that this current is continued in a direction N. W. by W. from the coaſt of France to the weſtward of Ireland and the Scilly iſlands. Hence he draws this uſeful practical inſtruction for navigators who are entering the Engliſh channel from the Atlantic, viz. that they ſhould keep no higher latitude than 48° 45′, leſt they ſhould be carried by the current upon the rocks of Scilly. For want of this neceſſary precaution, it is ſaid that many ſhips have been loſt on theſe rocks.

47 Lakes.

A body of freſh water, entirely ſurrounded by land, is called a *lake*, *loch*, or *lough* (as D, fig. 1), with the exception of the ſea above mentioned; as the lake of Geneva, Lake Ontario, Lake Champlain, Loch Lomond, &c.

This term, or its ſynonimes, loch or lough, is ſometimes applied to what is properly a gulf or inlet of the ſea, as Loch Fyne in Scotland, and Lough Swilly in Ireland.

48 Rivers.

A conſiderable ſtream of water riſing inland, and running towards the ſea, is called a *river*; a ſmaller ſtream of the ſame kind is called a *rivulet* or *brook*. Vid. E, fig. 1.

49 Continents.

The great extent of land which forms the reſt of the globe, is divided into innumerable bodies, ſome of which are very large, but the majority extremely ſmall. There are three very extenſive tracts of country, which may all be denominated continents, though only two of them have hitherto been diſtinguiſhed by that appellation. The moſt conſiderable of theſe continents is what has been called *the old world*, compriſing Europe, Aſia, and Africa. The ſecond comprehends North and South America, or what has been denominated *the new world*, and is little inferior in extent to the former. The third great diviſion forms the country called New Holland.

50 Iſlands.

A body of land entirely ſurrounded by water is called an *iſland*, (vid. *a*, fig. 1.) as Britain, Ireland, Jamaica, Madagaſcar, &c. According to the ſtrict meaning of this definition, the large diviſions juſt mentioned are iſlands; for it is almoſt certainly aſcertained, that the continent of North America is everywhere bounded by the ſea, and it has long ceaſed to be doubtful that New Holland is in the ſame circumſtances, and it is generally called the largeſt iſland in the word. But perhaps it would be better to confine the term to thoſe numberleſs ſmaller iſlands that appear above the ſurface of the waters. When a number of ſmaller iſlands are ſituated near each other, the whole aſſemblage is commonly called a group of iſlands, as *b*, *b*. The large aſſemblages of iſlands that have been diſcovered in the South Pacific ocean, have lately been comprehended under the name of Polyneſia, conſtituting a ſixth diviſion of the whole earth; the other five being Europe, Aſia, Africa, America, and the iſlands of New Holland and New Guinea, under the name of Auſtralaſia.

51 Peninſula.

A body of land that is almoſt entirely ſurrounded by water is called a *peninſula*, as *c*, fig. 1.; as the peninſula of Malacca, the Morea, or Grecian Peloponneſus, &c. Indeed the continent of Africa may be conſidered as a vaſt peninſula, being united to Aſia only by the ſmall iſthmus of Suez.

52 Iſthmus.

The narrow neck of land which joins a peninſula to the main land, or which connects two tracts of country together, is called an *iſthmus*, as *d*. The moſt remarkable iſthmuſes are the iſthmus of Darien, connecting the continents of North and South America, and the iſthmus of Suez, joining Africa to Aſia.

53 Promontory and cape.

A narrow tract of land ſtretching far out into the ſea, being united to the main land by an iſthmus, is called a *promontory*, and its extremity next the ſea, is called a *cape*; as *e f*, fig. 1. The moſt remarkable capes are the Cape of Good Hope, at the ſouthern extremity of Africa; Cape Horn at the ſouthern extremity of South America; the North Cape at the northern extremity of Europe; and Cape Talmara, at the northern extremity of Aſia.

It may aſſiſt the memory of the young geographer, to compare together the above diviſions of land and water. We may remark that the large bodies of land, called continents, correſpond to the extenſive tracts of water called oceans; that iſlands are analogous to lakes; peninſulas to ſeas or gulfs; iſthmuſes to ſtraits; promontories to creeks, &c.

The inhabited parts of the earth are calculated to occupy a ſpace of 38,990,569 ſquare miles, of which the four quarters into which the globe is uſually divided are ſuppoſed to have the following proportions:

Europe,	4,456,065
Aſia,	10,768,823
Africa,	9,654,807
America,	14,110,874.

The whole population of the earth has been computed at 700,500,000 ſouls; and of theſe

Aſia is ſuppoſed to contain	500,000,000
Europe,	150,000,000
Africa,	30,000,000
America,	20,000,000
and Auſtralaſia and Polyneſia, &c.	500,000

Hence the proportional number of inhabitants to every ſquare mile in each quarter is as follows:

In Aſia	46
Europe	34
Africa	3
America	3 to every two ſquare miles.

Chap. II. *Of the Conſtruction and Uſe of the Globes.*

Sect. I. *Deſcription and Uſe of the Terreſtrial Globes.*

54 Nature of the globes.

For the purpoſe of repreſenting more accurately the globe which we inhabit, geographers have long had recourſe to ſpherical balls, on the face of which are drawn the various diviſions of the earth, and which are fitted up with ſuch an apparatus, as enables us to illuſtrate and explain the phenomena produced by the motions

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tions of the earth, and the different ſituations of its various inhabitants. The ball thus prepared, is called an *artificial globe*, and what we have deſcribed is properly the *terreſtrial globe*, ſo called to diſtinguiſh it from another of a ſimilar form, and furniſhed in a ſimilar manner, but the ſurface of which repreſents the various aſſemblages of ſtars or conſtellations that appear in the heavens, and therefore this is called the *celeſtial globe*.

55 Circles on the globes.

In order to aſcertain the relative poſitions of places and countries on the earth, certain circles are ſuppoſed to be drawn on its ſurface, analogous to thoſe which were mentioned in Astronomy, as ſuppoſed to be drawn in the heavens. As theſe circles are really repreſented on the artificial globes, it will be proper here to conſider a little more particularly their nature and uſes.

56 Axis and poles.

As the earth turns about on an imaginary axis, once in 24 hours, the artificial globe is furniſhed with a real axis, formed by a wire paſſing through the centre, and on which the globe revolves. The two extremities of this axis are its poles, the one being called the *north*, and the other the *ſouth pole*.

57 Equator or equinoctial.

A great circle drawn on the globe, at an equal diſtance from both poles, is the equator or equinoctial line, and repreſents on the globe a ſimilar circle, ſuppoſed to be drawn round the earth, and diſtinguiſhed by the ſame names. By ſailors this is commonly called the *line*, and when they paſs over that part of the water, where it is imagined to be drawn, they often make uſe of various ſuperſtitious ceremonies. The two parts of the globe into which it is divided by the equator, are called the *northern and ſouthern hemiſpheres*.

The equinoctial line on the earth paſſes through the middle of Africa, in the almoſt unknown territories of Macoco, and Monemugi, traverſes the Indian ocean, paſſes through the iſlands of Sumatra and Borneo, and the immenſe expanſe of the Pacific ocean; then extends over the province of Quito in South America, to the mouth of the river Amazons.

As every circle is ſuppoſed to be divided into 360°, ſo the equator is thus divided on the artificial globe.

58 Meridians.

Through every 15° of the equator there is drawn on the globe a great circle paſſing through the poles. Theſe circles are called *meridians*, becauſe when the ſun in his apparent courſe from eaſt to weſt reaches the correſponding circle in the heavens, it is noon on that part of the earth over which the meridian is ſuppoſed to paſs. Properly ſpeaking, every place on the earth has its own meridian, though to prevent confuſion, theſe circles are drawn on the artificial globe, only through every 15° of the equator. To ſupply the place of the other meridians, the globe is hung in a ſtrong brazen circle, which is called the *brazen meridian*, or ſometimes only the *meridian*. The brazen meridian, like the equator, is divided into 360°, but theſe are marked by nineties on each quadrant, being on one half of the meridian numbered from the equator to the poles, and on the other half from the poles to the equator. On the oppoſite ſide of the brazen meridian there are two concentric ſpaces, which are divided into degrees correſponding to the months and days of each month, the degrees being marked on concentric ſpaces from the north pole to about $23\frac{1}{4}°$ both ways. The uſe of theſe diviſions will appear hereafter (B).

59 Brazen meridian.

60 Parallels of latitude.

Through every tenth degree of the meridians, there are drawn on the globe circles parallel to the equator, which, for a reaſon that will appear preſently, are called *parallels of latitude*.

Before we proceed in deſcribing the other circles, &c. of the artificial globe, we ſhall here make a few remarks on the uſes of the equator, the meridians and parallels (C).

61 Of latitude and longitude.

The equator ſerves to meaſure the diſtance of one place from another, either to the eaſtward or weſtward, and this diſtance is called the *longitude* of the place. The meridians ſerve in like manner to meaſure the diſtance of one place from another in a direct line north or ſouth of the equator, and the diſtance of the place thus meaſured is called its *latitude*.

The longitude and latitude of places may be illuſtrated in the following manner. Let PEP′Q (fig. 3) repreſent the earth or the globe, (ſuppoſed to be tranſverſe) whoſe axis is PCP′, the north pole being P, and the ſouth pole P′; and let EAQR repreſent a circle paſſing through the centre C, in a direction perpendicular to the axis PP′. This circle correſponds to the equator, and it divides the earth of the globe into two hemiſpheres, EPQ being the northern, and EP′Q the ſouthern hemiſphere. Let G, I, K, repreſent the ſituations of three places on the ſurface of the globe, through which let the great circles PKP′, PIP′, and PGP′, be drawn, interſecting the equator EQ, in *n*, *m*, *a*, reſpectively. The circles are the meridians of the places K, I, G. As every circle is ſuppoſed to be divided into 360°, there muſt be 90° from each pole to the equator. Hence the latitude of the place K is meaſured by the degrees of the arc intercepted between K and *n*, and the latitudes of G and I are meaſured by the degrees of the arcs intercepted between G and *a*, and I and *m* reſpectively. Theſe latitudes will be called north

(B) The meridians are properly only ſemicircles, reaching from pole to pole, and of theſe there are twenty-four.

(C) In Geography, as in other ſciences, there are two methods of conveying inſtruction. One is, to lay down the principles of the ſcience firſt, and afterwards apply theſe to the practice of it; the other method is, to combine the principles and practice in one view. The former is uſually conſidered as the more ſcientific, but we are inclined to think that the latter is often to be preferred, as being leſs dry and tedious, eſpecially to a general reader. We have here, therefore, choſen to explain the nature of latitude and longitude, and the problems reſpecting them, before completing the deſcription of the globe. We ſhall proceed in the ſame manner, uniting as far as poſſible, the principles and practice in one view. Making, therefore the terreſtrial globe our text book, we ſhall thence explain the principles of geography, rather than detail theſe in a ſeparate ſection, and afterwards illuſtrate them by the globe.

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north latitudes, because the places lie in the northern hemisphere. Let there be two other places, WV, in the southern hemisphere; the latitude of W will be measured by the degrees of the arc intercepted between W and *a*; and the latitude of V by the arc intercepted between V and *m*; and these will be called south latitudes. Further, let the circle *c*, *e*, *d*, *v*, G, be drawn parallel to the equator; this circle is called a parallel of latitude, and as it does not pass through the centre, it is evidently less than the equator, or it is a small circle. Now, all the arcs, such as R, *e*, *a*, G, &c. intercepted between the parallel and the equator, must be equal, since the circle is parallel to the equator; and hence every point in this parallel, or every place on the earth through which it is supposed to pass, has the same latitude.

Latitude is the same all over the earth, being constantly measured from the equator to the poles.

The longitude of a place is measured by the degrees of an arc of the equator, intercepted between some particular meridian, and the meridian passing through the place. Thus, suppose G to represent the particular meridian, and *m* to represent the place whose longitude is required; the longitude of *m* is measured by the arc *m a* of the equator, intercepted between *a*, the point where the meridian of G meets the equator, and *m* the point of the equator where it is cut by the meridian of the place *m*. The particular meridian from which we begin to reckon the degrees of longitude is called the *prime* or *first meridian*, and it is different in different countries.

The method of estimating the distances of places by longitudes and latitudes, is of considerable antiquity, and was employed by Eratosthenes, who first introduced a regular parallel of latitude, which began at the straits of Gibraltar, passed eastwards though the island of Rhodes to the mountains of India; all the intermediate places through which it passed being carefully noted. Soon after drawing this parallel through Rhodes, which was long considered with a degree of preference, Eratosthenes undertook to trace a meridian, passing through Rhodes and Alexandria, as far as Syene and Meroë. Pythias of Marseilles, according to Strabo, considering the island of Thule as the most western point of the then known world, began to count the longitude from thence, while Marianus of Tyre placed their first meridian at the Fortunate islands, or the Canaries; but they did not determine which was the westermost of these islands, and consequently which ought to serve as a first meridian. Among the Arabians, Alfragan, Albategnus, Nassir Eddin, and Ulug Beg, also reckoned from the Fortunate islands; but Abulfeda began to reckon his longitude from a meridian 10° to the eastward of that of Ptolemy, probably because it passed through the western extremity of Africa, where, according to him, were situated the pillars of Hercules; or because it passed through Cadiz, which was at that time rendered famous by the conquests of the Moors in Spain.

When the Azores were discovered by the Portuguese in 1448, some geographers made use of the island of Tercera as their first meridian. Other geographers, as Blaeu, father and son, placed the first meridian at the Peak of Teneriffe, a mountain so far elevated above the sea, that it may be easily known by navigators; while others have made the island of St Philip, one of the Cape de Verds, the first meridian, because they conceived this to be the place where the magnetic needle had no variation. For a long time it was customary to reckon the longitude in most countries from the isle of Ferro, one of the Canary isles; but it is now customary for each nation to reckon the longitude, either from the metropolis of the country, or from the national observatory situated near it. Thus in France, Paris is the first meridian, and in Great Britain, the Royal Observatory of Greenwich. As in several good maps, the isle of Ferro is still used as a first meridian, it may be proper to remark, that the observatory at Greenwich lies 17° 45′ to the east of Ferro. Hence it is very easy to reduce the longitude of Ferro to that of Greenwich; for if the longitude required be east, we have only to subtract 17° 45′ from the longitude of Ferro, and the remainder is the longitude east from London; on the other hand, if the place be west from Ferro, we obtain the longitude west from London by adding to that of Ferro 17° 45′. If the place lies between Ferro and London, its longitude from London will be obtained by subtracting its longitude east from Ferro from 17° 45. It is evident that by the reverse of this method, we may reduce the longitude from London to that of Ferro.

62 Method of reducing longitudes to the same meridian.

In the diagram referred to above, if G represent the observatory of Greenwich, *a* will be the point from which we begin to reckon the degrees of longitude, and all places situated to the east of *a*, such as R, *m*, will have east longitude, while those situated to the west, as *n*, will have west longitude. In reckoning the longitude, we sometimes number the degrees only as far as 180°, but at other times they are numbered all round the equator from the point *a*; for instance, 180°, till we come to *a* again; hence reckoning in the direction *a*, R, *m*, we should say that every place was in so many degrees east longitude, while if we reckoned in the direction *n*, E, we should say that all the places had so many degrees west longitude all round the equator. To accommodate the globes to both these modes of reckoning the longitude, the equator is usually divided both ways, in a continued series from 0 at the first meridian to 360°.

It is evident, that as the parallels of latitude become smaller as they approach the poles, the arcs of these parallels intercepted between the same two meridians will be also smaller as we proceed from the equator to the poles, though in fact they consist of the same absolute number of degrees. Hence it will be easy to see that a degree of longitude must be smaller towards the poles than at the equator, and must become gradually smaller and smaller till we arrive at the poles, where it will be equal to nothing. Thus the arc G *v*. contains the same number of degrees as the arc *a*, *m*, though the former arc is much smaller than the latter. As a degree of longitude is therefore different at every degree of latitude, it becomes necessary to ascertain the relative proportion between the two; and for this purpose the following table has been constructed, which shews the absolute measure of a degree of longitude in geographical miles and parts of a mile for every degree of latitude, taking the degree of longitude at the equator, equal to 60 geographical miles.

TABLE I. *Shewing the length of a degree of longitude for every degree of latitude, in geographical miles.*

Lat.	Geo. miles.	Lat.	Geo. miles	Lat.	Geo. miles	Lat.	Geo. miles	Lat.	Geo. miles	Lat	Geo. miles.
1	59.96	16	57.60	31	51.43	46	41.68	61	29.04	76	14.51
2	59.94	17	57.30	32	50.88	47	41.00	62	28.17	77	13.50
3	59.92	18	57.04	33	50.32	48	40.15	63	27.24	78	12.48
4	59.86	19	56.73	34	49.74	49	39.36	64	26.30	79	11.45
5	59.77	20	56.38	35	49.15	50	38.57	65	25.36	80	10.42
6	59.67	21	56.00	36	48.54	51	37.73	66	24.41	81	9.38
7	59.56	22	55.63	37	47.92	52	37.00	67	23.45	82	8.35
8	59.40	23	55.23	38	47.28	53	36.18	68	22.48	83	7.32
9	59.20	24	54.81	39	46.62	54	35.26	69	21.51	84	6.28
10	59.08	25	54.38	40	46.00	55	34.41	70	20.52	85	5.23
11	58.89	26	54.00	41	45.28	56	33.55	71	19.54	86	4.18
12	58.68	27	53.44	42	44.95	57	32.67	72	18.55	87	3.14
13	58.46	28	53.00	43	43.88	58	31.79	73	17.54	88	2.09
14	58.22	29	52.48	44	43.16	59	30.90	74	16.53	89	1.05
15	58.00	30	51.96	45	42.43	60	30.00	75	15.52	90	0.00

As it is often more convenient to estimate degrees of longitude in English statute miles, we have added the following

TABLE II. *Shewing the length of a degree of longitude for every degree of latitude, in English statute miles.*

Lat.	Eng. miles.	Lat.	Eng. miles.	Lat	Eng. miles.	Lat.	Eng. miles.	Lat.	Eng. miles.	Lat.	Eng. miles.
0	69.2000	16	66.5192	32	58.6851	48	46.3038	64	30.3352	80	12.0166
1	69.1896	17	66.1760	33	58.0360	49	45.3994	65	29.2453	81	10.8250
2	69 1578	18	65.8134	34	57.3696	50	44.4811	66	28.1464	82	9.6306
3	69.1052	19	65.4300	35	56.6852	51	43.5489	67	27.0385	83	8.4334
4	69.0312	20	65.0265	36	55.9842	52	42.6037	68	25.9230	84	7.2335
5	68.9363	21	64.6037	37	55.2659	53	41.6453	69	24.7992	85	6.0315
6	68.8208	22	64.1609	38	54.5303	54	40.6751	70	23.6678	86	4.8274
7	68.6845	23	63.6986	39	53.7788	55	39.6917	71	22.5294	87	3.6219
8	68.5267	24	63.2177	40	53.0100	56	38.6959	72	21.3842	88	2 4151
9	68.3481	25	62.7167	41	52.2259	57	37.6891	73	20.2320	89	1.2075
10	68.1489	26	62.1963	42	51.4253	58	36.6705	74	19.0743	90	0.0000
11	67.9288	27	61.6579	43	50.6094	59	35,6408	75	17.9103		
12	67.6880	28	61.1001	44	49.7783	60	34.6000	76	16.7409		
13	67.4264	29	60.5237	45	48.9313	61	33.5489	77	15.5665		
14	67.1448	30	59.9293	46	48.0705	62	32.4873	78	14.3874		
15	66.8424	31	59.3162	47	47.1944	63	31.4161	79	13.2041		

63
Method of reducing degrees to miles and v. v.

Hence it appears that the degrees of latitude are all equal, and that a degree of longitude at the equator is equal to a degree of latitude, as each is $\frac{1}{360}$th of a great circle. In the second of the above tables, a degree of longitude at the equator is estimated at 69.2 English miles, or about 69¼. The length of a degree in miles is usually estimated at 69½, but this is too much. Hence, to reduce degrees of latitude, and those of longitude near the equator, to English miles, it is necessary to multiply them by 69.2, or, if great accuracy is not required, by 70.

64
Problems on latitude and longitude.

PROBLEM I. *To find the latitude and longitude of a given place.*

Bring the place below the graduated edge of the *brazen meridian*, and the degree of the meridian that lies immediately over the place is its *latitude*. Observe where the meridian cuts the equator, and that degree will be the *longitude* of the place.

Example. To find the latitude and longitude of Edinburgh.—Bringing Edinburgh below the meridian, we find over it nearly the 56th degree of north latitude (55° 58′), and the point where the meridian cuts the equator is nearly 3¼ (3° 12′ W. Long.) degrees west from London.

N. B. The longitude and latitude of places cannot be ascertained exactly by the globes, as these are not calculated to show the fractional parts of a degree; but they may be found with sufficient correctness for ordinary purposes.

COROLLARY I. The difference of latitude and longitude

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gitude between two places is found by subtracting the less from the greater, if they lie the same way, i. e. north or south, east or west; or by adding the two together, if they lie in a different direction.

Cor. 2. Those places that have the same latitude with any given place are found, by bringing the given place to the meridian, and observing what places pass under the same degree, while the globe is turned round.

Cor. 3. Those places which have the same longitude with a given place, are found by bringing the place to the meridian, and observing what other places lie under the graduated edge, while the globe is at rest.

Problem II. *The latitude and longitude of a place being given, to find the place itself on the globe.*

Turn the globe till the given longitude comes under the brazen meridian; then mark the given latitude on the meridian, and immediately below it is the place required.

Example. What place is situated in 48° 23′ N. Lat. and 4° 29′ E. Long. from Greenwich? *Ans.* Brest in France.

65 Computation of longitude in time.

As the sun, in his apparent motion round the earth, measures a great circle in about 24 hours, or in one hour passes over $\frac{1}{24}$th of such circle, or 15°; it is evident that all places which lie 15° west of any meridian, must have noon or any other time of the day, an hour *later* than those situated under that meridian; and that all places which lie 15° *east* of any meridian, must have the same times of the day an hour *sooner*. Hence, because the meridians drawn on the globe make a difference of an hour each in the time of places, they are sometimes called hour-circles; and the longitude of places is sometimes reckoned in *time* as well as in *degrees*.

Degrees of longitude are reduced to hours and minutes, and *v. v.* by allowing an hour for every 15°, and four minutes for every degree.

66 Horary circles.

Though the meridians on the globe are sometimes called *horary circles*, this name is generally confined to a small brass circle, which is adapted to one or each pole, and graduated into twice twelve hours; so that an index fixed to the axis, or the meridian, points out the several hours of day and night as the globe revolves.

In globes of the old construction the hour circles are fixed on the outside of the meridian, but this prevents the meridian from being moved quite round, which is required in some problems.

Mr Joseph Harris, formerly assay-master of the mint, contrived an ingenious method of remedying this inconvenience. He placed two horary circles between the meridian and the globe, one at each pole, and they were fixed tightly between two brass rollers, placed about the axis, so that when the globe was turned, they were carried round with it, while the edge of the brazen meridian served as an index to cut the horary divisions. A globe, thus furnished, serves universally and readily for performing problems in both northern and southern latitudes; and also in places near the equator; whereas, in globes of the old construction, the axis and horary circle prevent the brazen meridian from being moved quite round in the horizon.

The construction of the hour circles was rendered somewhat more simple by Mr G. Wright of London. In his globes, there are engraved two hour circles, one at each pole, on the map of the globe, each circle being divided into a double set of 12 hours, as in the usual hour circles; but here the hours are numbered both to the right and left. (See fig. 4.) The hour hand, or index, is placed below the brazen meridian, in such a way that it may be moved at pleasure to any required part of the circle, and remain there sufficiently steady during the revolution of the globe on its axis, being entirely independent of the pole. In this manner the motion of the globe round its axis, carrying the hour circle, the time is pointed out by the stationary index.

In the globes constructed by the late Mr George Adams, the equator is made to answer the purpose of an hour circle, by means of a semicircular wire placed in its plane, (see Q F, fig. 5.) and carrying two indices F, one on the eastern, the other on the western, side of the brazen meridian. The method of using these indices will be shewn presently. In these globes the equator is also marked with twice 12 hours, which increase from east to west, the hours to the west of the first 12 being afternoon hours.

Problem III. *The hours at any place being given, to find what hour it is at any other place.* 67 Problems relating to time.

a, By the ordinary globes.

Bring the place at which the hour is given to the meridian, and set the index of the hour circle to the given hour. Then turn the globe till the other place comes under the meridian, and the index will now point to the hour required.

N. B. Where there is no index, the edge of the meridian will in both cases point out the hour.

b, By Adams's globes.

The steps are here the reverse of the former. Bring the place at which the time is required to the brazen meridian, and set the index to the given hour. Then turn the globe till the other place comes below the meridian, and the index will shew the time required.

N. B. In the ordinary globes, where the hour circle is usually marked with two sets of figures, it is proper, in performing this problem, to make use of that set which increases towards the right hand, observing that whichever XII. is fixed on for noon, the hours to the right or *east* of this are hours P. M. and those to the left or *west* are hours A. M. On Adams's globes the contrary of this takes place, from the hours being marked on the equator. They increase from east to west, and, of course, those to the east of XII. are morning hours, and those to the west of it afternoon hours.

Example 1. When it is noon at London, what hour is it in the Society isles? *Ans.* Two A. M.

Ex. 2. When it is 3 P. M. at Edinburgh, what hour is it at Delhi in Hindoostan? *Ans.* Thirty minutes past eight P. M.

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PROBLEM IV. *Having the hour at any place given, to find all thofe places where it is noon.*

a, By the ordinary globes.

Bring the given place to the meridian, and fet the index to the given hour. Then turn the globe till the index point to 12 at noon, and the places then under the meridian are thofe required.

b. By Adams's globes.

Bring the given place to the meridian, and fet the index to 12 at noon. Then turn the globe till the index fhall point to the given hour; and all the places then under the meridian have noon at that time.

Ex. 1. It is now 30 min. paft 10. A. M. at Edinburgh; In what places is it noon? *Anf.* Near Stockholm; at Dantzic, Breflaw, Prefburg, Vienna, Pofega, Ragufa, Tarento, and the Cape of Good Hope.

Ex. It is now midnight at London; Where is it noon? *Anf.* In the north-eaft parts of Afia, in the middle of Fox ifles; at the Friendly ifles (nearly), and at the eaft cape of New Zealand.

From the different fituation of places with refpect to latitude and longitude, the inhabitants of thefe places received from the ancients denominations that are ftill retained.

68 Antœci. Thus, thofe places which have the fame longitude, or are fituated under the fame meridian, but are in oppofite latitudes, the one lying as many degrees to the north of the equator as the other lies to the fouth of it, are faid to be ANTOECI to each other. From this definition it is evident, that thofe places fituated under the equator have no *antœci*.

The appearances arifing from the changes of the heavenly bodies are different in the oppofite places. Thus, 1. The days of the one are equal to the nights of the other, and *vice verfa;* but they have noon, midnight, and all the other hours at the fame time. 2. They have contrary feafons at the fame time: when it is fummer at one place it is winter at the other, and fo of fpring and autumn. 3. The ftars that never fet at one place, never rife at the other, and *vice verfa*.

69 Periœci. Again, thofe places that have the fame latitude, or are under the fame parallel, but are in oppofite longitudes, i. e. lie under oppofite arcs of the fame meridional circle, or 180° from each other, are faid to be PERIOECI to each other. Thofe places which may be fituated at the poles, have evidently no *periœci*.

The celeftial appearances to the periœci are as follow. 1. The length of the day or night is the fame to both places; but the hours, though diftinguifhed by the fame numbers, are contrary; noon at the one being midnight at the other; and any hour in the forenoon at the one being the fame of the afternoon to the other. 2. Both places have the fame feafons of the year at the fame time. 3. The fame ftars that never rife or fet to one place, alfo never rife or fet to the other. 4. The heavenly bodies rife in the fame point of the horizon at both places, and continue for the fame interval above or below it.

70 Antipodes. Laftly, Thofe places which are fituated directly oppofite to each other, by a diftance equal to the diameter of the earth, are faid to be ANTIPODES to each other. If we conceive a line through the centre of the earth, and terminated in two points of its furface, thefe extreme points are antipodes to each other. Thus, the city of Lima in Peru is nearly the antipodes to Siam in the Eaft Indies; and Pekin in China has for its antipodes Buenos Ayres in South America. Thefe places are always in oppofite longitudes, and (except under the equator) in oppofite latitudes.

The celeftial appearances to the antipodes are thefe. 1. The hours are contrary, as to the periœci. 2. The days of the one are of the fame length with the nights of the other; hence the longeft day to one is the fhorteft to the other, and *vice verfa*. 3. They have contrary feafons at the fame time. 4. Thofe ftars which, at one place are always above the horizon, are, to the other, always below it. 5. When the heavenly bodies are rifing at one place, they are fetting at its *antipodes*, and *vice verfa*. For various opinions refpecting the antipodes, fee the article ANTIPODES.

The antipodes of any place are the periœci to the antœci of that place; and the antœci to their periœci. This will account for the method prefently defcribed of finding the antipodes on the globe.

PROBLEM V. *To find the* antœci *to any given place.* 71 Problems.

Bring the given place to the meridian, and thus afcertain its latitude. Then count from the equator towards the oppofite pole as many degrees as are equal to the latitude of the place; and the point where this reckoning ends is the place required.

Ex. 1. Where are the *antœci* to the Cape of Good Hope? *Anf.* At Malta nearly.

Ex. 2. What people are the *antœci* to the inhabitants of Quebec in North America? *Anf.* The inhabitants of Patagonia in South America.

PROBLEM VI. *To find the* periœci *of any given place.*

Bring the given place to the brazen meridian, and fet the horary index to the upper XII. Then turn the globe till the index point to the lower XII. The place which is then below the meridian in the fame latitude with that of the given place, is the fituation required.

Ex. 1. Where are fituated the *periœci* of Newcaftle upon Tyne? *Anf.* In the Alcoufki or Fox iflands.

Ex. 2. Required the periœci to California in North America. *Anf.* Near the mouth of the river Indus.

PROBLEM VII. *To find the* antipodes *to any given place.*

Find the *antœci* of the given place (by Problem V.) and then find the *periœci* of the latter (by Problem VI.) This laft is the place required.

Ex. 1. It is required to find the antipodes of London. *Anf.* The latitude of London is 51° 31′ N. the antœci to this, or 51° 31′ S. on the prime meridian, is in the fouth Atlantic ocean; the periœci to this is in 180° W. Long. and 51° 31′ S. Lat. a little to the fouth of the iflands of New Zealand. The inhabitants of the fouthern ifland of New Zealand are therefore the neareft antipodes to London.

Several other circles befides thofe which we have mentioned are defcribed on the artificial globe, and are fuppofed to be drawn on the earth. Thefe we fhall now proceed to defcribe, and explain their geographical ufes.

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72 The Ecliptic.

The *Ecliptic* (ASTRONOMY, N° 43.) is a great circle drawn on the globe, crossing the equator obliquely in two points, called the equinoctial points. (ASTRONOMY, N° 44.) This circle extends on each side of the equator to the latitude of 23° 28′, and is divided into 12 great parts corresponding to the 12 signs of the zodiac (see ASTRONOMY, N° 52.), and marked with their characters, and each sign is subdivided into 30 degrees. The ecliptic has also its poles, which are two points that are distant 90° every way from the circle on each side. As the ecliptic declines from the equator 23° 28′, its poles are consequently distant from those of the equator, or of the globe, by the same measure. This circle properly belongs to the celestial globe, but as it is extremely useful in performing many geographical problems, it is always drawn on both globes, and requires to be noticed here, since it determines the position of several of the circles which we are about to mention.

73 Tropics.

Through those two points of the ecliptic, where it is at the greatest distance from the equator, there are drawn on the globes two circles parallel to the equator, called *tropics*. That in the northern hemisphere is called the *Tropic of Cancer*, as it passes through the sign Cancer; and, for a similar reason, that which is in the southern hemisphere is called the *Tropic of Capricorn*. The two points through which they are drawn are called *solstitial points*. The imaginary line which corresponds to the tropic of Cancer on the earth passes from near Mount Atlas on the western coast of Africa, past Syene in Ethiopia: thence, over the Red sea, it passes to Mount Sinai, by Mecca the city of Mahomet, across Arabia Felix to the extremity of Persia, the East Indies, China, over the Pacific ocean to Mexico, and the island of Cuba. The tropic of Capricorn takes a much less interesting course, passing through the country of the Hottentots, across Brasil, to Paraguay and Peru.

74 Polar circles.

If the poles of the ecliptic be supposed to revolve about the poles of the earth, they will describe two circles parallel to the equator, and 23° 28′ distant from it. Two such circles are drawn on the globes, and are called *Polar Circles*, that in the north being called the *Arctic Polar Circle*, or merely the *Arctic Circle*, while that in the south is called the *Antarctic Polar Circle*, or *Antarctic Circle*.

Both the tropics and the polar circles are marked on the globes by dotted lines, to distinguish them from the other parallels.

75 Colures.

The meridional circles that pass through the equinoctial and solstitial points are called *Colures*; the former being called the *Equinoctial* and the latter the *Solstitial Colure*.

For an account of the variety of day and night in different parts of the globe, see ASTRONOMY, Part II. ch. i. sect. 2.

76 Zones.

By means of the tropics and polar circles, the earth is supposed to be divided into five spaces, to which the ancients gave the name of *Zones*, or *Belts*. Thus the space included between the two tropics was called the *Torrid Zone*, because it was supposed to be so much heated or *roasted* by the vertical sun, which there prevails, as to be uninhabitable. The ancient terms are still occasionally used, but the countries between the tropics are now more commonly called the *Intratropical Regions*. The two spaces included between each tropic and its corresponding polar circle were called *Temperate Zones*, and were distinguished according to their position into *Northern* and *Southern Temperate Zones*. Lastly, The spaces between the polar circles and the poles were called the northern and southern *Frigid Zones*, and were supposed uninhabitable from excessive cold. These last are usually denominated the *Polar Regions*.

77 Countries between the tropics.

The countries lying between the tropics are the greater part of Africa, the southern parts of Arabia, the eastern and western peninsulas of India; all those clusters of islands lying between the southern continent of Asia and New Holland, called the Sunda, Molucca, Philippine, Pelew, Ladrone, and Carolina islands; the northern half of New Holland, New Guinea, New Britain; most of the groups of islands in the Pacific ocean, as the New Hebrides, New Caledonia, the Friendly and Society isles, the Sandwich and Navigators isles; the West India islands; the greater part of South America; the Cape de Verd islands, and those of St Helena, Ascension, St Matthew, and St Thomas. See the map of the world in Plate CCXXXVI, or the plain chart in Plate CCXXXVII.

All places situated between the tropics have the sun vertical twice in the year, at noon; but the time of the year when this happens is different in the different latitudes; at the equator, the sun is vertical when he is in the equinoctial points, or when he has no declination. The inhabitants of the other *intratropical regions* have the sun vertical when his declination is equal to their latitude, and on the same side of the equator. Thus, the inhabitants of New Caledonia, about 20° S. Lat. have the sun vertical when his declination is 20° S. To illustrate this, it will be sufficient to observe that, as the ecliptic is that circle in the heavens in which the sun is supposed to move, the sun's rays are perpendicular successively to every point of the earth which lies below that point of the ecliptic in which the sun happens to be, and he will therefore be vertical to all the places through which the ecliptic (continued to the earth) passes successively.

78 Amphiscii.

The inhabitants of the torrid zone have their shadows at noon day sometimes to the south, i. e. when the sun's declination is north, and sometimes to the north, i. e. when the sun's declination is south. They were therefore called by the ancients *Amphiscii*, from αμφι, *about*, and σκια, *shadow*. See AMPHISCII and ASCII.

79 Countries in the temperate zone.

In the north temperate zone are situated the whole of Europe except Lapland; Barbary, and part of Egypt, in Africa; nearly the whole continent of Asia; a great part of North America; the Azores, and the Canary and Madeira islands.

In the south temperate zone lie the southern part of Africa, the southern half of New Holland, New Zealand, and the southern part of South America.

In the temperate zones the sun is never vertical, and the length of the days and nights differs much more than in the torrid zone.

80 Heteroscii.

The inhabitants of these regions have their shadows at noon always in the same direction; those in the north temperate zone having them directed to the north

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north, and those in the southern zone, towards the south. They were hence called by the ancients *Heteroscii*. See HETEROSCII.

81 Countries in the frigid zones.

The countries that are situated in the northern frigid zone, are Lapland, Spitzbergen, Nova Zembla, the northern parts of Asia and America, and part of Greenland.

No land has yet been discovered within the south polar circle, though it was long supposed that a large continent was situated there, which was called *Terra Australis Incognita*. Our celebrated navigator Cook made many attempts to penetrate the icy fields which abound in these seas, in search of this imaginary continent, but without success, he having penetrated no farther than 72°. See COOK's *Discoveries*, N° 49. and 71.

Within the polar circles the sun does not always rise or set every 24 hours as in the other zones; but for a certain number of days in summer he never sets, and for a certain number of days in winter he never rises; the number of days during which the sun is present or absent increasing from the polar circles to the poles, so that at the poles he never sets for six months, nor rises during a like period.

82 Periscii.

When the sun continues above the horizon more than 24 hours, the inhabitants of the polar regions have their shadows cast all around them; and hence they have been called *Periscii*. See PERISCII.

83 Climates.

The ancients did not employ regular parallels of latitude, but they divided the spaces between the equator and the poles into small zones corresponding to the length of the longest day in each division. To these subdivisions they gave the name of climates, the situation and extent of which they determined in the following manner. As the day at the equator is exactly 12 hours throughout the year, but the longest day increases as we approach the poles, the ancients made the first climate to end at that latitude where the longest day was 12½ hours, which by observation they found to be in the latitude of 8° 25′. The second climate extended to latitude 16° 25′, where the longest day is 13 hours, and thus a new climate extended, so as to divide the whole tract between the equator and the poles into 24 climates, in each of which the longest day was longer by half an hour than in that nearer the equator. The space between the polar circles and the poles they divided into six climates, in each of which the length of the longest day increased by a month, till at the poles it was six months long. Hence, the 24 climates between the equator and the polar circles are called *Hour Climates*; and the six between the polar circles and the poles are called *Month Climates*. For further particulars respecting this ancient division of the globe, and a table of the climates by Ricciolus, see CLIMATE. As the table given under that article is calculated only for the middle of each climate, and neither mentions the breadth of each, nor is extended to all the climates, we shall here subjoin one in which are given the latitude at which each climate terminates, its breadth in degrees, and the length of the longest day at the parallel terminating each.

84 Table of climates.

HOUR CLIMATES.

Climates.	Latitude.		Breadth.		Longest Days.	
I	8°	25′	8°	25′	12h	30m
II	16	25	8		13	
III	23	50	7	25	13	30
IV	30	25	6	30	14	
V	36	28	6	8	14	30
VI	41	22	4	54	15	
VII	45	29	4	7	15	30
VIII	49	1	3	32	16	
IX	52		2	57	16	30
X	54	27	2	29	17	
XI	56	37	2	10	17	30
XII	58	29	1	58	18	
XIII	59	38	1	29	18	30
XIV	61	18	1	20	19	
XV	62	25	1	7	19	30
XVI	63	22	0	52	20	
XVII	64	6	0	44	20	30
XVIII	64	49	0	43	21	
XIX	65	21	0	32	21	30
XX	65	45	0	26	22	
XXI	66	6	0	19	22	30
XXII	66	20	0	14	23	
XXIII	66	28	0	8	23	30
XXIV	66	31	0	3	24	

MONTH CLIMATES.

Climates.	Latitude.		Breadth.		Longest Day.
I	67°	21′		50′	1 month.
II	69	48	2°	27	2
III	73	37	3	49	3
IV	78	30	5	8	4
V	84	5	5	35	5
VI	90		5	55	6

85 Places in the northern climates.

As the division of the globe into climates, though now almost disused, is of service in shewing the length of the longest day in different countries, we shall here enumerate the principal places in each northern climate, these being best known and most interesting.

I. The Gold and Silver Coasts in Africa; Malacca in the East Indies; and Cayenne and Surinam in South America.

II. Abyssinia in Africa; Siam, Madras, and Pondicherry, in the East Indies; the isthmus of Darien; Tobago, the Grenades, St Vincent, and Barbadoes, in the West Indies.

III. Mecca in Arabia; Bombay, part of Bengal, in the East Indies; Canton in China; Mexico and the bay of Campeachy, in North America; and Jamaica, Hispaniola, St Christopher's, Antigua, Martinique, and Guadaloupe, in the West Indies.

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IV. Egypt and the Canaries in Africa; Delhi, the capital of the Mogul empire, in Asia; most of the gulf of Mexico, and East Florida, in North America; and the Havannah in the West Indies.

V. Gibraltar; part of the Mediterranean sea; the Barbary coast in Africa; Jerusalem, Ispahan, capital of Persia, and Nankin, in China, in Asia; and California, New Mexico, West Florida, Georgia, and the Carolinas in North America.

VI. In Europe, Lisbon, Madrid, the islands of Minorca and Sardinia, and part of Greece or the Morea; in Asia, Asia Minor, part of the Caspian sea, Samarcand, Pekin, Corea, and Japan; and in North America, Maryland, Philadelphia, and Williamsburgh in Virginia.

VII. In Europe, the northern provinces of Spain, the southern provinces of France, Turin, Genoa, Rome, and Constantinople; in Asia, the rest of the Caspian, and part of Tartary; and in North America, Boston and New York.

VIII. Paris and Vienna, in Europe; and New Scotland, Newfoundland, and Canada, in North America.

IX. London, Flanders, Prague, Dresden, Cracow, in Europe; the southern provinces of Russia and the middle of Tartary in Asia; and the northern part of Newfoundland, in America.

X. Dublin, York, Holland, Hanover, Warsaw; the west of Tartary, Labrador, and New South Wales, in North America.

XI. Newcastle, Edinburgh, Copenhagen, and Moscow.

XII. Southern part of Sweden; and Tobolsk in Siberia.

XIII. Stockholm; and the Orkney isles.

XIV. Bergen in Norway, and St Petersburgh.

XV. Hudson's straits in North America.

XVI. Most of Siberia; and the southern parts of Greenland.

XVII. Drontheim in Norway.

XVIII Part of Finland in the Russian empire.

XIX. Archangel on the White sea.

XX. Iceland.

XXI. Northern parts of Russia in Europe, and Siberia in Asia.

XXII. New North Wales, in North America.

XXIII. Davis's straits, in North America.

XXIV. Samoieda in Asia.

XXV. Northern parts of Lapland.

XXVI. West Greenland.

XXVII. Southern part of Nova Zembla.

XXVIII. Northern part of Nova Zembla.

XXIX. Spitzbergen.

XXX. Unknown.

The only parts of the terrestrial globe that we have yet to describe and illustrate are the *Quadrant of Altitude*, and the *Wooden Horizon;* and these it is necessary to explain, before we proceed to consider the remaining problems performed with this globe.

86 Quadrant of altitude.

The *Quadrant of Altitude* is a thin flexible slip of brass, graduated into 90°, and made to fix on any part of the brazen meridian by means of a nut and screw. Round this nut it moves on a pivot, and by its flexibility may be applied close to the surface of the globe. The quadrant of altitude is used to measure the distances of places from each other on the terrestrial globe, and to ascertain the altitudes of the sun, stars, &c. on the celestial globe.

To measure the distance between two places on the globe, nothing more is required than to stretch the graduated edge of the quadrant between them, and mark the number of degrees intercepted. These reduced to geographical, or to English miles (by N° 63.) give the absolute distance between the places. It is most convenient to bring one of the places to the zenith, which may be done by rectifying the globe for the latitude of that place as immediately to be explained, and then to stretch the quadrant to the other place, the distance marked, subtracted from 90°, gives the true distance in degrees. If the distance required be greater than 90°, it is proper to rectify the globe for the *antipodes* of the given places, and add the distance observed to 90°: the sum is the distance required.

It has been very generally stated that the bearing of one of the places from the other may be found by observing, on the wooden horizon, in what point of the compass the quadrant of altitude thus fixed in the zenith, cuts the horizon. This is considered by Mr Patteson as a mistake: "For (says he) supposing one of the places to lie due east of the other, they are in the same parallel of latitude, and consequently it is impossible that the prime vertical of either of them (that is, a circle cutting the east and west points of the horizon, should pass through the other, unless they both lay under the equator. A line shewing the bearings of places is called a rhumb line. The lines of north and south on the globe, being meridians, and those of east and west, being parallels of latitude, are consequently circles; but all the remaining rhumbs are a kind of spiral lines."

87 Wooden horizon.

The globes are supported by a wooden frame ending above in a broad flat margin, on which is pasted a paper marked with several graduated circles. This broad margin is called the wooden horizon, and represents the rational horizon of the earth, or the limit between the visible and the invisible hemispheres. On the paper with which the wooden horizon is covered, are drawn four concentric circles. The innermost of these is divided into 360 degrees, divided into four quadrants. The second circle is marked with the points of the compass, i. e. the four cardinal points, east, west, north, and south, (D) each being subdivided into eight parts or rhumbs, (see COMPASS.) The circle next to that just mentioned contains the twelve signs of the zodiac, distinguished by their proper names and characters; and

(D) The cardinal points of the compass are thus determined. The two points in which the meridian of any place when produced so as to pass through the nearest pole, cuts the horizon, (using this in an astronomical sense, see ASTRONOMY,) are the north and south points; the former being that point where the meridian first cuts the horizon in the *northern* hemisphere, and the south, that where it first meets the horizon in the southern hemisphere. Again, the two points where a great circle, passing through the zenith at right angles with the meridian, (and called

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and each sign is divided into 30 degrees. The last circle shews the months and days corresponding to each sign.

This wooden ring can represent the rational horizon of any place marked on the terrestrial globe only, when that place is situated in the zenith; and the method of bringing the place into this situation is called *rectifying the globe.*

88
To rectify the globe.

Problem VIII. *To rectify the globe according to the latitude of any place.*

Find the latitude of the place, (by Problem I.) and see whether it be north or south. Then elevate the pole of the globe which is in the same hemisphere with the latitude, as far above the wooden horizon as is equal to the latitude; bring the given place to the brazen meridian, and it will be in the zenith.

Example. To rectify the globe for the latitude of Edinburgh. The latitude of Edinburgh is 55° 58′ N. therefore raise the *north* pole 55° 58′ above the horizon, and bring Edinburgh below the brass meridian.

It is for the purpose of more easily rectifying the globe, that one half of the brazen meridian is graduated from the poles to the equator; as, where this is not done, it is necessary to take the complement of the latitude, or the difference between it and 90°, which in some cases requires a calculation.

The place being brought below the meridian, when the pole is elevated to the proper degree, it is evidently in the zenith, or 90° distant every way from the horizon. Thus, in the above example, if we count the degrees from that part of the meridian below which Edinburgh is situated, we shall find that they amount to 90° each way; for counting from Edinburgh along the meridian to the north pole, we have 34° 2′; which added to 55° 58′ the elevation of the poles gives 90° on that side. Again, counting from the same point of the meridian towards the southern part of the horizon, we have 55° 58′, as far as the equator, and 34° 2′ from thence to the horizon, making, as before, 90°, and as the graduated edge of the meridian is 90° both from the eastern and western side of the horizon, Edinburgh, in this situation of the globe, is in the zenith.

89
Oblique sphere.

When either of the poles of the globe is thus elevated above the horizon, so as not to be in the zenith, the globe is said to be in the position of an *oblique sphere*, in which the equator and all its parallels are unequally divided by the horizon. This is the most common situation of the earth, or it is the situation which it has with respect to all its inhabitants, except those at the equator and the poles. To the inhabitants of an oblique sphere the pole of their hemisphere is elevated above the horizon as many degrees as are equal to their latitude, and the opposite pole is depressed as much below the horizon, so that the stars only at the former are seen; the sun and all the heavenly bodies rise and set obliquely, the seasons are variable, and the days and nights unequal. This position of the sphere is represented at fig. 6. where the equator EQ, and the parallels cut the horizon HO obliquely, and the axis PS is inclined to it. Hence this position is called *oblique*.

90
Right sphere.

If the globe is placed in such a position that any point of the equator is in the zenith, it is said to be in the position of a *right* or *direct sphere*, because the equator and its parallels are vertical, or over the horizon at right angles. This position is seen at fig. 7. where the axis PS is in the plane of the horizon, and the equator EQ is in a plane perpendicular to it. The inhabitants of such a sphere, which are the inhabitants of the earth below the line, have no elevation of the poles, and consequently no latitude: they can see the stars at both poles; all the stars rise, culminate, and set to them; and the sun always moves in a curve at right angles to their horizon, and is an equal number of hours above and below it, making the days and nights always equal.

91
Parallel sphere.

If the globe be so placed that one of the poles is in the zenith, and consequently the other in the nadir, it is in the position of a *parallel sphere;* so called because the equator EQ (fig. 8.) coincides with the horizon, and the parallels are of course parallel to it; while all the meridians cut the horizon at right angles. The inhabitants of a sphere, in this position, have the greatest possible latitude; the stars, which are situated in the hemisphere to which the inhabitants belong, never set, but describe circles all around; while those of the contrary hemisphere never rise: the sun is above the horizon for six months, during which it is day, and is, below the horizon for an equal interval, when it is night.

The wooden horizon is a necessary part of the apparatus of both globes; but it has been shewn, that in the terrestrial globe, it can represent the rational horizon of a place, only when the globe is rectified for the latitude of that place. In the celestial globe, it represents the rational horizon in all positions.

In Adams's globes there is a thin brass semicircle NHS (fig. 5.) that is moveable about the poles, and has a small thin circle N sliding on it. This semicircle is graduated into two quadrants, the degrees of which are marked both ways from the equator to the poles in the terrestrial globe: this semicircle represents a moveable meridian; and the small sliding circle, which is marked with a few of the points of the compass, is called a *visible horizon*, the use of which will appear presently.

Before we proceed to the remaining problems on the terrestrial globe, it will be proper to take notice of some geographical principles that are connected with the horizon.

It is evident, that the extent of the sensible horizon of an observer depends on the height of his eye above the level surface of the earth. An eye placed on the surface of the earth sees scarcely any thing around it; but if it is elevated above that surface, it sees farther in proportion to its elevation, provided always that its view is not obstructed by intervening objects. Thus, in an extensive plain, the eye can see farther, if elevated to

called the *prime vertical*) cuts the horizon, are the east and west points; the former being on the *left* hand of a person facing the sun at noonday, while the latter is on his *right* hand.

to a proper height, than it can from the ſame height in a town or among hills; and, at ſea, where the ſurface is perfectly equal, the view is in proportion to the height of the eye. It becomes an intereſting problem to aſcertain the extent of the viſible horizon, or the diſtance to which a perſon can ſee at any given height of the eye; as, when this is known, we can calculate pretty accurately the diſtance of an object ſeen from ſuch a height, as land ſeen from the topmaſt of a ſhip at ſea.

For ſolving this problem, it muſt be remarked, that the diſtance of an obſerver from the boundary of the horizon, or from a diſtant object, is different when meaſured along the ſurface of the earth, and when meaſured in a direct line. To illuſtrate this, let HDN (fig. 9.) repreſent a ſection of the earth, of which C is the centre, and let D be the ſituation of an obſerver, whoſe eye is elevated to B. The lines BA, BE, tangents to the curve at H and E, repreſent the limit of the viſible horizon, or the radii of the circle circumſcribing viſion. If the eye were elevated ſtill higher, as to G, it is evident, that the extent of the viſible horizon will be increaſed, being now repreſented by the tangent GF. The length of the tangent BA, or GF, is eaſily found by plane trigonometry (E).

93 Horizon of the ſea.

It was remarked above, that the viſible horizon is moſt diſtinct at ſea, from the abſence of thoſe objects which obſtruct viſion on land. Hence the ſenſible horizon is ſometimes called the horizon of the ſea, and this may be obſerved by looking through the ſights of a quadrant at the moſt diſtant part of the ſea. In making this obſervation, the viſual rays BA, or GF, by reaſon of the ſpherical ſurface of the ſea, always extend a little below the true ſenſible horizon SS, and conſequently below the rational horizon HN, which is parallel to it. Hence the quadrant ſhews the depreſſion of the horizon of the ſea lower than it really is; and it is obvious from the figure, that the higher the eye is ſituated, the greater muſt be this depreſſion. Thus, the depreſſion, when the eye is at G, marked by GF, is evidently much greater than that marked by BE, when the eye is at B. The depreſſion of the horizon of the ſea is not always the ſame, though there be no variation in the height of the eye; but the difference in this caſe is very ſmall, amounting only to a few ſeconds, and is owing to a difference of the degree of refraction in the atmoſphere. Were there no refraction, the viſual ray would be BE (when the eye is at B), and E would be the moſt diſtant point; but, by reaſon of the refraction, a point on the ſurface of the earth beyond E, as F, may be ſeen by an eye ſituated no higher than B; and if the refraction were ſtill greater, a ſtill more diſtant point might be obſerved.

94 Difference between the apparent and true level.

It will be neceſſary here to anticipate a few remarks reſpecting the difference between the apparent and true levels; a ſubject that will be more fully diſcuſſed under Levelling. Two or more places are on a true level, when they are equally diſtant from the centre of the earth, and one place is higher than another, or above the true level, when it is farther from the centre of the earth. A line that is equally diſtant in all its points from the centre, is called the line of true level, and it is evident that this line muſt be curved; and either make part of the earth's ſurface, or be concentrical with it. Thus the line DAO, which has all its points, D, A, O, equally diſtant from the centre C, is the line of true level. But the line of ſight DMP, as given by the operation of a level, is a ſtraight line, which is a tangent to the earth's ſurface at D, always riſing higher above the true line of level, according as it extends to a greater diſtance. This ſtraight line is called the line of apparent level. Thus MA is the height of the apparent level above the true at the diſtance DA, and OP is the exceſs of the apparent above the true level, at the diſtance DO.

The following table was conſtructed by Caſſini, for the purpoſe of ſhewing the exceſs of the apparent above the true level at various diſtances from the point of obſervation. It conſiſts of three columns, in the firſt of which the diſtance of the obſerved object from the place of obſervation is given, from one ſecond to 60 minutes, or a degree. In the ſecond is given the length of the arc meaſured on a great circle of the earth, that correſponds to the obſerved diſtance, in feet and inches; and in the third is given the height of the apparent above the true level in feet and inches, correſponding to each obſerved and real diſtance of the object.

(E) In the right-angled triangle ACB (fig. 9.), the length of CB is given, ſuppoſing the height of the eye BD to be 6 feet; for adding 6 feet to 19,943,400 feet, the length of the ſemidiameter of the earth, we have 19,943,406 feet for the length of BC. Then, making the hypothenuſe CB radius, we ſhall have, As radius to the ſine of the angle BCA, ſo is CB to BA; and this will be nearly the ſame as the arc DA. Again, without finding the quantity of the angle at C, BA may be found, by conſidering that BA^2 is equal to the difference of the ſquares of CB and CA, i. e. $BA^2 = CB^2 - CA^2 = (CB + CA) \times (CB - CA) = CB + CA$ into BD; and hence $BA = \sqrt{(CB + CA) \times BD}$.

To illuſtrate the laſt in numbers, we have CB = 19,943,406 feet, and CA = 19,943,400 feet. Then, to find BA, we have $\overline{19,943,406 + 19,943,400}\ (=39,886,806) \times \overline{19,943,406 - 19,943,400}\ (=6) = 239,320,836$; whence $BA = \sqrt{239,320,836} = 15470$ feet nearly, or about three miles.

The diſtance, to which a perſon can ſee, is found to vary as the ſquare root of the altitude of the eye. To find a general expreſſion for this quantity,

let a be the altitude of the eye in feet,
d the diſtance at that altitude in miles;

then we have $\sqrt{6} : \sqrt{a} = 3 : d = \frac{3}{\sqrt{6}} \times \sqrt{a} = 1.2247 \times \sqrt{a}$. Hence, we deduce this general rule: *Multiply the ſquare root of the height of the eye in feet by* 1.2247, *and the product will be the diſtance to which we can ſee from*

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Seconds.	Feet.	Inch.	Inch.
1	101	6.8	
2	203	1.6	
3	304	8.4	
4	406	3.2	
5	507	10.0	0 074
6	609	4.8	
7	710	11.6	
8	812	6.4	
9	914	1.2	
10	1015	8.0	0.296
11	1117	2.8	
12	1218	9.6	
13	1320	4.4	
14	1421	11.2	
15	1523	6.0	
16	1625	0.8	
17	1726	7.6	
18	1828	2.4	
19	1929	9.2	
20	2031	4.0	1.186
21	2132	10.8	
22	2234	5.6	
23	2336	0.4	
24	2437	7.2	
25	2539	2.0	
26	2640	8.8	
27	2742	3.6	
28	2843	10.4	
29	2945	5.2	
30	3047	0.0	2.670
31	3148	6.8	
32	3250	1.6	
33	3351	8.4	
34	3453	3.2	
35	3554	10.0	
36	3656	4.8	
37	3757	11.6	
38	3859	6.4	
39	3961	1.2	
40	4062	8.0	4.746
41	4164	2.8	
42	4265	9.6	
43	4367	4.4	
44	4468	11.2	
45	4570	6.0	
46	4672	0.8	
47	4773	7.6	
48	4875	2.4	
49	4976	9.2	
50	5078	4.0	7.409
51	5179	10.8	
52	5281	5.6	
53	5383	0.4	
54	5484	7.2	
55	5586	2.0	
56	5687	8.8	
57	5789	3.6	
58	5890	10.4	
59	5992	5.2	
60	6094	0.0	10.680

Minutes.	Feet.	Feet.	Inch.
1	6094	0	10.680
2	12188	3	6.580
3	18282	7	11.853
4	24376	14	1.812
5	30470	22	1.932
6	36564	31	11.412
7	42658	42	5.436
8	48752	56	9.384
9	54846	71	9.876
10	60940	88	7.728
11	67034	107	2.940
12	73128	127	7.512
13	79222	149	9.444
14	85316	173	8.736
15	91410	199	4.320
16	97504	226	9.264
17	103598	255	11.568
18	109692	286	11.232
19	115786	319	7.188
20	121880	354	0.504
21	127974	390	4.248
22	134068	428	5.352
23	140162	468	10.224
24	146256	510	6.084
25	152350	553	11.232
26	158444	599	1.776
27	164538	646	1.680
28	170632	694	10.944
29	176726	745	5.568
30	182820	797	8.484
31	188914	851	9.828
32	195008	907	8.532
33	201102	965	3.528
34	207196	1024	7.884
35	213290	1085	9.600
36	219384	1148	8.676
37	225478	1213	5.112
38	231572	1277	10.908
39	237666	1348	2.064
40	243760	1417	1.764
41	249854	1496	11.388
42	255948	1569	10.452
43	262042	1638	9.084
44	268136	1716	0.108
45	274230	1794	11.424
46	280324	1875	7.032
47	286418	1958	0.000
48	292512	2042	2.328
49	298606	2128	2.016
50	304700	2215	6.792
51	310794	2305	5.472
52	316888	2396	9.240
53	322982	2489	10.368
54	329076	2584	8.856
55	335170	2681	4.704
56	341264	2779	9.912
57	347358	2880	0.480
58	353452	2982	0.408
59	359546	3085	8.628
60	365640	3191	2.208

from that height in miles. Example. Let the height of the eye be 49 feet. Multiply the ſquare root of 49 or 7, by 1,2247, and we have 8.5729 or about $8\frac{1}{2}$ miles for the diſtance to which the eye can ſee at the height of 49 feet.

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The above table will anſwer ſeveral uſeful purpoſes. In the firſt place, the height of the apparent level above the true may be found by it at any diſtance, from one ſecond to one degree, or $69\frac{2}{10}$ miles. Thus, at the diſtance of 30′=about 35 miles, we have 182820 feet for the length of the arch of a great circle on the earth, and correſponding to this we have 797 feet 8 inches 484 parts for the exceſs of the apparent level above the true. 2. The extent of the viſible horizon correſponding to any height of the eye, may be found from the table by obſervation. The ſemidiameter of the horizon does not ſenſibly differ from an arc of a great circle on the earth, containing as many minutes and ſeconds as are equal to the angle of depreſſion obſerved, and the number of feet contained in ſuch an arc may be found in the table. Thus, if the depreſſion, as obſerved by obſervation, be 40″, its ſemidiameter is alſo about 40″, and the length of the arc correſponding to it is 243,760 feet.

The following table, alſo taken from Caſſini, ſhews the different depreſſions of the horizon of the ſea at different heights of the eye, both by obſervation and calculation; with the difference betwixt the two occaſioned by refraction.

The height of the eye above the ſurface of the ſea. Feet.	Inches.	*The depreſſion of the horizon of the ſea.* ′ ″	
1157	6,9	32 30	by obſervation
		36 18	by calculation
Difference by refraction		3 48	
775	2,3	27 0	by obſervation
		29 36	by calculation
Difference by refraction		2 36	
571	11,0	24 0	by obſervation
		25 25	by calculation
Difference by refraction		1 25	
387	3,4	19 45	by obſervation
		20 54	by calculation
Difference by refraction		1 9	
288	4,3	15 0	by obſervation
		17 1	by calculation
Difference by refraction		2 1	

The height of the eye above the ſurface of the ſea. Feet.	Inches.	*The depreſſion of the horizon of the ſea.* ′ ″	
187	0,9	13 0	by obſervation
		14 41	by calculation
Difference by refraction		1 41	
9	7,3	3 20	by obſervation
		3 18	by calculation
Difference by refraction		0 2	

In the above table, the depreſſion, as eſtimated by calculation, is greater than that by obſervation in every caſe except the laſt, in which the latter is greater by two ſeconds than the former; but this difference was too ſmall to be diſcovered by the inſtrument that Caſſini employed.

Refraction leſſens the angle of depreſſion, by raiſing the objects obſerved; but as this refraction is itſelf variable, the depreſſion and extent of the horizon alſo vary. We are informed by Caſſini, that even in the fineſt weather he obſerved the refraction to differ at the ſame hour of different days, and at different hours of the ſame day. The truth of this obſervation may be eaſily aſcertained by looking through a teleſcope furniſhed with croſs hairs, and fixed in ſuch a poſition that ſome highly elevated object, as the weathercock of a ſteeple, may be ſeen through it; for, on obſerving the weathercock at different times of the day, it will be ſeen ſometimes on the centre of the object-glaſs; ſometimes above, and ſometimes below it. A ſimilar experiment may alſo be made with plane ſights fixed on a croſs-ſtaff. It has long been obſerved, that the top of a diſtant hill may ſometimes, when the refraction is very great, be diſtinctly ſeen from a ſituation from which, at other times, when the refraction is much leſs, it is not diſcernible, even though the ſky be very clear.

Many of the following problems may ſeem to belong to the celeſtial rather than the terreſtrial globe; but as they may be ſolved equally well by means of both, and as perſons not uncommonly poſſeſs a terreſtrial globe without its uſual companion, we ſhall throw as many problems as poſſible under this head.

95 Problems reſpecting the ſun.

PROBLEM IX. *To find the ſun's place in the ecliptic for any given time.*

Find the day of the month in the calendar on the wooden horizon; and oppoſite to it, in the adjoining circle, will be found the ſign and degree in which the ſun

From the above, it is eaſy to deduce the method of computing the diſtance of any object ſeen in the horizon from a certain height. Thus, ſuppoſe a man at the maſt-head, 130 feet above the water, ſees land or a ſhip juſt coming in ſight. We know, that, at this height, an eye can ſee 14 miles, conſequently the object ſeen will be about 14 miles or about five leagues diſtant. If the object is within the horizon, or nearer the place of obſervation, its diſtance may be calculated pretty exactly, by deſcending from the maſt-head till the object juſt comes to the horizon; meaſuring the height at which this takes place, and thence computing the diſtance.

sun is on the given day. Then look for the same sign and degree in the circle of the ecliptic drawn on the globe, and that is the sun's place at noon for the given time.

Ex. 1. What is the sun's place on the 4th of June? *Ans.* In 13° 57′ of the sign Gemini.

Ex. 2. Required the sun's place for the first day of every calendar month?

For January	♑	11°	23′	July	♋	9°	42′
February	♒	12	35	August	♌	9	18
March	♓	11	9	September	♍	9	9
April	♈	11	56	October	♎	8	27
May	♉	11	14	November	♏	9	16
June	♊	11	3	December	♐	9	33

PROBLEM X. *To find the sun's declination for any given time.*

Find the sun's place for the given day by Prob. X. and bring it to the brazen meridian. The degree marked on the meridian immediately over the place is the declination required.

Ex. Required the sun's declination for 18th March? The sun's place for the given day is 20° 7′ of ♓, and this being brought to the meridian, will be immediately below 3° 54′ S. which is therefore the declination required.

From the above example, it is evident that the method of finding the declination of the sun corresponds to that of finding the latitude of a place on the globe, given in Problem I. the sun's declination being measured in the same way by an arc of the meridian interposed between the equator and the sun's place in the ecliptic (F).

PROBLEM XI. *To rectify the globe for the sun's place and the day of the month.*

Find the sun's declination for the given day, by Problem XI.; then elevate the pole that is in the same hemisphere with the degree of declination, as many degrees as are equal to the declination.

Ex. Rectify the globe for the sun's place on the 6th October? *Ans.* The sun's declination on that day is 5° S. therefore the south pole must be elevated 5° above the horizon.

Rectifying the globe for the sun's declination corresponds to the rectifying of it for the latitude of a given place. See N° 88.

PROBLEM XII. *To find the time of the sun's rising and setting at a given place, for any given day.*

Rectify the globe for the declination on the given day, and bring the given place to the meridian, and set the index of the hour circle at XII. Turn the globe, till the given place come to the eastern edge of the horizon, and the time of sunrise will be shewn by the position of the index. Then turn the globe till the given place come to the western part of the horizon, and the position of the index will point out the time of sunset.

To perform the same problem by Adams's globes. Rectify the globe for the declination, bring the given place to the meridian, and set the horary index at 12 as before; then turn the globe towards the west, till the given place reach the western edge of the horizon, and the index will point to the time of sunrise. The time of sunset will be known, in like manner, by bringing the place to the eastern side of the horizon.

If the hour circle in the ordinary globes has a double row of figures, the sun's rising and setting may be found at the same time; for if the place be brought to the eastern part of the horizon, the time of sunrise will be shewn by the index, in that circle where the hours increase towards the east; and the time cut by the index in the circle where the hours increase towards the west, will show the time of sunset.

Ex. 1. Required the time of the sun's rising and setting at London, on the 29th August? *Ans.* The sun rises at nine minutes after five, and sets nine minutes before seven.

Ex. 2. Required the time of sunrise and sunset at Edinburgh on the 1st of June? *Ans.* For sunrise, 27 minutes after three; for sunset, 33 minutes after eight.

COROLLARY. From this problem we may easily find the length of the day and night for any given time; for, having found by the globe the time of sunrise and sunset, the double of the latter is the length of the day, and the double of the former the length of the night.

PROBLEM XIII. *To find the sun's meridian altitude on any given day, at a given place.*

Rectify the globe for the latitude of the given place, by Problem VIII.; find the sun's place on the given day by Problem IX. and bring it to the brazen meridian. Then fix the quadrant of altitude in the zenith, or over the given place, and bring it over the sun's place; and the degree of the quadrant lying over the sun's place will shew the meridian altitude.

If the globe has no quadrant of altitude, the sun's meridian altitude may be found by counting the number of degrees on the meridian, between the horizon and the sun's place.

Ex. Required the sun's meridian altitude at Edinburgh on the 21st of June? *Ans.* 57° 30′, or the greatest possible, this being the summer solstice.

COROLLARY. It may be known whether the sun's meridian altitude be north or south, by the following observations. When the sun's decliuation and the latitude of the place are of different names, i. e. the one north and the other south, the meridian altitude is of the same name with the declination. If the declination and latitude be both north or both south, the altitude is of the same name with the declination, if the latter be the greater; but, otherwise, the altitude is of an opposite name.

PROBLEM XIV. *Having the latitude of the place and the day of the month given, to find the sun's altitude for any given hour.*

Rectify the globe for the latitude; find the sun's place, and bring it to the meridian, and set the horary index

(F) For a table of the sun's declination corresponding to his true place, see Vol. III. p. 170.

index to noon; turn the globe till the index point to the given hour, then fix the quadrant of altitude in the zenith, and bring its graduated edge over the sun's place, and the degree cut by the sun's place will be the altitude required.

Ex. What will be the sun's altitude at 10 o'clock A. M. on the 30th of November at Edinburgh? *Ans.* 8° 50′.

Problem XV. *Having the sun's meridian altitude given at any place, to find the latitude of the place.*

Bring the sun's place for the given day to the meridian, and move the globe in the horizon till the distance between the sun's place and the northern or southern edge of the horizon, (according as the case may require), be equal to the given altitude. The degree of elevation of the pole will shew the latitude required.

Ex. The sun's meridian altitude observed at a certain place on 5th August is 74° 24′ N. What is the latitude of the place? *Ans.* 1° 36′ N.

Problem XVI. *The latitude of the place and the day of the month being given, to find when the sun is due east or due west.*

Rectify the globe for the latitude of the place, bring the sun's place to the meridian, and set the index to XII. Fix the quadrant of altitude in the zenith, and if the sun's declination be of the same name with the latitude, bring the graduated edge of the quadrant to the eastern side of the horizon; but if the declination is of a different name from the latitude, bring the quadrant to the western part of the horizon. Turn the globe till the sun's place in the ecliptic come below the edge of the quadrant, and the index will point to the hour when the sun is due east. Subtract this from XII. and the remainder shews the time when the sun is due west.

Ex. At what hours is the sun due east and west at the summer and winter solstice at Greenwich? *Ans.* At the summer solstice he is due east at 20 minutes past seven, and due west at 20 minutes before five. At the winter solstice he is due east at 20 minutes before five, and due west at 20 minutes past seven.

Corollary. When the declination and latitude are of the same name, the sun is due east after rising; but when the declination and latitude are of different names, he is due east before rising. As it is not convenient to observe on the globe when the sun is due east before rising, or while he is under the horizon, it is better to bring the opposite point of the ecliptic due west, and then the index shews the time when he is due east.

Problem XVII. *Having a place in the torrid zone given, to find on what two days of the year the sun is vertical at that place.*

Find the latitude of the given place, and keeping that in view, turn the globe round, noting the two points at the ecliptic that pass below the degree of latitude. Find in the calendar circle of the horizon the days corresponding to those points of the ecliptic; and these are the days on which the sun is vertical at the given place.

Ex. 1. On what days is the sun vertical at St Helena, in latitude 15° 55′ S.? *Ans.* On 6th February and 6th November.

Ex. 2. Required the days on which the sun is vertical at Tobago, in latitude 11° 29′ N? *Ans.* On April 19. and August 23.

Problem XVIII. *To find those places in the torrid zone where the sun is vertical on a given day.*

Find the sun's place for the given day, and bring it to the brazen meridian; then turn the globe, and note all the places which pass under that point of the meridian: these will be the places to which the sun is vertical on the given day.

Ex. 1. In what places is the sun vertical at the summer solstice? *Ans.* At Canton in China, at Calcutta in Bengal, at Mecca in Arabia, and at the Havannah.

Ex. 2. To what places is the sun vertical on the 16th of May and 29th of July? *Ans.* At Bombay, Pegu, in the northern part of Manilla, in the middle of the Ladrone islands, at Owhyhee, Mexico, in Hispaniola, and at Tombuctoo in the central parts of Africa.

Problem XIX. *Having the day and hour at any given place, to find where the sun is then vertical.*

Find the sun's declination by Problem XI. and the places where it is noon at the given time, by Problem III.; then any of those places where it is noon, whose latitude is the same as the sun's declination, will have the sun vertical at the given time.

Ex. On the 1st of August at Edinburgh, it being 35 minutes past four, P. M. it is required to find where the sun is vertical? *Ans.* The sun's declination on that day is 18° 14′ N. and the place where it is noon at the given time, that lies nearest in latitude to the declination, is Kingston in Jamaica: this, therefore, is the place required.

Problem XX. *A place in the northern frigid zone being given, to find when the sun begins to appear above the horizon, and when to disappear; as also the length of the longest day and night.*

Rectify the globe for the latitude, and bring the *ascending* signs of the zodiac (see Astronomy, N° 52) to the southern part of the horizon; observe what degree of the ecliptic is intersected by that point of the horizon, and in the calendar circle find the day of the month answering to that degree. That will shew the time of the sun's first appearance above the horizon at the given place, and this is the end of the longest night in that latitude. Then bring the *descending* signs to the same part of the horizon, and observe the day which answers to the degree of the ecliptic intersected; this will shew the time of the sun's disappearance, or the beginning of the longest night. Now bring the ascending signs to the northern part of the horizon, and observe the degree of the ecliptic, and the corresponding day as before, which will give the time when the sun begins to shine continually, or the beginning of the longest day. Again, bring the descending signs to the same point, and thus will be given the time when the sun ceases to shine continually, or the end of the longest day.

Ex. At what time does the sun begin to appear above

above the horizon at North Cape in Lapland, the latitude of which is 72° N.? When does he diſappear, and how long is he entirely abſent during the longeſt night? *Anſ.* He begins to appear on the 26th of January, and entirely diſappears on the 16th of November; he is therefore abſent for 71 days.

Cor. From the ſun's firſt appearance at the end of the longeſt night to the beginning of the longeſt day, and from the end of the longeſt day to the ſun's total diſappearance at the beginning of the longeſt night, he riſes and ſets every day.

Problem XXI. *To find in what part of the northern frigid zone the ſun begins to ſhine continually on a given day.*

Find the ſun's declination for the given day, and ſubtract this from 90°, the remainder will ſhew the latitude required.

Note.—The given day muſt be between the 21ſt of March and the 21ſt of June, as at no other time does the ſun begin to ſhine continually in the northern frigid zone.

Ex. Required the latitude in which the ſun begins to ſhine without ſetting on the 1ſt of June? *Anſ.* The ſun's declination for that day is 22° N. and this ſubtracted from 90° leaves 68° N. the latitude required.

96 Problems reſpecting the climates.

Problem XXII. *The length of the longeſt day in any place being given, to find the latitude of that place.*

Bring the firſt degree of Cancer to the meridian, and ſet the horary index at noon. Then turn the globe towards the weſt, till the index point to the hour of ſunſet, or half of the length of the given day; raiſe or depreſs the pole, till the ſun's place in the ecliptic is exactly in the weſtern edge of the horizon. The elevation thus obtained will be equal to the required latitude.

In Adams's globes, after bringing the firſt degree of Cancer to the meridian, and ſetting the index to noon, the globe muſt be turned towards the weſt, till the index ſhew the time of ſunſet, and the ſun's place muſt be brought to the eaſtern ſide of the horizon.

Ex. In what latitude is the longeſt day 18 hours long? *Anſ.* In latitude 58° 30′ N.

By this problem the limits of the hour climates may be pretty nearly aſcertained.

Problem XXIII. *To find the latitudes of thoſe places in the frigid zone where the ſun is continually above the horizon for a given number of days.*

Count from the firſt degree of Cancer towards the neareſt equinoctial point, as many degrees as is equal to half the given number of days; bring the point thus obtained below the meridian, and note the degree of the meridian which it interſects. This ſubtracted from 90° will leave a remainder that is nearly equal to the latitude of the place.

Ex. In what latitude does the ſun never ſet during 76 days? *Anſ.* In latitude 71° 30′, or very near the ſouthern part of Nova Zembla.

Note.—This problem cannot be performed accurately by the globe; for as the ſun requires 365 days ſix hours to move through the whole 360° of the ecliptic, he does not advance quite a degree in 24 hours.

By this problem the limits of the month climates may be pretty nearly aſcertained.

Problem XXIV. *The hour and day being given at any place, to find in what places the ſun is riſing, and in what he is ſetting; where it is noon, and where midnight.*

Find by Problem XIX. the place to which the ſun is vertical at the given time; rectify the globe for the latitude of that place, and bring the place below the meridian. In this poſition of the globe all thoſe places that lie within the weſtern edge of the horizon will have the ſun riſing, and all thoſe which are in the eaſtern edge of the horizon will have it ſetting. Again, to thoſe places which lie under the upper ſemicircle of the brazen meridian, it will be noon; and to thoſe which lie below the lower ſemicircle, it will be midnight.

Ex. Suppoſe it to be four o'clock P. M. on the 4th of June at London; where is the ſun at that time riſing, and where is he ſetting; to what places is it noon, and to what midnight? *Anſ.* The north-eaſtern part of Siberia, Kamtſchatka, the moſt weſtern of the Sandwich iſles, and the moſt eaſtern of the Society iſles, are within the weſtern edge of the horizon, and conſequently to theſe the ſun is riſing. At Tobolſk, in the Caſpian ſea, in the deſert of Arabia, in the middle of the Red ſea, in Abyſſinia, in the central parts of Africa, and in the country of the Hottentots, the ſun will be ſetting, as theſe places lie within the eaſtern edge of the horizon. New Britain, the iſlands of Martinique and Trinidad, and the middle part of South America, which lie below the upper ſemicircle of the meridian, have noon; and Chineſe Tartary, the eaſtern part of China, the Philippine iſles, and the weſtern part of New Holland, which are ſituated below the under edge of the ſemicircle, have midnight.

As the remaining problems on the terreſtrial globe chiefly reſpect the continuance of twilight, it is proper, before we proceed, to make a few remarks on this ſubject. For the explanation of the term, ſee Crepusculum and Twilight. 97 On twilight.

The *Crepuſculum*, or *Twilight*, it is ſuppoſed, uſually begins and ends when the ſun is about 18° below the horizon; for then the ſtars of the 6th magnitude diſappear in the morning, and appear in the evening. It is of longer duration in the ſolſtices than in the equinoxes, and longer in an oblique ſphere than in a right one; becauſe in thoſe caſes the ſun, by the obliquity of his path, is longer in aſcending through 18° of latitude.

Twilight is occaſioned by the ſun's rays refracted in our atmoſphere, and reflected from the particles of it to the eye. For let A (fig. 10.) be the place of an obſerver on the earth ADL, AB the ſenſible horizon, meeting in B the circle CBM bounding that part of the atmoſphere which is capable of refracting and reflecting light to the eye. It is plain that when the ſun is under this horizon, no direct rays can come to the eye at A: but the ſun being in the refracted line CG, the particle C will be illuminated by the direct rays of the ſun; and that particle may reflect thoſe rays to A, where they enter the eye of the ſpectator. And thus the ſun's light illuminating an innumerable multitude of particles, may be all reflected to the ſpectator at A.

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A. From B draw BD touching the circle ADL in D, and let the ſun be at S in the line AD; then the ray SB will be reflected into the ſituation BA, and will enter the eye, becauſe from a principle in optics the angle of incidence DRC is equal to the angle of reflection ABE. See OPTICS. This ray SB, or BA, will therefore be the firſt that reaches the eye at dawn in the morning, and the laſt that falls on the eye at night, when twilight ceaſes, becauſe as the ſun gets lower down, the particles of the air at B will no longer be illuminated.

The depth of the ſun below the horizon at the beginning of the morning or end of the evening twilight, is determined by obſerving the moment when the air firſt begins to ſhine in the morning, or ceaſes to ſhine in the evening; then finding the ſun's place for that time, and hence the time till his riſing in the horizon, or after his diſappearance below. This depth of the ſun below the horizon has been variouſly ſtated by different aſtronomers, but it is now generally eſtimated at 18°. Accordingly in Mr Adams's globes there is a circular wire fixed 18° below the horizon, to repreſent the limits of the crepuſculum (ſee PWY, fig. 5.)

As the cauſe of twilight is not conſtant, its limits muſt continually vary; for if the exhalations in the atmoſphere be more copious or more extenſive than uſual, the morning twilight will begin ſooner, and that of the evening laſt longer than ordinary; as the more copious the exhalations, the more rays will be reflected from them, and conſequently the more they will ſhine, and again, the higher they are, the ſooner they will be illuminated by the ſun. From this circumſtance the evening twilight is commonly longer than the morning, at the ſame time, and in the ſame place. The refraction is alſo greater according as the air is more denſe, and not only is the brightneſs of the atmoſphere variable, but the ſame takes place in its height above the earth; therefore, the twilight is longeſt in hot weather, and in hot countries, all other things being equal. The chief differences, however, ariſe from the different ſituations of places on the earth, or from the difference of the ſun's place in the heavens. Thus, the twilight is longeſt when the earth is the poſition of a parallel ſphere, and ſhorteſt in that of a right ſphere (ſee N° 90.): and in an oblique ſphere, the twilight continues longer at any place, in proportion as that place is nearer to either of the poles; a circumſtance which affords conſiderable relief to the inhabitants of the northern countries in their long winter nights. Twilight continues longeſt in all places of north latitude, when the ſun is in the tropic of Cancer, and to thoſe in ſouth latitude when he is in the tropic of Capricorn. The time of the ſhorteſt twilight alſo varies in different latitudes: thus, in England, the ſhorteſt twilight is about the beginning of October and of March, when the ſun is in ♎ and ♓; hence, when the difference between the ſun's declination and the depth of the equator is leſs than 18°, ſo that the ſun does not deſcend more than 18° below the horizon, the twilight will continue through the whole night, as happens in Britain from the 22d of May to the 22d of July.

In the latitude of 49° N. twilight continues for the whole night, only on the 21ſt of June, or the time of the ſummer ſolſtice; but at all places further to the north it continues for a certain number of days before and after the ſummer ſolſtice.

Near the north pole there is continual twilight from the 22d of September, the time of the ſun's permanent abſence, to the 12th of November. It then ceaſes till about the 30th of January, when it again appears, and continues till the 21ſt of March, the time of the ſun's permanent appearance. Hence the inhabitants of thoſe places neareſt the pole, though they never ſee the ſun for nearly ſix months, have, however, the benefit of twilight for above the half of that time, and are entirely excluded from the ſun's light little more than 12 weeks, during ſix of which the moon is conſtantly above the horizon.

98 Uſes of twilight.

Were it not for the gradual change from light to darkneſs, and *vice verſa*, which is the conſequence of twilight, much inconvenience would ariſe. A ſudden change from the darkneſs of midnight to the full ſplendor of the ſun, and the reverſe, would injure the ſight, and would, in many caſes, be productive of much danger to travellers, who would be overtaken by utter darkneſs before they had time to prepare for its approach.

99 Problems reſpecting twilight.

PROBLEM XXV. *To find where it is twilight at any given time.*

Find where the ſun is vertical at the given time, and rectify the globe for the latitude of that place. Obſerve what places are within the limits of twilight, or not quite 18° below the horizon. To thoſe which are ſituated within the weſtern zone, between the horizon and the parallel of 18°, it will be twilight in the morning; and thoſe which are in the eaſtern zone will have it twilight in the evening.

This problem may be more conveniently performed by rectifying the globe for the antipodes of the place which has the ſun then vertical, and obſerving what places are ſituated in the zone formed above the horizon, between it and a parallel circle of 18°.

Ex. It is required to find where it is twilight on the 4th of June, when it is three o'clock, P. M. at London. *Anſ.* Kamtſchatka, the Sandwich iſles, and the Marqueſas, have twilight in the morning; and the inhabitants of Madagaſcar, of Tibet, and the eaſtern part of Perſia, have twilight in the evening.

PROBLEM XXVI. *To find the duration of twilight at a given place on any given day.*

Rectify the globe for the latitude of the place; find the ſun's place for the given day by Problem X. and bring it below the meridian, and ſet the horary index to XII. Turn the globe till the ſun's place be juſt within the circle that marks the limit of twilight, and the index will ſhew the beginning of twilight. Subtract the time of the beginning of twilight from the time of ſunriſing at the given place (found by Problem XII.) and the remainder will ſhew the duration of twilight at the given place.

Note.—The above rule will anſwer both for the ordinary globes, and for thoſe of Adams, except that in the latter the ſun's place muſt be brought below the weſtern part of the horizon. A more convenient way in both globes will be, to bring that point of the ecliptic which is oppoſite to the ſun's place, 18° above the

the weſtern horizon, and the index will then ſhew the beginning of twilight.

Ex. How long will twilight continue at London on the following days: March 2d; September 25th; and December 26? *Anſ.* On the 2d of March it will continue one hour and fifty minutes; on the 25th of September two hours; and on the 26th of December, two hours ten minutes (G).

100 Cauſe of day and night.

Problem XXVII. *To ſhew the cauſe of day and night by the globe.*

It will have appeared, from the conſideration of the cauſe of day and night given under the article Astronomy, that only that half of the earth which is oppoſite to the ſun, is illuminated by his rays, while that which is turned from him is involved in darkneſs. As the earth revolves on its axis from weſt to eaſt, in the ſpace of 24 hours, every place on the earth in the courſe of that time alternately enjoys the light of the ſun, and is deprived of it.

To illuſtrate this by the globe, rectify the globe for the ſun's declination, ſo as to place the ſun in the zenith, and the horizon will repreſent the boundary between light and darkneſs; that hemiſphere which is above the horizon being illuminated by the ſun's rays, and that which is below the horizon being derived of light. If now a patch is put on the globe, ſo as to repreſent any place, and if the globe be made to revolve from weſt to eaſt; when the place is brought to the weſtern edge of the horizon, the ſun will appear to the inhabitants of that place to be riſing in the eaſt, though, in fact, the appearance ariſes from the place itſelf coming beyond the limit of darkneſs. As the globe continues to turn, the place riſes towards the meridian, and this produces the appearance as if the ſun were advancing towards the meridian in a contrary direction. When the place comes below the meridian, it is noon to that place, and the ſun appears to have attained its greateſt height.

As the place proceeds towards the eaſt, it gradually recedes from the meridian, and the ſun appears deſcending in the weſt. When it reaches the eaſtern edge of the horizon, and is proceeding below the boundary of light and darkneſs, the ſun appears to be ſetting; and during the whole time that the place is moving below the horizon, the ſun will not appear till the place once more riſes in the weſt.

101 Problem on lunar eclipſes.

Problem XXVIII. *To find at what places an eclipſe of the moon is viſible at any given time.*

Find the place to which the ſun is vertical at the given time, and rectify the globe for the latitude of that place. As the moon is oppoſite to the ſun, which illuminates the ſuperior hemiſphere of the globe, the eclipſe of the moon will be viſible to all the places that lie below the horizon.

As the places below the horizon are not eaſily examined, this problem may be more conveniently performed by rectifying the globe for the antipodes of the place to which the ſun is vertical at the given time, rather than for the place itſelf; as in this latter poſition of the globe the moon being in oppoſition to the ſun, will be vertical to the place below the zenith, and its eclipſe will be viſible at all the places now above the horizon.

Ex. 1. On the 4th of January 1806, at 55 minutes paſt 11 P. M. reckoning the time at Greenwich, there was an eclipſe of the moon. It is required to find thoſe places to which the eclipſe was viſible? *Anſ.* Through the greateſt part of Africa, in ſome part of Europe, in Aſia, South America, and a great part of North America.

Ex. 2. On the 10th of May 1808, when it is eight o'clock A. M. at Greenwich, the moon will be totally eclipſed. In what places will the eclipſe be viſible? *Anſ.* In moſt parts of America; in the iſlands of the Pacific ocean, and on the eaſtern coaſt of New Holland.

Sect. II. *Of the Uſe of the Celeſtial Globe.*

102 Celeſtial globe.

The celeſtial globe, with reſpect to the circles that are deſcribed on it, and the apparatus with which it is furniſhed, ſcarcely differs from the terreſtrial globe, which has been ſo fully deſcribed in the preceding ſection. The ſurface of the celeſtial globe is made to repreſent all the ſtars that are commonly viſible to the naked eye, arranged under their conſtellations, and bounded by the figures which have been given to theſe conſtellations by the early aſtronomers. (See fig. 5.) In Adams's celeſtial globe the moveable ſemicircle (N° 91.) turning round the poles repreſents a circle of declination, and the ſmall circle on it, an artificial ſun or planet.

Both the globes are often furniſhed with a mariner's compaſs, which is uſually placed in the lower part of the frame.

It muſt here be remarked, that the repreſentation of the heavens on the celeſtial globe, though probably much more accurate than that of the earth on the terreſtrial, is not ſo natural as the latter; for, in viewing the ſtars on the external ſurface of a globe, the ſpectator ſees them in an oppoſite poſition to that in which he obſerves them in the heavens, ſo that to form a juſt conception of their exact ſituation, he muſt ſuppoſe his eye to be ſeated in the centre of the globe. Hence, if a large hollow hemiſphere were made of glaſs, and if the ſtars in the correſponding hemiſphere of the firmament were painted in tranſparent colours on its ſurface; an eye ſituated in the centre of ſuch a hemiſphere

(G) If we have the latitude of a place, and the ſun's declination given, we may find the beginning of the morning and the end of the evening twilight by calculation. Thus, in the oblique-angled ſpherical triangle ZPN (fig. 11.) we have given ZP the co-latitude; PN the co-declination, and ZN=108° being the ſum of 90° the quadrant, and 18° the depreſſion at the extremity of twilight. Then by ſpherical trigonometry we may calculate the triangle ZPN, the hour angle from noon, and this reduced to time, at the rate of 15° per hour, gives the time from noon to the beginning or end of twilight. For the mode of calculation, ſee Spherics.

Principles and Practice.

ſphere would ſee the ſtars exactly as they appear in the heavens.

The great uſe of the celeſtial globe is to perform a variety of problems with reſpect to the ſtars, and the motions of the heavenly bodies through the ſpace which they occupy.

PROBLEM I. *To place the celeſtial globe in ſuch a ſituation as that it ſhall exhibit an accurate repreſentation of the face of the heavens at any given place, and at any given time.*

Rectify the globe for the latitude of the place, as in Problem VIII. of the terreſtrial globe, or by ſetting the pole of the celeſtial globe pointing to the pole of the earth, by means of the compaſs that is uſually annexed to the globes; find the ſun's place in the ecliptic; bring this to the meridian, and ſet the horary index at noon. Again, make the globe turn on its axis till the index point to the given time, and in this poſition the globe will exactly repreſent the face of the heavens, correſponding to the given time and place; every conſtellation and ſtar in the heavens anſwering in poſition to thoſe on the globe. Hence, by examining the globe, it will immediately be ſeen what ſtars are above or below the horizon, which are on the eaſtern and weſtern parts of the heavens, which have juſt riſen above the horizon, and which are about to ſink below it.

As this problem will be found extremely uſeful to the ſtudent of aſtronomy, we ſhall here quote the example given in illuſtration of it by Meſſrs Bruce of Newcaſtle.

" Required the ſituation of the ſtars for the latitude of Newcaſtle, on October 6th, at eight o'clock in the evening?

" In our preſent ſurvey of the heavens, we ſhall commence at the north point of the horizon, and proceed round eaſtward; noticing the different conſtellations, and the relative ſituation of the principal ſtars in theſe conſtellations.

" The firſt ſtar which ſtrikes the eye of the obſerver, in the north-eaſt part of the heavens, is Capella, in the conſtellation Auriga, or the Waggoner: It is of the firſt magnitude, of the altitude of 23°, or nearly the fourth part of the diſtance from the horizon to the zenith. There are two ſtars of the ſecond magnitude, which form with Capella a triangle:—The ſtar which forms the ſhort ſide of the triangle is in the right ſhoulder of Auriga, and is marked β; it lies at the diſtance of about 8° from Capella, further to the north; its altitude is 18°:—The ſtar forming the longer ſide of the triangle is in the Bull's northern horn; its diſtance from Capella is more than 26°; its altitude not more than 5°, and azimuth N. E. There are three ſtars of the fourth magnitude, a little to the ſouth of Capella, that bear the name of the *Kids*.

" If a line be drawn through the two ſtars that form the upper ſide of the triangle, and continued to the horizon, it will point out Caſtor, α, in Gemini juſt riſing, azimuth E. N. E: it is between the firſt and ſecond magnitude. The other ſtars in this conſtellation have not yet riſen.

" A line drawn between Caſtor and Capella, and continued higher in the heavens, will point out Perſeus, in which there are three ſtars, one of the ſecond magnitude, α, named *Algenib*, and two of the third magnitude, one on each ſide of Algenib, at the diſtance of about 5°: they form a line a little curved on the ſide next Auriga. The altitude of Algenib is 37°; azimuth N. E. by E.

" A little to the ſouth of Perſeus is the Head of Meduſa, which Perſeus is holding in his hand. Beſides two or three ſmall ſtars, it contains one of the ſecond, and one of the third magnitude. The name of the brighteſt is *Algol;* altitude 33°, azimuth E. N. E. Algol is only 10° diſtant from Algenib.

" Directly below the Head of Meduſa, about 14° above the horizon, are the Pleiades or ſeven ſtars: They are ſeated in the ſhoulder of Taurus, and are ſo eaſily known, that no deſcription is neceſſary. Aldebaran, a ſtar of the firſt magnitude, which forms the eye of Taurus, is juſt riſing; azimuth E. N. E. A vertical circle drawn through Algol will point to it. There are two ſtars of the third magnitude, and ſeveral ſmaller very near Aldebaran, which form with it a triangle. The whole cluſter is called the *Hyades*.

" A line drawn from Aldebaran through Algol, and continued to the zenith, will direct to Caſſiopeia. This contains five ſtars of the third magnitude, beſides ſeveral of the fourth: it is in form ſomething like the letter Y, or, as ſome think, an inverted chair. It is ſituated above Perſeus, within 30° of the zenith. The altitude of the brighteſt ſtar, α, called *Schedar*, is 60°; azimuth, E. N. E.

" Below Caſſiopeia and weſt of Perſeus is Andromeda, which contains three ſtars of the ſecond magnitude. A line from Algenib, parallel to the horizon towards the ſouth, will paſs very near theſe three ſtars; and, as they are all of the ſame magnitude, and placed nearly at the ſame diſtance of 15° from each other, they may eaſily be known. The name of the ſtar neareſt Perſeus, and which is in the foot of Andromeda, marked γ, is Almaak: its altitude is 49°; azimuth E. N. E. The name of β, in the girdle, is Mirach: its altitude 44°; azimuth E. The altitude of α, in the head of Andromeda, is 46°; azimuth E. S. E.

" About 18° below Mirach are two ſtars in Aries, not more than 5° diſtant from each other, forming with Mirach an iſoſceles triangle: the moſt eaſtern ſtar, α, is of the ſecond magnitude; the other, β, of the third, attended by a ſmaller ſtar, marked γ, of the fourth magnitude. A line drawn from Mirach, perpendicular to the horizon, will paſs between the two, and beſides, will point to a ſtar of the ſecond magnitude, directly E. not above 3° from the horizon.

" This ſtar is the firſt of Cetus, marked α, and is of the ſecond magnitude: it is named *Menkar*. A line drawn from Capella through the Pleiades will alſo point to it. Cetus is a large conſtellation, and contains eight ſtars of the third magnitude; they all lie to the weſt of Menkar; β, a ſtar in the tail, is more than 40° diſtant from it. The azimuth of β is S. E. by E; altitude nearly the ſame as Menkar.

" The conſtellation Piſces is ſituated next to Aries; it contains one ſtar of the third magnitude, marked α: its altitude is 10°, azimuth E. by S. It is diſtant from Menkar 15°. A line drawn from Almaak, through α in Aries, will point to it.

" If we return again to α, in the head of Andromeda, we ſhall find three other ſtars nearer the meridian, which, with

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with it, form a ſquare. Theſe ſtars are in Pegaſus, and are placed at the diſtance of 15° from each other; they are all of the ſecond magnitude. The two ſtars forming the weſtern ſide of the ſquare are called—the upper one Scheat, which is marked β, and which is in the thigh of Pegaſus; the under one Markab, which is marked α, and which is in the wing; the loweſt ſtar in the eaſtern ſide of the ſquare is in the tip of the wing, and is marked γ. The altitude of Scheat is 55°; azimuth S. E. $\frac{1}{4}$ E. Altitude of Markab, 43°; azimuth S. E. by S $\frac{1}{2}$ E.

"A line drawn through γ and β (the diagonal in the ſquare of Pegaſus) and continued to the meridian, will point out Cygnus, a remarkable conſtellation in the form of a large croſs, in which there is a ſtar of the ſecond magnitude, named *Deneb*, or *Arided;* it is marked α, and is almoſt directly upon the meridian at the altitude of 80°. Cygnus contains ſix ſtars of the third magnitude. The conſtellation Cepheus, which contains no remarkable ſtars, is ſituated between Cygnus and the north pole.

"Below Pegaſus, and nearer the meridian, is Aquarius, containing four ſtars of the third magnitude. A line drawn from α in Andromeda, through Markab, will point to α in Aquarius. Its altitude is 32°; azimuth S. S. E.

"A bright ſtar of the firſt magnitude named *Fomelhaut*, in Piſces Auſtralis, is then upon the horizon; azimuth S. S. E.

"Delphinus is a ſmall conſtellation, ſituated about 30° below Cygnus upon the meridian; it contains five ſtars of the third magnitude, four of them being placed cloſe together, and forming the figure of a rhombus or lozenge. A line drawn through the two under ſtars of the ſquare will point to it. Its altitude is about 50°.

"A little to the weſt of Delphinus, but not quite ſo high, is Aquila, containing one very bright ſtar of the firſt magnitude, named *Atair*: It may very eaſily be known from having a ſtar on each ſide of it of the third magnitude, forming a ſtraight line. The length of the line is only about 5°; altitude of Atair 40°; azimuth S. S. W.

"Conſiderably above Atair, and a little to the W. of Cygnus, is Lyra, containing a ſtar of the firſt magnitude, one of the moſt brilliant in the firmament. It it called Lyra or Vega, and is 35° to the N. W. of Atair; altitude 60°; azimuth W. S. W. Lyra, Atair, and Arided, form a large triangle.

"We come now to notice three conſtellations, which occupy a large ſpace in the weſtern ſide of the heavens: theſe are Hercules immediately below Lyra; Serpentarius between Hercules and the horizon, extending a little more towards the ſouth; and Boötes, reaching from the horizon W. N. W. to the altitude of 45°.

"Hercules contains eight ſtars of the third magnitude; the ſtar in the head, α, named Ras Algethi, is within 5° of α in the head of Serpentarius. This laſt is a ſtar of the ſecond magnitude, and is named Ras Alhague: its altitude is 30°; azimuth, S. W. by W. $\frac{1}{2}$ W. A line drawn from Lyra, perpendicular to the horizon, will paſs between theſe two ſtars. The other ſtars in Hercules extend towards the zenith, and thoſe in Serpentarius towards the horizon.

"The conſtellation Boötes may eaſily be known from the brilliancy of Arcturus, a ſtar of the firſt magnitude, and ſuppoſed to be the neareſt to our ſyſtem of any in the northern hemiſphere: it is within 10° of the horizon; azimuth W. N. W. Boötes alſo contains ſeven ſtars of the third magnitude, moſtly ſituated higher in the heavens than Arcturus. The ſtar immediately above Arcturus is called Mezen Mirach, and is marked ε. The ſtar in the left ſhoulder, δ, named Seginus, forms with Mirach and Arcturus a ſtraight line.

"Between Serpentarius and Boötes is *Serpens*, containing one ſtar of the ſecond magnitude, and eight of the third: α in *Serpens* is nearly at the ſame diſtance from the horizon, as Arcturus; azimuth W.

"Above Serpens, and a little to the eaſt of Boötes, is the Northern Crown, containing one ſtar of the ſecond magnitude, named Gemma, and ſeveral of the third, which have the appearance of a ſemicircle. A line drawn from Lyra to Arcturus will paſs through this conſtellation.

"We come now to Urſa Major, a conſtellation containing one ſtar of the firſt, three of the ſecond, and ſeven of the third magnitude. It may eaſily be diſtinguiſhed by thoſe ſeven ſtars, which, from their reſemblance to a waggon, are called Charles's Wain. The four ſtars in the form of a long ſquare, are the four wheels of the waggon; the three ſtars in the tail of the Bear, are the three horſes, which appear fixed to one of the wheels. The two hind wheels, α named Dubhe, and β, are called the pointers, from their always pointing nearly to the north pole. Hence the pole ſtar may be known. The altitude of Dubhe is 30°; azimuth N. by W. $\frac{1}{2}$ W. The diſtance between the two pointers is 5°; the diſtance between the pole ſtar and Dubhe, the upper pointer, is 30°.

"Urſa Minor, beſides the pole ſtar of the ſecond magnitude, ſituated in the tail, contains three of the third, and three of the fourth magnitude. Theſe form ſome reſemblance to the figure of Charles's Wain inverted, and may eaſily be traced.

"Draco, containing four ſtars of the ſecond and ſeven of the third magnitude, ſpreads itſelf in the heavens near Urſa Minor: the four ſtars in the head are in the form of a rhombus or lozenge: the tail is between the pole ſtar and Charles's Wain.

"Beſides theſe conſtellations, there are a number of others, which, as they contain no remarkable ſtars, we have not deſcribed; an enumeration of theſe will ſuffice. The Lynx, between Urſa Major and Auriga; Camelopardalus, between Urſa Major and Caſſiopeia; Muſca, and the Greater and Leſs Triangles between Aries and Perſeus, Aculeus, cloſe to the head of Pegaſus; Sagittarius ſetting in the ſouth-weſt; Antinous and Sobieſki's Shield below Aquila; the Fox and Gooſe between Aquila and Cygnus; the Greyhounds and Berenice's Hair between Boötes and Urſa Major, and Leo Minor below Urſa Major" *.

* *Bruce's Introduction to Geography and Aſtronomy*, 2d ed. p. 262.

The aſtronomical terms that we muſt here employ in deſcribing the method of performing the problems on the celeſtial globe, will be found explained in the article Astronomy, or under their proper heads in the general alphabet of this work. See Ascension, Azimuth, Declination, &c.

Problem

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103 Problems respecting the stars.

PROBLEM II. *To find the right ascension and declination of any given star.*

Bring the given star below the brazen meridian, and mark the degree of the meridian under which it lies. That degree shews the declination of the star, and the degree of the equator cut by the meridian gives the star's right ascension.

The right ascension of a star may also be found by placing the globe in the position of a right sphere, and then bringing the star to the eastern part of the horizon; for that point of the equator which comes to the horizon at the same time with the star, marks its right ascension. See ASTRONOMY, N° 249, 250.

Ex. 1. What is the right ascension and declination of the star Sirius? *Ans.* Its right ascension is 99°, and its declination 16° 27′ S.

Ex. 2. Required the right ascension and declination of Aldebaran, or the star in the Bull's Eye marked α. *Ans.* Its right ascension is 66°, and its declination 16° 5′ N.

PROBLEM III. *Having the right ascension and declination of a star given, to find the star on the globe.*

Bring that degree of the equator which marks the right ascension below the brazen meridian, and counting along the meridian towards the north or south, as far as the degree of declination, the required star will be there found.

Ex. 1. The right ascension of a certain star is 162° 15′ and its declination is 57° 27′ N.; What is the name of the star? *Ans.* The lower pointer of Ursa major, marked β.

Ex. 2. The right ascension of Arcturus is 211° 30′, and its declination is 20° 13′ N.: it is required to find it on the globe.

This problem is extremely useful in discovering the names and relative situations of the different stars.

PROBLEM IV. *To find the latitude and longitude of a given star.*

Bring the solstitial colure (see N° 75) below the brazen meridian, and there fix the quadrant of altitude over that pole of the ecliptic which is in the same hemisphere with the given star. Then, keeping the globe steady, bring the graduated edge of the quadrant over the given star, and the degree of the quadrant cut by the star, counted from the ecliptic, marks its latitude, and the degree of the ecliptic that is cut by the quadrant is the longitude of the given star (H). See ASTRONOMY, N° 252, 253.

Ex. 1. What is the latitude and longitude of Arcturus? *Ans.* Lat. 31° N. Long. Libra 20°.

Ex. 2. What is the latitude and longitude of Capella? *Ans.* Lat. 23° N. Long. Gemini 18° 30′.

PROBLEM V. *Having the day of the month given, to find at what hour any star comes below the meridian.*

Find the sun's place, and bring it to the meridian, and set the horary index to XII.; turn the globe till the given star come below the meridian, and the index will point out the hour.

To know whether the hour is in the forenoon or afternoon, it is necessary to observe, that if the star be to the east of the sun, it will reach the meridian later than the sun, but if it be to the west of that luminary, it will come to the meridian sooner: hence, in the former case, the hour will be P. M. and in the latter A. M.

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Ex. 1. At what hour does Sirius come to the meridian on the 9th of February? *Ans.* At 7 minutes past 9 P. M.

Ex. 2. Required the hour when Castor passes the meridian on the same day. *Ans.* At 52 minutes past 9 P. M.

PROBLEM VI. *Having any star given, and a given hour, to find on what day the star will come to the meridian at a given hour.*

Bring the given star below the meridian, and set the horary index to the given hour. Make the globe revolve till the index come to twelve at noon; and the day of the month which corresponds to the degree of the ecliptic then below the meridian, found in the calendar circle of the wooden horizon, will be the day required.

Ex. 1. On what day does Algenib, the first star of Perseus, come to the meridian at midnight? *Ans.* On the 13th of November.

Ex. 2. On what day does Arcturus come to the meridian at 9 o'clock P. M. *Ans.* On the 10th of June.

PROBLEM VII. *Having the latitude, the day of the month and the hour of the night given, to find the altitude and azimuth of any given star.*

Rectify the globe for the given latitude; bring the sun's place below the meridian, and set the horary index at XII. then turn the globe till the index point at the given hour. Fix the quadrant of altitude at 90° from the horizon, that is, in the zenith, and bring its graduated edge over the place of the star: the degree of the quadrant intercepted between the horizon and the star is the altitude required; and the distance between the foot of the quadrant and the nearest part of the horizon, will be the azimuth.

It is evident that this problem on the celestial globe is exactly similar to Problem XIII. on the terrestrial globe, for finding the altitude of the sun.

Ex. 1. What will be the altitude and azimuth of Cor Hydræ on the 21st of December at London, at 4 o'clock A. M.? *Ans.* The altitude 30°, the azimuth S. 14° W.

Ex. 2. Suppose an observer at the Cape of Good Hope, on the 21st of June at midnight; required the altitude and azimuth of Arcturus to him? *Ans.* Altitude 12°, azimuth N. 55° W.

PROBLEM VIII. *Having given the azimuth of any given star, and the day of the month in a given latitude; to find the hour of the night, and altitude of the star.*

Rectify the globe as in the last problem; fix the quadrant of altitude in the zenith, and bring it to the given azimuth. Turn the globe till the star comes below

(H) It must be remembered that the longitude of the heavenly bodies is not estimated in degrees and minutes like their right ascension, but in signs, degrees, and minutes, as the sun's place is reckoned.

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low the graduated edge of the quadrant, when the horary index will point out the hour, and the altitude of the ſtar will be ſeen by the quadrant.

Ex. Suppoſe the azimuth of Dubhe to be N. 23° W. at London on the 1ſt of September; it is required to find the altitude of the ſtar, and the hour of the night? *Anſ.* The altitude of Dubhe at that time is 31°, and the hour is 9 o'clock P. M.

PROBLEM IX. *The latitude of the place, the altitude of a ſtar, and the day of the month, being given; to find the azimuth and the hour of the night.*

Rectify the globe as before, and having fixed the quadrant of altitude in the zenith, turn the globe and quadrant of altitude till the latter comes over the ſtar at the given degree of altitude. In this poſition the index will ſhew the time of night, and the poſition of the quadrant at the horizon will ſhew the azimuth of the ſtar.

In the ſame way the hour of the night and the azimuth of the ſun may be found, by fixing a patch on the globe in the ſun's place, and bringing it to the quadrant as directed for the ſtar.

As the ſun and ſtars have the ſame altitude twice in the day, it is proper to know whether they are to be eaſt or weſt of the meridian; or whether the hour required be in the evening or the morning.

Ex. At Edinburgh, on the 25th of December, in the forenoon, when the ſun's altitude is 7° 20′, required the hour and the ſun's azimuth? *Anſ.* It is 10 o'clock A. M. and the ſun's azimuth is S. 27° 30′ E.

PROBLEM X. *Having the azimuth of the ſun or a ſtar, the latitude of the place, and the hour of the day given; to find the altitude and day of the month.*

Rectify the globe for the latitude of the place, fix the quadrant in the zenith, and bring its edge under the given azimuth. Bring the ſun's place or the ſtar to the edge of the quadrant, and ſet the index at the given hour. The degree marked in the quadrant will ſhew the altitude; and if the globe be turned till the index points to twelve at noon, the day of the month, anſwering to that degree of the ecliptic which is interſected by the brazen meridian, is the day required.

Ex. The azimuth of the ſtar α in the Northern Crown was obſerved at London at 9 o'clock P. M. to be S. 89° W.; required the altitude and day of the month? *Anſ.* Altitude 38°; day of the month 1ſt of September.

PROBLEM XI. *Having obſerved two ſtars to have the ſame azimuth; to find the hour of the night.*

Rectify the globe as before; turn the globe and move the quadrant till the edge of the latter comes over both ſtars, and the horary index in this poſition of the globe will give the hour required.

The following is a ſimple and eaſy method of finding when two ſtars have the ſame azimuth. Hold a ſmall line with a plummet at its lower extremity between the eye and the two ſtars, and if both ſtars fall within the line, they have the ſame azimuth. The ſame may be done by obſerving when any two ſtars paſs behind the perpendicular edge of a wall at the ſame time.

Ex. Vega and Atair were obſerved to have the ſame azimuth at London on the 11th of May; required the hour of the night? *Anſ.* 15 minutes paſt 2 A. M.

This problem may be applied to the regulating of clocks and watches, by reducing apparent to real time, as explained under ASTRONOMY.

PROBLEM XII. *To find the riſing, ſetting, and culminating of any ſtar or planet, its continuance above the horizon, its oblique aſcenſion and deſcenſion, and its eaſtern and weſtern amplitude; the place and day being given.*

Rectify the globe as in the foregoing problems; bring the given ſtar or the given planet (finding its place in an ephemeris for the given day, and marking it by a patch on the globe), to the eaſtern part of the horizon, and the index of the hour circle will point out the time of riſing: the degree of the equator that comes to the horizon with the given ſtar or planet, marks its oblique aſcenſion, and the eaſtern amplitude is ſhewn by the diſtance of the ſtar or planet from the eaſtern part of the horizon.

Bring the ſtar or planet to the meridian, and the index will point to the time of its culminating.

Move the globe till the ſtar or planet come to the weſtern part of the horizon, and the time of its ſetting, its oblique deſcenſion, and its weſtern amplitude, may be found in the ſame manner as directed above; for its riſing, oblique aſcenſion, and eaſtern amplitude, the number of hours paſſed over by the index, while the ſtar or planet is moving from eaſt to weſt, will ſhew the time of its continuance above the horizon.

Ex. 1. Required the above circumſtances with reſpect to Sirius on the 14th of March at London. *Anſ.* It riſes at 24 minutes paſt two P. M.; comes to the meridian, or culminates, at 57 minutes paſt ſix P. M.; and ſets at half-paſt eleven PM. Hence it remains above the horizon nine hours and ſix minutes. Its oblique aſcenſion is 120° 47′, its oblique deſcenſion 77° 17′, and its amplitude 27° S.

Ex. 2. It is required to find the ſituation of the ſeveral planets on the 19th of January 1806. *Anſ.* Mercury is about 22° to the weſt of the ſun, and riſes ſouth-eaſt by eaſt, at 20 minutes before ſeven A. M. Venus is an evening ſtar, and ſets about half paſt eight. Mars is a very little to the eaſt of the ſun, and riſes and ſets ſo near the ſame time with the ſun, that he cannot be ſeen. Jupiter is a morning ſtar, and riſes about ſix o'clock. Saturn is a little to the eaſt of the ſtar Spica Virginis, and riſes about half an hour after midnight. Herſchel is very near Saturn, and riſes about the ſame time.

PROBLEM XIII. *To find thoſe ſtars which never riſe, and thoſe which never ſet, in a given latitude.*

Rectify the globe for the latitude of the place; then, holding a black lead pencil ſo as to touch the ſurface of the globe at the northern point of the horizon, turn the globe, ſo that the pencil may deſcribe a circle: all the ſtars which are between this circle and the elevated pole, never ſet. Again, holding the pencil at the ſouthern point of the horizon, turn the globe ſo as to deſcribe another circle there, and all the ſtars that are between that circle and the pole, below the horizon, never riſe.

If the place is in ſouthern latitude, the ſtars that never ſet are found by deſcribing a circle at the ſouthern point,

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point of the horizon, and those that never rise by a similar circle at the northern point (1).

103 Harvest moon illustrated. Throughout almost the whole year, the moon rises later every successive day, by above three quarters of an hour; but at a considerable distance from the equator, as in the latitude of Britain, France, and some other countries, a remarkable anomaly takes place in the moon's motion about the time of harvest. At this season, when the moon is about full, she rises for several nights successively at about 17 minutes only later than on the preceding day. This is attended with considerable advantage, for as the moon rises before twilight is well ended, the light is as it were prolonged, and thus an opportunity given to the industrious farmer to continue longer in the field, for the purpose of gathering in the fruits of the earth. From the advantage derived from the full moon at the season of harvest, it has been called the *harvest moon*. The following problem has been contrived for the purpose of illustrating the phenomenon by means of the globe.

Problem XIV.

Rectify the globe for any considerable northern latitude, suppose that of London. As the angle which the moon's orbit makes with the ecliptic is but small, we may suppose, without any considerable error, her orbit to be represented by the ecliptic. In September the sun is in the beginning of ♎, so that the moon, when full, being in opposition to the sun, must be in or near the beginning of ♈. Put a patch, therefore, in the globe at the first point of ♈ in the ecliptic; and as the moon's mean motion is about 13° in a day, put another patch on the ecliptic 13° beyond the former, and it will point out the moon's place the night after it is full. A third and fourth patch, put at the distance of 13° further on, will shew the moon's place on the second and third nights after full, &c. Now, bring the first patch to the horizon, and observe the hour pointed out by the index; turn the globe till the second patch comes to the horizon, and it will appear by the index that there are only 17 minutes between the time of the first patch rising, and that of the second. This small difference in the motion of the moon evidently arises from the small angle which her orbit makes with the horizon. The remaining patches will come to the horizon with a little greater difference of time, and this difference will gradually increase as the moon advances in the ecliptic; but for the first week after the full moon at harvest the difference will not be more than two hours. If patches be continued on to the first point in ♎, it will be found that the time of their rising, or coming to the horizon, will increase considerably till the last will be above 1¼ hour later in coming to the horizon, because that point of the ecliptic makes the greatest angle with the horizon.

The point of the ecliptic, which makes the least angle with the horizon at rising, makes the greatest angle at setting; and, consequently, when the difference is least at the time of rising, it is greatest at the time of setting.

Problem XV. *To explain the equation of time by the globe.*

104 Equation of time illustrated. The difference between apparent time and mean or equal time, has been explained in Astronomy, from N° 50 to 60; and the method of computing the equation of time is also there described.

To explain the equation of time on the globe, make, with a black lead pencil, marks all round the equator and ecliptic, beginning with ♈, at equal distances from each other, suppose about 15°. Then, on turning the globe, it will be seen that all the marks on the first quadrant of the ecliptic, reckoning from ♈ to ♋, come to the brazen meridian sooner than the corresponding marks on the first quadrant of the equator. Now, as the former marks represent time as measured by the sun, or a dial, and the latter represent it as measured by an accurate clock, it will be evident, that through the first quarter the dial is faster than the clock.

Still turning the globe, it will be seen that the marks on the second quarter of the ecliptic, reckoning from ♋ to ♎, come to the meridian later than the corresponding marks of the equator; consequently in this quarter the sun or the dial is slower than the clock. By moving the globe round, and marking the approach of the dots in the third quadrant, it will be seen that, as in the first, the dial now precedes the clock, and in the fourth quadrant, that it is behind it, according to the explanation given in Astronomy.

Sect. III. *Of the Construction of Globes.*

105 General construction of globes. The construction of globes is of considerable importance; as, in performing the problems in which they are employed, very much depends on the accuracy with which they have been constructed. We shall here, therefore, describe pretty minutely the methods in which the artists of Britain and France make their globes.

There are certain general circumstances which are attended to in the construction of every globe.

There is first provided a wooden axis, somewhat less than the intended diameter of the globe, and to the extremities of this axis, which is the basis of the whole succeeding structure, there are fixed two metallic wires, to serve as poles. Now, two hemispherical caps formed on a wooden mould or clock, are applied in the axis. These caps are composed of pasteboard, or folds of paper laid one over another on the mould, till they are of the thickness of a crown piece; and after the whole has stood to dry, and has become a solid body, an incision is made with a sharp knife along the middle, and the two caps are thus slipped off the mould. These caps are now to be applied on the poles of the axis, as they were before on those of the mould; and to fix them

(1) This problem may be performed without the globe, by the following method. Find the latitude of the place in a table, and subtract it from 90°; the remainder will be the complement of the latitude. Then, if the declination of the given star be of the same name with the co-latitude, and exceed it in quantity, it will never set. If it be of a contrary name, and exceed it, it will never rise.

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them firmly on the axis, the two edges are fewed together with packthread.

When the rudiments of the globe are thus laid, the artift proceeds to ftrengthen the work, and make the furface fmooth and equal. For this purpofe, the two poles are fixed in a metallic femicircle, of the propofed fize; and a compofition made of whitening, mixed with water and glue, heated, melted, and incorporated together, is daubed all over the paper furface. While the plafter is applied, the globe is turned round in the femicircle, the edge of which pares away all the matter that is fuperfluous and exceeds the proper dimenfions, and fpreads the reft over thofe parts that require it. After this operation the ball ftands to dry, and when it is thoroughly dried, it is again put in the femicircle, and frefh plafter applied to it; and thus they continue to apply compofition and dry the ball alternately, till the furface accurately touches the femicircle in every point, when it becomes perfectly firm, fmooth, and equal.

When the ball of the globe is thus finifhed, the map, containing a delineation of the furface of the earth, is to be pafted on the globe. For this purpofe, the map is engraved in feveral gores or guffets, fo that when thefe are accurately joined together on the fpherical furface, they may cover every part of the ball, without overlapping each other. The greateft nicety is required in forming thefe engraved guffets, as well in the accuracy of the engraving, as in the choice and fhape of the paper employed. The method of defcribing the gores or guffets, ufually employed by the Britifh artifts, is as follows.

1. From the given diameter of the globe there is found a right line AB (fig. 12.), equal to the circumference of a great circle correfponding to that diameter; and this line is divided into 12 equal parts.

2. Through the feveral points of divifion, 1, 2, 3, 4, &c. with a diftance equal to ten of the divifions, arches are defcribed croffing each other as in D and E; and thefe figures are pafted on the globe, fo as when joined together to cover its whole furface.

3. Each part of the line AB is divided into 30 equal parts, fo that the whole line, which may reprefent the equator, is divided into 360°.

4. From the points D and E, which reprefent the poles, with a diftance $=23\frac{1}{2}°$, there are defcribed arches *a b*, *a b*, (fig. 13.) which form twelfth parts of the polar circles.

5. In a fimilar manner about the fame poles D and E, with a diftance $=66\frac{1}{2}°$, reckoned from the equator, there are defcribed other arches, *c d*, *c d*, which are the twelfth parts of the tropics.

6. In forming the celeftial globe, through the point of the equator marked *e* (fig. 13.) reprefenting the right afcenfion of a given ftar, and through the two poles D and E, there is drawn an arch of a circle; and if the complement of the declination from the pole D be taken in the compaffes, and an arch be defcribed, interfecting the former in the point *i*, this point *i* will be the place of the given ftar.

7. In this way all the ftars of each conftellation are laid down, and the circumfcribing outline of the conftellation is drawn as figured in the tables of Bayer, Flamftead, &c.

8. In the fame manner are determined the declinations and right afcenfions of every degree of the ecliptic, *d*, *g*.

The above is the method defcribed by Mr Chambers, of laying down or delineating the gores of a celeftial globe. Thofe of the terreftrial globe are delineated in much the fame manner, only that every place is laid down on the gores, according to its longitude and latitude, determined by the interfection of circles; and then the outline of the coafts, boundaries of countries, &c. are added, like the figures of the conftellations above mentioned.

9. When the furface of the globe has been thus projected on a plane, the guffets are to be engraved on copper, to fave the trouble of making a new projection for every globe.

10. In the mean time, a ball of paper, plafter, or the like, of the intended diameter of the globe, is prepared in the manner above defcribed, and by means of a femicircle and ftyle, great circles are drawn on its furface, fo as to divide it into a number of equal parts, correfponding to the number of guffets; and fubdividing each of thefe according to the other lines and divifions of the globe. When the ball is thus prepared, the guffets are to be accurately cut from the printed engraving, and pafted on the ball.

When the papers have been thus pafted on, and fuffered to dry, nothing remains but to colour and illuminate the globe, and to cover it with a thin layer of the fineft varnifh, that it may the better refift duft and moifture. The ball of the globe is now finifhed, and is to be hung in a ftrong brazen meridian, furnifhed with hour circles and a quadrant of altitude, and fitted into a ftrong wooden horizon.

106 Method of forming the gores.

The method employed by the French artifts in projecting the guffets of globes, is thus defcribed by M. La Lande.

"To form celeftial and terreftrial globes, it is neceffary to engrave gores, which are a fort of projection or developement of the globe. The length PC (fig. 14.) of the axis of the curve, is equal to a fourth part of the circumference of the intended globe; the intervals of the parallels on the axis PC are all equal; the radii of the circles K D I, which reprefent the parallels, are equal to the co-tangents of the latitudes, and the arches of each, fuch as KI, are nearly equal to the number of degrees that correfpond to the breadth of the gore (ufually 30°), multiplied by the fine of the latitude: thus, there will be found no difficulty in tracing them; but the principal difficulty proceeds from the change which thofe parts of the gores undergo, when they are glued upon the globe; as, in order to adjuft them to the fpace which they ought to occupy, it is neceffary to make the paper lefs on the fides than in the middle, becaufe the fides are too long.

"The method employed by artifts for engraving thefe gores, is thus defcribed by Bion (*Ufage des Globes*, tom. iii.), and by Robert de Vaugondy in the feventh volume of the Encyclopedié, and this method is fufficient for practical purpofes.

"Draw on the paper a line AC, equal to the chord of 15°, to make the half breadth of the gore; and a perpendicular PC, equal to three times the chord of 30°, to make the half length: for thefe papers, the dimenfions of which will be equal to the chords, become equal to the arcs themfelves when they are pafted on the globe. Divide the height CP into nine parts, if the parallels are to be drawn in every 10°; divide alfo the quadrant BE into nine equal parts; through each divifion

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vision point of the quadrant, as G, and through the corresponding point D of the right line CP, draw the perpendiculars HGF and DF, the meeting of which in F gives one of the points of the curve BFP, which will terminate the circumference of the gore. When a sufficient number of points are thus found, trace the outline PIB with a curved rule. By this construction are given the gore breadths, which are on the globe, in the ratio of the cosines of the latitudes, supposing those breadths taken perpendicular to CD, which is not very exact; but it is impossible to prescribe a rigid operation sufficient to make a plane which shall cover a curved surface, and that on a right line AB shall make lines PA, PC, PD, equal to each other, as they ought to be on the globe. To describe the circle KDI, which is at the distance of 30° from the equator, there must be taken above D, a point that shall be distant from D the value of the tangent of 60°, which may be taken either from tables, or may be measured on a circle equal to the circumference of the globe that is to be drawn; this point will serve as a centre for the parallel DI, which ought to pass through the point D; for it is supposed equal to that of a cone circumscribing the globe, and which would touch it at the point D.

"The meridians are traced to every 10°, by dividing each parallel, as KI, into three equal parts at the points L and M, and drawing from the pole P, through all these points of division, curves which represent the intermediate meridians lying between PA and PB, such as BR and ST (fig. 15.)

"The ecliptic AQ (fig. 15.) is traced by means of the known declination, from different points of the equator, as found in the tables; for 10° it is equal to 3° 58′; for 20°=7° 50′=BQ 20; for 30°=11° 29′, &c."

In general, it is observed that the paper on which maps are printed, such as that called in France *colombier*, contracts itself $\frac{1}{72}$, or a line in six inches, upon an average, when it is dried after printing; hence it is necessary to prevent this inconvenience in engraving the gores: if, however, notwithstanding this, the gores are still found too short, it must be remedied by taking from the surface of the ball a little of the white with which it is covered; thus making the dimensions of the ball correspond to those of the gores as they are printed. But, what is singular, in drawing the gore, moistened with the paste to apply it on the globe, the axis GH lengthens, and the side AN shortens in such a manner that neither the length of the side ACK, nor that of the axis GEH of the gore are exactly equal to the quarter of the circumference of the quarter of the globe, when compared to the figure on the copper, or to the numbers shewn on the side of fig. 15.

"Mr Bonne having made several experiments on the dimensions which the gores take after being covered with paste in order to apply them to the globe, especially of the paper called *jesus*, which had been employed in covering globes of a foot in diameter; found that it was necessary to give to the gore engraved on copper the dimensions laid down in fig. 15. Supposing that the radius of the globe contains 720 parts, the half of the breadth of the gore AG=188.5; the distance AC for the parallel of 10° taken on the straight line LM is =128.1, the small deviation from the parallel of 10° in the middle of the gore ED is 4, the line ABN is a straight line, the radius of the parallel of 10° or of the circle CET, is 4083, &c. The small circular cap which is placed under H, has its radius 253, instead of 247, which it would have if the sine of 20° had been the radius of it."*

Globes are made of various sizes, from a diameter of three inches, to that of as many feet; but their most usual diameter is that of 18 inches, which are sufficiently large for most of the purposes for which globes are employed. Some large globes were made about 100 years ago, in France, by P. Coronelli, a Franciscan monk, which were in considerable reputation. They were engraved, and the plates are still to be seen at Paris, at the house of M. Desnos, in the Rue St Jacques. There are some large globes at Cambridge, which were drawn by the hand; but the largest globes of which we have any account, are those which were made for the late unfortunate Louis XVI. and were kept in the palace of Marly. They were 12 feet in diameter, and we believe, are still existing at Paris, where they occupy four entire rooms, each of them being partly in an upper room, and partly in that below it, the floor of the upper room forming the horizon.

* La Lande *Astronomie*, tom. iii. p. 616. 3d ed

The account which we have given of the method of constructing globes, will be useful to those who purchase these instruments; but to assist them still further, we shall subjoin the following practical rules for the choice of globes.

107 Rules for choosing globes.

1. The papers should be well and neatly pasted on the globes, which may be known by the lines and circles meeting exactly, and continuing all the way even and whole; the circles not breaking into several arches, nor the papers either coming short, or lapping over one another.

2. The colours should be transparent, and not laid too thick upon the globe, to hide the names of the places.

3. The globe should hang evenly between the brazen meridian and the wooden horizon, not inclining either to the one side or the other.

4. The globe should move as close to the horizon and the meridian as it conveniently may, otherwise there will be too much trouble to find against what part of the globe any degree of the meridian or horizon is.

5. The equinoctial line should be even with the horizon all round, when the north or south pole is elevated 90° above the horizon.

6. The equinoctial line should cut the horizon in the east and west points, in all the elevations of the pole from 0 to 90°.

7. The degree of the brazen meridian marked 0, should be exactly over the equinoctial line of the globe.

8. Exactly half of the brazen meridian should be above the horizon, which may be known by bringing any of the decimal divisions on the meridian to the north point of the horizon, and finding their complement to 90° on the south point.

9. When the quadrant of altitude is placed as far from the equator, or the brazen meridian, as the pole is elevated above the horizon, the beginning of the degrees of the quadrant should reach just to the plane surface of the horizon.

10. When the index of the hour circle passes from one

one hour to another, 15 degrees of the equator muſt paſs under the graduated edge of the brazen meridian.

11. The wooden horizon ſhould be made ſubſtantial and ſtrong; it being generally obſerved, that, in moſt globes, the horizon is the firſt part that fails, on account of its having been made too ſlight.

108 In uſing a globe, the eaſtern ſide of the horizon ſhould be kept towards the obſerver, (unleſs in particular problems which require a different poſition); and that ſide may be known by the word *eaſt* on the horizon. In this poſition the obſerver will have the graduated ſide of the meridian towards him, and the quadrant of altitude directly before him; and the globe will be exactly divided into two equal parts by the graduated ſide of the meridian.

In performing ſome problems, it will be neceſſary to turn about the whole globe and horizon, in order to look at the weſt ſide; but this turning will be apt to diſturb the ball, ſo as to ſhift away that degree of the globe which was before ſet to the horizon or meridian. This inconvenience may be avoided by thruſting the feather end of a quill between the ball of the globe and the brazen meridian, and thus, without injuring the ſurface of the globe, it will be kept from turning in the meridian, while the whole is moved round, ſo as to examine the weſtern ſide.

We have already mentioned ſome improvements which have been made on the globes, for the purpoſe of remedying the defect in the old conſtruction, of placing the hour circles on the outſide of the brazen meridian. Some other improvements and modifications have been contrived by various artiſts; but of theſe we ſhall only mention thoſe of Mr Senex, Mr B. Martin, Mr Smeaton, and Mr Adams.

109 Mr Senex's improvement in the globes.

Mr John Senex, F. R. S. invented a contrivance for remedying theſe defects, by fixing the poles of the diurnal motion to two ſhoulders or arms of braſs, at the diſtance of $23\frac{1}{2}°$ from the poles of the ecliptic. Theſe ſhoulders are ſtrongly faſtened at the other end to an iron axis, which paſſes through the poles of the ecliptic, and is made to move round with a very ſtiff motion; ſo that when it is adjuſted to any point of the ecliptic which the equator is made to interſect, the diurnal motion of the globe on its axis will not diſturb it. When it is to be adjuſted for any particular time, either paſt or future, one of the brazen ſhoulders is brought under the meridian, and held faſt to it with one hand, while the globe is turned about with the other; ſo that the point of the ecliptic which the equator is to interſect may paſs under the 0 degree of the brazen meridian; then holding a pencil to that point, and turning the globe about, it will deſcribe the equator according to its poſition at the time required; and transferring the pencil to $23\frac{1}{2}$ and $66\frac{1}{2}$ degrees on the brazen meridian, the tropics and polar circles will be ſo deſcribed for the ſame time. By this contrivance, the celeſtial globe may be ſo adjuſted, as to exhibit not only the riſing and ſetting of the ſtars in all ages and in all latitudes, but likewiſe the other phenomena that depend upon the motion of the diurnal round the annual axis. Senex's celeſtial globes, eſpecially the two greateſt, of 27 and 28 inches in diameter, have been conſtructed upon this principle; ſo that by means of a nut and ſcrew, the pole of the equator is made to revolve about the pole of the ecliptic.

To repreſent the above appearances in the moſt natural and eaſy manner, Mr B. Martin applied to the contrivance of Mr Senex a moveable equinoctial and ſolſtitial colure, a moveable equinoctial circle, and a moveable ecliptic; all ſo connected together as to repreſent thoſe imaginary circles in the heavens for any age of the world.

110 Improvements by Mr Smeaton.

In order to the performance of the problems which relate to the altitudes and azimuths of celeſtial objects, Mr Smeaton, F. R. S. has made ſome improvements applicable to the celeſtial globe; and to give ſome idea of the conſtruction, they may be deſcribed as follows: Inſtead of a thin flexible ſlip of braſs, which generally accompanies the quadrant of altitude, Mr Smeaton ſubſtitutes an arch or a circle of the ſame radius, breadth, and ſubſtance, as the braſs meridian, divided into degrees, &c. ſimilar to the diviſions of that circle, and which, on account of its ſtrength, is not liable to be bent out of the plane of a vertical circle, as is uſual with the common quadrant put to globes. That end of this circular arch at which the diviſion begins, reſts on the horizon, being filed off ſquare to fit and reſt ſteadily on it throughout its whole breadth; and the upper end of the arch is firmly attached, by means of an arm, to a vertical ſocket, in ſuch a manner that when the lower end of the arch reſts on the horizon, the lower end of this ſocket ſhall reſt on the upper end of the braſs meridian, directly over the zenith of the globe. This ſocket is fitted to and ground with a ſteel ſpindle of the length, ſo that it will turn freely on it without ſhaking; and the ſteel ſpindle has an apparatus attached to its lower end, by which it can be faſtened in a vertical poſition to the braſs meridian, with its centre directly over the zenith point of the globe. The ſpindle being fixed firmly in this poſition, and the ſocket which is attached to the circular arch put on it, and ſo adjuſted that the lower end of the arch juſt reſts on and fits cloſe to the horizon; it is evident that the altitude of any object above the horizon will be ſhewn by the degree which it interſects on this arch, and its azimuth by that end of the arch which reſts on the horizon.

Beſides this improvement, Mr Smeaton propoſes that, inſtead of fixing the hour index, as is uſually done, on one end of the axis, it be placed in ſuch a manner that its upper ſurface may move in the plane of the hour circle rather than above it. To effect this, he directs the extremity of the index to be filed off ſo as to form a circular arc, of the ſame radius with the inner edge of the hour circle, to which it is made to fit exactly, and a fine line is drawn in the middle of its upper ſurface, to point out the hour, inſtead of the tapering point uſually employed. By this contrivance, if the hour circle be made four inches in diameter, the time may be ſhewn to half a minute. For a more particular account of Mr Smeaton's improvements, we refer the reader to the 79th volume of the Philoſophical Tranſactions.

Another improvement of the celeſtial globe, by which it is better adapted to aſtronomical purpoſes, is deſcribed in the article ASTRONOMY, Vol. III. p. 178.

111 Adams's late improvements.

Beſides the modifications in the conſtruction of globes, introduced by Mr Adams, and which have been already

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The globes conftructed after this manner do not hang in a frame like the ordinary globes, but are fixed on a pedeftal, and fupported by an axis which is inclined $66\frac{1}{2}°$ to the ecliptic, and is of courfe always parallel to the axis of the earth, fuppofing the orbit of this planet to be parallel to the ecliptic. On the pedeftal below the globe is a graduated circle, marked with the figns and degrees of the ecliptic; and adjoining to this is a circle of months and days, anfwering to every degree of the ecliptic; and within this is a third circle fhewing the fun's declination for every day of the month. There is a moveable arm on the pedeftal, which being fet to the day of the month, immediately points out the fun's place and declination.

Round the globe there is a circle reprefenting the horizon of any place, and at right angles to this is fixed a femicircle, ferving for a general meridian. The middle point of this femicircle ferves to reprefent the fituation of any inhabitant on the earth; for this purpofe there is fixed a fteel pin over the middle point of this femicircle.

Mr Adams alleges that only one fuppofition is neceffary for performing every problem with this globe, namely, that a fpherical luminous body will enlighten one half of a fpherical opaque body, and confequently that a circle at right angles with the central folar ray, and dividing the globe in half, will be a terminator fhewing the boundary of light and darknefs for any given day. For this purpofe, at the end of the moveable arm, oppofite to the fun, there is a pillar, from the top of which projects a piece carrying a circle that furrounds the globe, dividing it into equal portions, and feparating the illuminated from the dark parts; and 18° behind this there is another circle parallel to it, reprefenting the limit of twilight.

There are two plates below the globe, which are turned by the diurnal revolution of the globe, each of them being divided into twice 12 hours, and on the outfide being marked with the degrees of longitude correfponding to every hour; fo that thefe circles give at fight the hour of the day at any two places on the globe, and the correfponding difference of longitude.

The celeftial globe is mounted in a fimilar manner, except that it is fixed on the axis, and the ecliptic exactly coincides with the fun's apparent path from the earth *.

* *Adams's Lectures*, vol. iv. p. 199.

SECT. IV. *Of the Armillary Sphere.*

112 Armillary fphere.

IF a machine be conftructed that is compofed only of the circles of the fphere, and made fo as to revolve like a globe, a great many of the moft ufeful problems relating to the heavenly bodies may be folved by it. An inftrument of this kind is called an *armillary fphere*, and of thefe there are various forms. One of the moft convenient is that contrived by the late Mr James Fergufon, and is thus defcribed in his Lectures. It is reprefented at fig. 16.

The exterior parts of this machine are a compages of brafs rings, which reprefent the principal circles of the heaven, viz. 1. The equinoctial AA, which is divided into 360 degrees, (beginning at its interfection with the ecliptic in Aries) for fhewing the fun's right afcenfion in degrees; and alfo into 24 hours, for fhewing his right afcenfion in time. 2. The ecliptic BB, which is divided into 12 figns, and each fign into 30 degrees, and alfo into the months and days of the year, in fuch a manner, that the degrees or points of the ecliptic in which the fun is on any given day, ftands over that day in the circle of months. 3. The tropic of *Cancer*, CC, touching the ecliptic at the beginning of Cancer in *e*; and the tropic of *Capricorn* DD, touching the ecliptic at the beginning of Capricorn in *f*; each $23\frac{1}{2}$ degrees from the equinoctial circle. 4. The Arctic circle E, and the Antarctic circle F, each $23\frac{1}{2}$ degrees from its refpective pole at N and S. 5. The equinoctial colure GG, paffing through the fouth and north poles of the heaven at N and S, and through the equinoctial points Aries and Libra, in the ecliptic. 6. The folftitial colure HH, paffing through the poles of the heaven, and through the folftitial points Cancer and Capricorn, in the ecliptic. Each quarter of the former of thefe colures is divided into 90 degrees, from the equinoctial to the poles of the world, for fhewing the declination of the fun, moon, and ftars; and each quarter of the latter, from the ecliptic at *e* and *f*, to its poles *b* and *d*, for fhewing the latitudes of the ftars.

In the north pole of the ecliptic is a nut *b*, to which is fixed one end of a quadrantal wire, and to the other end a fmall fun Y, which is carried round the ecliptic BB, by turning the nut: and in the fouth pole of the ecliptic is a pin at *d*, on which is another quadrantal wire, with a fmall moon Z upon it, which may be moved round by hand; but there is a particular contrivance for caufing the moon to move in an orbit which croffes the ecliptic at an angle of $5\frac{1}{3}$ degrees, in two oppofite points called the moon's nodes; and alfo for fhifting thefe points backward in the ecliptic, as the moon's nodes fhift in the heaven.

Within thefe circular rings is a fmall terreftrial globe I, fixed on the axis KK, which extends from the north and fouth poles of the globe at *n* and *s*, to thofe of the celeftial fphere at N and S. On this axis is fixed the flat celeftial meridian LL, which may be fet directly over the meridian of any place on the globe, and then turned round with the globe, fo as to keep over the fame meridian upon it. This flat meridian is graduated the fame way as the brafs meridian of a common globe, and its ufe is much the fame. To this globe is fitted the moveable horizon MM, fo as to turn upon two ftrong wires proceeding from its eaft and weft points to the globe, and entering the globe at oppofite points of its equator, which is a moveable brafs ring let into the globe in a groove all around its equator. The globe may be turned by hand within this ring, fo as to place any given meridian upon it, directly under the celeftial meridian LL. The horizon is divided into 360 degrees all around its outermoft edge, within which are the points of the compafs, for fhewing the amplitude of the fun and moon, both in degrees and points. The celeftial meridian LL, paffes through two notches in the north and fouth points of the horizon, as in a common globe; but here, if the globe be turned round, the horizon and the meridian turn with it. At the fouth pole of

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of the ſphere is a circle of 24 hours, fixed to the rings, and on the axis is an index which goes round that circle, if the globe be turned round its axis.

The whole fabric is ſupported on a pedeſtal N, and may be elevated or depreſſed upon the joint O, to any number of degrees from 0 to 90, by means of the arc P, which is fixed into the ſtrong braſs arm Q, and ſlides in the upright piece R, in which is a ſcrew at *r*, to fix it at any proper elevation.

In the box T are two wheels and two pinions, whoſe axes come out at V and U; either of which may be turned by the ſmall winch W. When the winch is put upon the axis V, and turned backward, the terreſtrial globe, with its horizon and celeſtial meridian, keep at reſt; and the whole ſphere of circles turns round from eaſt, by ſouth, to weſt, carrying the ſun Y, and moon Z, round the ſame way, cauſing them to riſe above and ſet below the horizon. But when the winch is put upon the axis U, and turned forward, the ſphere with the ſun and moon keep at reſt; and the earth, with its horizon and meridian, turn round from weſt, by ſouth, to eaſt; and bring the ſame points of the horizon to the ſun and moon, to which theſe bodies come when the earth kept at reſt, and they were carried round it; ſhewing that they riſe and ſet in the ſame points of the horizon, and at the ſame times in the hour circle, whether the motion be in the earth or in the heaven. If the earthly globe be turned, the hour index goes round its hour circle; but if the ſphere be turned, the hour circle goes round below the index.

And ſo, by this conſtruction, the machine is equally fitted to ſhew either the real motion of the earth, or the apparent motion of the heaven.

To rectify the ſphere for uſe, firſt ſlacken the ſcrew *r* in the upright ſtem R, and taking hold of the arm Q, move it up or down until the given degree of latitude for any place be at the ſide of the ſtem R; and then the axis of the ſphere will be properly elevated, ſo as to ſtand parallel to the axis of the world, if the machine be ſet north and ſouth by a ſmall compaſs; this done, count the latitude from the north pole upon the celeſtial meridian LL, down towards the north notch of the horizon, and ſet the horizon to that latitude; then turn the nut *b* until the ſun Y comes to the given day of the year in the ecliptic, and the ſun will be at its proper place for that day: find the place of the moon's aſcending node, and alſo the place of the moon, by an Ephemeris, and ſet them right accordingly: laſtly, turn the winch W, until either the ſun comes to the meridian LL, or until the meridian comes to the ſun (according as you want the ſphere or the earth to move), and ſet the hour index to the XII. marked noon, and the whole machine will be rectified. Then turn the winch, and obſerve when the ſun or moon riſe and ſet in the horizon, and the hour index will ſhew the times thereof for the given day.

Thoſe who have made themſelves acquainted with the uſe of the globes, as deſcribed in the firſt and ſecond ſections of this chapter, will be at no loſs to perform many problems reſpecting the motions of the heavenly bodies by means of this ſphere.

113 Dr Long's ſphere.

Dr Long, ſome years ago, conſtructed an armillary ſphere of glaſs, in Pembroke hall at Cambridge. It was 18 feet in diameter, and could contain below it more than 30 perſons, ſitting in ſuch a manner within the ſphere, as to view from its centre the repreſentation of the heavens drawn in its concavity. The lower part of the ſphere, or that part which is not viſible in the latitude of Britain, is wanting; and the whole apparatus is ſo contrived, that it may be turned round with as little exertion as is requiſite to wind up a common jack. Dr Long has given a deſcription of this ſphere, accompanied with a figure, in his Aſtronomy.

The invention of the armillary ſphere is thought by La Lande to be as ancient as that of aſtronomy itſelf. It has been attributed to Atlas, to Hercules, to Anaximander, and Muſeus; while others have ſuppoſed that it originated in Egypt. The ſphere of Archimedes, which became ſo celebrated, appears to have been ſomething like that of Dr Long, as it was certainly compoſed of a globe of glaſs, which, beſides containing the circles of the ſphere, ſerved as a planetarium, and repreſented the motions of the planets. Claudian has celebrated it in ſome beautiful lines. See ARCHIMEDES.

A combination of the armillary ſphere with a planetarium was conſtructed by the late Mr George Adams, and is figured in Plate XIII. fig. 1. of his Aſtronomical and Geographical Eſſays.

CHAP. III. *Of the Conſtruction and Uſe of Maps and Charts.*

SECT. I. *Deſcription of Maps and Charts.*

114 Diſtinction of maps and charts.

IT has been ſeen, that the ſurface of the earth may be delineated, in the moſt accurate manner, on the ſurface of a globe or ſphere. This mode of delineation, however, can be employed only for the purpoſe of repreſenting the general form and relative proportions of countries on a very confined ſcale; and is, beſides, from its bulk and figure, not well ſuited to many of the purpoſes of the geographer. To obviate theſe inconveniences, recourſe has been had to maps and charts, or delineations of the earth's ſurface on a plane; where the form and boundaries of the ſeveral countries, and the objects moſt remarkable in each, whether by ſea or land, are repreſented according to the rules of perſpective, ſo as to preſerve the remembrance that they are parts of a ſpherical ſurface. In this way, the ſeveral countries or diſtricts of the earth may be repreſented on a larger ſcale, and delineations of this kind admit of more eaſy reference.

115 Deſcription of a map.

In maps, the circles of the ſphere, and the boundaries of the countries within them, are drawn as they would appear to an eye ſituated in ſome point of the ſphere, or at a conſiderable diſtance above it. In maps of any conſiderable extent of country, the meridians and parallels of latitude are circular lines, but, if the map repreſents only a ſmall diſtrict, as a province or county, thoſe circles become ſo large, that they may, without any conſiderable error, be repreſented by ſtraight lines. In charts, which are alſo called *hydrographical maps*, as they are repreſentations rather of the water than land, the meridians and parallels are uſually repreſented by ſtraight lines, croſſing each other at right angles, as in the ſmaller maps; and, in particular parts, there are drawn lines diverging from ſeveral points, in the direction of the points of the compaſs, in order to mark the

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the bearings of particular places. In maps, the inland face of the country is chiefly regarded in the delineation; but in charts, which are deſigned for the purpoſes of navigation, the internal face of the land is left nearly blank, and only the ſea-coaſt, with the principal objects on it, ſuch as churches, light-houſes, beacons, &c. are accurately delineated; while particular care is taken to mark the rocks, ſhoals, and quickſands in the ſea, that may endanger the ſafety of veſſels; the depths or ſoundings of the principal bays and harbours, and the direction of the winds, where theſe are ſtationary or peculiarly prevalent. Another diſtinction of maps and charts is, that in the former, the ſea-coaſt is ſhaded on the ſide next the land, while, in the latter, it is ſhaded towards the ſea.

In maps the upper ſide repreſents the north, the lower ſide the ſouth; that on the right hand the eaſt, and that on the left hand the weſt. All the margins of the map are graduated; the upper and lower ſhowing the degrees of longitude, and the right and left margins the degrees of latitude. (See fig. 1. to which the reader muſt refer in going over the following deſcription). If the map is on a ſmall ſcale, only every ten degrees of longitude or latitude are marked on the margin; but, if the map is drawn on a large ſcale, every degree is numbered, and ſometimes every half degree is marked with the number 30 in ſmaller figures. The ſpace included between every ten degrees in ſmall maps, or between every two degrees in thoſe on a larger ſcale, is uſually divided into ten ſpaces, which are alternately left blank, and marked with parallel lines, to denote the ſubdiviſions of ſingle degrees or minutes. Through every ten degrees of latitude a line is drawn, repreſenting a parallel of latitude; and through every ten degrees of longitude, or at ſmaller intervals in each, where the ſize of the map will admit of it, there are drawn lines repreſenting meridians. In ſome maps theſe lines are continued from ſide to ſide, or from top to bottom, acroſs both ſea and land; but in other maps, they are ſometimes only drawn acroſs the ſea. The firſt meridian, however, and the principal circles of the ſphere, as the equator, tropics, &c. ſhould always be drawn directly acroſs the map. In moſt maps, it is marked on the margins, whether the longitude is eaſt or weſt, and the latitude north or ſouth; but, if this is not marked, it may eaſily be known, by obſerving towards what part of the map the degrees increaſe. If the degrees of latitude increaſe from the lower to the upper part of the map, the country delineated lies in north latitude; but if they increaſe from above downwards, it lies in ſouth latitude. Again, if the degrees of longitude increaſe towards the right, the countries are in eaſt longitude; but if towards the left, they are in weſt longitude.

The principal objects that diverſify the face of the country delineated in the map, ſuch as rivers, mountains, foreſts, lakes, roads, cities, towns, forts, &c. are marked in ſuch a manner, as that they may be moſt eaſily diſtinguiſhed. A river is denoted by a black crooked line, drawn very fine towards the ſource or head of the river, and gradually becoming broader as it approaches towards the mouth; and the leſſer rivers, or rivulets, which unite their waters with thoſe of the principal ſtream, are denoted by ſimilar lines appearing to branch off from the firſt.

Mountains are repreſented by the figures of little hills; and if theſe figures are placed in a row, they denote a ridge of mountains running acroſs the land. If a mountain is a volcano, it is denoted in the map by the appearance of ſmoke iſſuing from its ſummit. Woods or foreſts are repreſented by a number of little trees or ſhrubs, placed in a group. Lakes are denoted by a circumſcribed ſpot ſhaded with dark lines, and bays or fens by a more regular ſpot of the ſame kind, more lightly ſhaded, or, where the map is coloured, painted of a light green. Roads are repreſented in a map by two ſtraight lines drawn parallel to each other, for the principal roads, or by a ſingle ſtraight line for the leſſer or croſs roads. Cities are denoted by a large houſe, or the figure of a church with the ſteeple in the middle; and if the city is the metropolis of the country, this is denoted by a white circular ſpace in the middle of the houſe or church. Small towns are uſually repreſented by circles; and where a ſmall church with the ſteeple at one end occurs, it denotes a pariſh. Where the map is on a large ſcale, or repreſents only a ſmall diſtrict, the towns are denoted by a group of ſmall houſes, or more commonly by a number of ſmall ſhaded ſpots on each ſide of the road. A fort, caſtle, or fortified town, is denoted by a ſemicircular ſpace ſurrounded by an angular edge repreſenting baſtions. The ſhoals upon the coaſt are repreſented by ſmall dots; the depth of water in bays and harbours by figures, denoting the number of fathoms, among which is ſometimes drawn the figure of an anchor, to ſhew that in that place there is good anchorage for ſhips.

The boundaries or limits that divide countries from each other are diſtinguiſhed in maps by dotted lines drawn round each country or diſtrict, in ſuch a direction as to ſhow its proper form. Where the map is coloured, the countries or diſtricts are diſtinguiſhed from each other by the ſide of the boundary next each being ſhaded by a different colour from that of the adjoining. Thus, in a map of Europe, the boundary of France may be ſhaded green, that of Spain red, that of Italy yellow, that of Germany blue, &c. In one corner of the map there is uſually drawn a ſcale divided into a number of equal parts, by which the number of miles or leagues from one part of the map to another may be meaſured. Sometimes the parts into which the ſcale is divided are uſed to denote geographical miles, of 60 to a degree; but more commonly they correſpond to the miles in uſe in the country where the map is made, as, in Britain, to Britiſh ſtatute miles of 69½ to a degree.

To mark more diſtinctly the bearings of different parts of the map, there is uſually added in ſome blank ſpace a circle with four radii, marking the four cardinal points of the compaſs; the north point being diſtinguiſhed by the figure of a *fleur de lis*, and the eaſt point by a croſs.

Till of late, the only diſtinction between the land and water in maps and charts, was afforded by the ſhading of the ſea coaſt, as mentioned above. In this way, however, the eye cannot eaſily and expeditiouſly diſtinguiſh the form and extent of the land; and, where the ſhading is carried much beyond the boundary of the coaſt, as is often done, eſpecially in engraving ſmall iſlands, the land is made to appear much larger than it really is.

The ingenious Mr Wilſon Lowry having lately contrived an inſtrument for engraving parallel ſtraight lines, in a much more clear and commodious way than

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than could be done by the common graver, it occurred to Mr Pinkerton, while preparing his Modern Geography, that this invention might be applied with advantage to the improvement of maps. A set of maps was, accordingly engraved by Mr Lowry for Pinkerton's Geography, in which the water was marked by dark parallel lines to discriminate it from the land. These lines are drawn horizontally; and Mr Pinkerton proposed that, in engraving charts, the land should be marked with similar lines drawn in a perpendicular direction, while the water should be left blank. This improvement has since been adopted by other constructors of maps and charts, and bids fair to be generally used. The effect is pleasing; and the progress of instruction will be greatly facilitated by the new method, as the extent and bearings of the several countries are seen, as it were, with a glance of the eye. In many of these maps which we have seen, however, the lines are drawn too strongly, which renders the sea so dark, that the names of islands and places on the sea coast can with difficulty be perused. As the line of coast in these maps is strongly marked, the parallel lines denoting the sea should be engraved in a light and soft style; and in this way Mr Lowry's first specimens are executed.

Sect. II. *Of the Construction of Maps and Charts.*

116 Construction of maps.

The construction of maps consists in making a projection of the surface of the globe on the plane of some one of its circles, supposing the eye to be placed in some particular point. The describing of these projections depends on the principles of perspective, and the projection of the sphere. The general principles will be explained under those articles, but the particular mode of drawing maps properly forms a part of the present treatise.

The methods of constructing maps vary according to the size or scale of the map, and to the projection employed in constructing it.

117 Orthographic projections.

There are three projections employed in constructing maps, the *orthographic*, the *stereographic*, and the *globular*. In the orthographic projection the eye is supposed to view the part of the globe to be projected, from an infinite distance. In this projection the parts about the middle of the map are very well represented, but those towards the margin are too much contracted.

118 Stereographic projections.

In the stereographic projection, the eye is supposed to be situated in the surface of the globe to be represented, and looking towards the opposite surface. This is the method usually employed in constructing most maps, especially maps of the world, or planispheres.

In constructing a map of the world, as well as most partial maps, the part of the sphere to be represented is supposed to be in the position of a right sphere (see No. 90). In this mode of projection, the hemisphere to be represented is supposed to be delineated on the plane of that meridian by which it is bounded, in the same manner as its concave surface, conceiving the sphere to be transparent, would appear to an eye placed in the opposite hemisphere, where the equator crosses a meridian; that is, 90° distant from that which forms the plane of the projection. In a delineation of this kind, the meridians and parallels of latitude are represented by arches of circles, except the equator and the central meridian, which are straight lines; and each parallel or meridian forms an arc of a greater circle, in proportion as it approaches nearer to the centre of the map.

By either of these projections only half the globe can be represented in one projection; but in the map of the world, the two hemispheres are usually drawn on the plane of the same circle, adjacent to each other. By Mercator's projection, usually employed for charts, and to be described presently, the whole globe may be represented in one projection, but much distorted.

If the projection of a map of the world be formed on the plane of a meridian, the two projections will represent the eastern and western hemispheres of the globe.

When the projection is made on the plane of the equator, in the situation of a parallel sphere, the projections represent the northern and southern hemispheres, which appear as their concave surface would be seen by an eye placed at the opposite pole. In this way the meridians become straight lines diverging from the same centre, and the parallels are circles having the same common centre.

The following is the method of constructing a map of the world, on the plane of a meridian, according to the globular projection. (See fig. 17).

119 Globular projection of a map of the world.

About the centre C, with any radius as CB, describe a circle, representing the meridian that is to form the plane of the hemisphere. Draw the diameters NS, and AB, crossing each other at right angles, and the former of these will be the central meridian, and the latter the equator. Divide each semidiameter into nine equal parts, and divide each quadrant of the circle also into nine equal parts, each of which will be equal to 11°. If the scale of the map be sufficiently large, each of these may again be divided into ten equal parts or degrees. The next object is to describe the meridians passing through every 10° of the equator. Suppose we are to draw the meridian of 80° west of Greenwich. We have here three points given, the two poles and the point 80° on the equator, and it is easy to describe a circle that shall pass through these three points. This arch will be the meridian. The method of drawing a circle through any three points is, in this case, as follows. About the centre S, with the radius SC, describe a circular arch, as XX; and about the centre N, with the same radius, describe the arch ZZ; then about the centre 80°, with the same distance, describe arches 1, 1, 2, 2, crossing the former, and draw lines from 2 to 1 on each side of AB, crossing each other, and AB produced, in D. D is the centre of the circular arc, representing the meridian of 80° west from Greenwich; and with the same radius the meridian of 140° west longitude may be drawn. All the other meridians are to be drawn in a similar manner, by describing a circular arch through three points N, S, and the required degree. (See Geometry.)

For describing the parallels, suppose that of 60° N. Lat.; about the centre O, with any radius, describe the circle FGH, and about the points 60°, 60°, in the primitive circle, with the same distance, describe the arcs *cc*, *dd*, cutting the circle FGH: through the points of intersection draw straight lines, and the point where these lines meet in NS produced, as in I, is the centre of the arch that will represent the parallel of 60°. The other parallels are drawn in a similar manner, observing that the first circle, such as FGH, must have for its centre that point in the central meridian through which the parallel is to be drawn. Fig. 18. represents this projection

projection with all the meridians and parallels completed.

If the map is very large, and the paper on which it is to be drawn does not admit of so many circles, the centres of the meridians and parallels are more easily found in the following manner. Having divided the semi-diameters and quadrants, each into 9 equal parts, find, from a scale of equal parts, the length of the half chord of each arc, and the versed sine of half the same arc; then add together the square of the half chord, and the square of the versed sine, and divide the sum by the versed sine; the quotient is equal to the diameter, and $\frac{1}{2}$ of this to the radius of the circle required. In this manner the radii of all the meridians and parallels may be found.

As, in drawing maps on a large scale, compasses of an ordinary size will not answer for describing the circular arcs, it is convenient to have some other mechanical contrivance for this purpose; and it is found that a thin flexible ruler of tough wood, called a *bow*, may be so bended as to form a curve, very nearly circular, that will pass through the three points that are to determine the meridian or parallel. In this way the circles on maps on a large scale are usually drawn by engravers and students of geography; and where the circle is of very large radius, the method is sufficiently accurate; but it ought by no means to be employed where compasses of a proper size can be procured, or conveniently used.

The following is the method given by Dr Hutton, for describing a globular projection of the earth on the plane of the equator. For the north or south hemispheres draw AQBE, for the equinoctial (fig. 19.), dividing it into the four quadrants EA, AQ, QB, and BE; and each quadrant into 9 equal parts, representing each 10° of longitude; and then from the points of division, draw lines to the centre C, for the circles of longitude. Divide any circle of longitude, as the first meridian EC, into 9 equal parts, and through these points describe circles from the centre C, for the parallels of latitude, numbering them as in the figure. In this method equal spaces on the earth are represented by equal spaces on the map, as nearly as any projection will bear; for a spherical surface can in no way be represented exactly upon a plane. Then the several countries of the world, seas, islands, sea-coasts, towns, &c. are to be entered in the map, according to their latitudes and longitudes.

To draw a Map of any particular Country.

120 Construction of particular maps.

There are three methods of doing this.

1st, For this purpose its extent must be known as to latitude and longitude; as suppose Spain, lying between the north latitudes 36° and 44°, and extending from 10° to 23° of longitude, so that its extent from north to south is 8°, and from east to west 13°.

Draw the line AB for a meridian passing through the middle of the country (fig. 20.), on which set off 8° from B to A, taken from any convenient scale; A being the north and B the south point. Through A and B draw the perpendiculars CD, EF, for the extreme parallels of latitude. Divide AB into eight parts, or degrees, through which draw the other parallels of latitude parallel to the former.

For the meridians, divide any degree in AB into 60 equal parts, or geographical miles. Then, because the length in each parallel decreases towards the pole, from the table shewing this decrease given in p. 514. take the number of miles answering to the latitude of B, which is $48\frac{1}{2}$ nearly, and set it from B, seven times to E, and six times to F; so is EF divided into degrees. Again, from the same table take the number of miles of a degree in the latitude A, viz. $43\frac{1}{6}$ nearly; which set off from A, seven times to C, and six times to D. Then from the points of division in the line CD, to the corresponding points in the line EF, draw so many right lines for the meridians. Number the degrees of latitude up both sides of the map, and the degrees of longitude on the top and bottom. Also in some vacant place make a scale of miles, or of degrees, if the map represent a large part of the earth; to serve for finding the distances of places upon the map.

Then make the proper divisions and subdivisions of the country; and having the latitudes and longitudes of the principal places, it will be easy to set them down in the map; for any town, &c. must be placed where the circles of its latitude and longitude intersect. For instance, Gibraltar, whose latitude is 36° 11′, and longitude 12° 27′, will be at G; and Madrid, whose latitude is 40° 10′, and longitude 14° 44′, will be at M. In the same manner the mouth of a river may be set down; but to describe the whole course of the river, the latitude and longitude of every turning, and of the towns and bridges by which it passes, must also be marked down. The same is necessary for woods, forests, mountains, lakes, castles, &c. The boundaries are described by setting down the remarkable places on the sea coast, and drawing a continued line through them all. This method is very proper for small countries.

2d *Method*. Maps of particular places are but portions of the globe, and may therefore be drawn in the same manner as the whole globe, either by the orthographic or stereographic projection of the sphere. But in partial maps a more easy method is as follows. Having drawn the meridian AB in the last figure, and divided it into equal parts as before, draw lines through all the points of division; put them together to AB, to represent the parallels of latitude. Then to divide these, set off the degrees in each parallel; diminish after the manner directed for the two extreme parallels CD and EF, and through all the corresponding points draw the meridians, which will be curved lines; these were right lines in the last method, because only the extreme parallels were divided acccording to the table. This method is proper for a large tract, as Europe, &c. in which case the parallels and meridians need be drawn only through every 5° or 10°. This method is much used in drawing maps, as all the parts are nearly of their due magnitude, except being a little distorted towards the outside, from the oblique intersection of the meridians and parallels.

3d *Method*. Draw PB of a convenient length, for a meridian; divide it into nine equal parts, and through the points of division, describe as many circles for the parallels of latitude, from the centre P, which represents the pole. Suppose AB (fig. 21.) the height of the map; then CD will be the parallel passing through the greatest latitude, and EF will represent the equator. Divide the equator EF into 9 equal parts of the same size as those in AB, both ways beginning AB; divide

Principles and Practice.

divide alſo all the parallels into the ſame number of equal parts, but leſſer, in proportion to the numbers for the ſeveral latitudes, as directed in the laſt method for the rectilineal parallels. Then through all the correſponding diviſions draw curved lines, which will repreſent the meridians, the extreme meridians being EC and FD. Laſtly, Number the degrees of latitude and longitude, and place a ſcale of equal parts, either in miles or degrees, for meaſuring diſtances.

When the place of which a map is to be made is but ſmall, as when a county is to be delineated, the meridians will be ſo nearly parallel to one another, and the whole will differ ſo little from a plane, that the map may be laid down in a much more eaſy manner than what is given above. It will be here ſufficient to meaſure the diſtances of places in miles, and note them down in a plane rectangular manner. The method of delineating ſuch partial maps is the province of the ſurveyor. See SURVEYING.

121 Mercator's projection. Mercator's projection is chiefly confined to charts for the purpoſes of navigation. In this projection the meridians, parallels, and rhumbs, are all ſtraight lines; but inſtead of the degrees of longitude being everywhere equal to thoſe of latitude, as is the caſe in plain charts, the degrees of latitude are increaſed as we approach towards either pole, being made to thoſe of longitude in the proportion of radius to the ſine of the diſtance from the pole, or coſine of the latitude, or, what is the ſame thing, in the ratio of the ſecant of the latitude to radius. Hence all the parallel circles are repreſented by equal and parallel ſtraight lines, and all the meridians are parallel lines alſo; but theſe increaſe indefinitely towards the poles.

From this proportional increaſe of the degrees of the meridian, it is evident that the length of an arc of the meridian beginning at the equator, is proportional to the ſum of all the ſecants of the latitude; or that the increaſed meridian bears the ſame proportion to its true arc as the ſum of all the ſecants of the latitude to as many times the radius. The increaſed meridian is alſo analogous to a ſcale of the logarithmic tangents, though this is not at firſt very evident. It is not certain by whom this analogy was firſt diſcovered, but the diſcovery appears to have been made by accident. It was firſt publiſhed and introduced into the practice of navigation by Mr Henry Bond, by whom this property is mentioned in an edition of Norwood's Epitome of Navigation, printed about 1645. This analogy, though it had been found true by actual meaſurement, was not accurately demonſtrated. Nicholas Mercator offered to diſcloſe, for a ſum of money, a method which he had diſcovered for demonſtrating it; but this was not accepted, and the demonſtration was, we believe, never diſcloſed. See *Nicholas* MERCATOR. About two years after, however, the demonſtration was again diſcovered, and publiſhed by James Gregory.

The meridian line in Mercator's chart is a ſcale of logarithmic tangents of the half colatitudes. The differences of longitude on any rhumb, are the logarithms of the ſame tangents, but of a different ſpecies; thoſe ſpecies being to each other as the tangents of the angles made with the meridian. Hence any ſcale of logarithmic tangents is a table of the differences of longitude, to ſeveral latitudes, upon ſome one determinate rhumb; and therefore as the tangent of the angle of ſuch a rhumb is to the tangent of any other rhumb, ſo is the difference of the logarithms of any two tangents, to the difference of longitude on the propoſed rhumb, intercepted between the two latitudes, of whoſe half complements the logarithmic tangents were taken.

It was the great ſtudy of our predeceſſors to contrive ſuch a chart in plano, with ſtraight lines, on which all or any parts of the world might be truly ſet down, according to their longitudes and latitudes, bearings, and diſtances. A method for this purpoſe was hinted at by Ptolemy, near 2000 years ſince, and a general map in ſuch an idea, was made by Mercator: but the principles were not demonſtrated, and a ready way ſhown of deſcribing the chart, till Wright explained how to enlarge the meridian line by the continual addition of ſecants, ſo that all degrees of longitude might be proportional to thoſe of latitude, as on the globe; which renders this chart, in ſeveral reſpects, far more convenient for the navigator's uſe, than the globe itſelf, and which will truly ſhew the courſe and diſtance from place to place, in all caſes of ſailing.

For further particulars reſpecting the conſtruction, and for the uſe of charts, ſee NAVIGATION.

In chooſing maps, it is proper to examine particularly whether the curved lines of thoſe that ought to have the meridians and parallels arches of circles be truly circular. If the map is compoſed of more than one ſheet, the ſheets ſhould be ſo joined together as that the correſponding meridional lines and parallels be each in one continued line. The colours in painted maps, as was obſerved with reſpect to globes, ſhould be fine and tranſparent, and not laid on too thickly.

Maps folded for the pocket anſwer very well for travelling, in ſo far as they point out the relative ſituation of places; but, owing to the intervals at which the parts are paſted on the canvaſs, the diſtances between places cannot be aſcertained with any degree of accuracy.

SECT. III. *Of the Uſe of Maps.*

MAPS are of great utility in the ſtudy of geography and hiſtory; and if they are accurately drawn, many of the problems that are uſually performed on the globes, may be ſolved mechanically by means of maps.

In conſulting a map, it is not ſufficient to find out in it the name of the place of which you deſire to know the ſituation, although this is frequently all at which the conſulter of a map aims: it is, beſides, proper for the ſtudent to inform himſelf reſpecting the relative poſition of the place, with regard to its vicinity to other places; its bearings and diſtance from the principal places in the ſame or neighbouring diſtricts; whether it is near the ſea ſhore, and is near a convenient harbour; whether it be ſeated on ſome principal river, and on what ſide of the river; whether it is in the neighbourhood of a conſiderable canal; whether it be near a lake, mountain, foreſt, &c. and many other little particulars that will readily ſuggeſt themſelves to an attentive reader.

The problems that are uſually performed by means of maps, are the following.

PROBLEM I. *To find the latitude and longitude of any given place.*

In maps on a large ſcale, or where the meridians and parallels of latitude are ſtraight lines, the latitude of the place 122 Uſe of maps.

place may be easily found by stretching a thread over the place, so that it may cross the same degree of latitude on each side of the map; and the degree crossed will be the latitude required. Or, with a pair of compasses measure the shortest distance of the place from the nearest parallel, and apply this distance to either side of the map, so as to keep one point of the compasses on the same parallel; then the other point will shew the degree of latitude as measured on the graduated margin, counting from the parallel north or south, according as the place is in north or south latitude.

The longitude of the place may be found in a similar manner, by stretching the thread over the place, or laying a ruler across it, so as to cut the same degree of longitude on the top and bottom of the map, and that is the degree required.

The above methods answer very well in plain charts or in maps of counties; but when the meridians and parallels are curved lines, we must find how often the distance of the place, measured by the compasses from the nearest parallel, will reach the next parallel in a straight direction, and from thence the latitude may be found with sufficient exactness. Thus, suppose we are required to find the latitude of Berlin, the capital of Prussia. The nearest parallel is that of 50° north latitude; the distance of Berlin from this parallel will reach the parallel of 60° in four times, measuring on the map of Europe. The fourth part of ten, or two and a half, added to 50, gives the latitude required, or $52\frac{1}{2}$.

To find the longitude on such maps, measure how often the distance of the place from the nearest meridian will reach the next meridian. Thus, in the same instance, the distance of Berlin from the meridian of 10, which is the nearest towards the east, taken three times, will extend a little beyond the meridian of 20. Add to 10 the third part of this distance, which is about three and a half, and we have 13° 30′ for the longitude of Berlin east from London.

Problem II. *The latitude and longitude of a place being given; to find the place on the map.*

Where the meridians and parallels are straight lines, this is done by stretching one thread from the given latitude on one side of the map to the same latitude on the other side; while another thread is stretched between the corresponding degrees of longitude. The intersecting point of the two threads shews the place required. Thus, suppose we are required to find the place whose latitude is 34° 29′ S. and longitude 18° 23′ E. Stretching one thread between the given latitudes, and another between the given longitudes, we shall find that they cross over the Cape of Good Hope, which is therefore the place required.

When the meridians and parallels are curved lines, the most accurate way will be to describe a circle of latitude through the given degree of latitude on each side, and a circle of longitude through the corresponding degrees of longitude, and the intersection of these circles will shew the place. An easier method will be, knowing between what two parallels of latitude and longitude the place lies, and consequently by what four lines it is bounded, to find the place by trial, by considering the proportional distance of it from each line.

Problem III. *The latitude of a place being given; to find all those places on the same map that have the same latitude.*

If a parallel of latitude happen to be drawn on the map through the given place, this problem is easily solved, by tracing along the parallel, and seeing what other places it passes through. If a parallel is not drawn through the given place, take with a pair of compasses the distance of the place from the nearest parallel; then keeping one foot on the parallel, and the other in such a position as to describe a line parallel to the parallel of latitude, move the compasses, and all the places over which the point that is not on the parallel passes, have the same latitude with the given place.

This method will not succeed in maps on which a large tract of country is delineated on a small scale.

Problem IV. *Given the longitude of a place; to find on the map all those places that have the same longitude.*

Find the longitude of the given place, and if a meridian passes through it, observe all the places that lie under this meridian; or, if a meridian does not pass through the place, find by the compasses, as in the last problem, those places that are situated at the same parallel distance with the given place from the nearest meridian. These places have nearly the same longitude with the given place.

Problem V. *To find the antœci of a given place.*

Find the latitude and longitude of the place by Problem I. and find another place of the same longitude, whose latitude is equal to that of the former, but in a contrary direction. The inhabitants of this latter place are the antœci to the latter.

Ex. Suppose a ship to be in the Indian ocean, in lat. 13° S. and long. 80° E. it is required to find the antœci to her present situation? *Ans.* The place which has nearly the same longitude, and an equal latitude in a contrary direction, viz. 13° N. is Madras.

Problem VI. *To find the periœci of a given place.*

Find the longitude of the given place, and subtract it from 180°: the remainder will be the longitude in an opposite direction of the periœci. Then find a place having an equal longitude with this last, and having the same latitude with that of the given place: this latter is the situation required.

Ex. It is required to find the periœci to the inhabitants of the gulf of Siam. *Ans.* The longitude of Siam is 100° 50′ E. which, subtracted from 180°, leaves 79° 10′ W. Now, the place that has this longitude, and the same latitude with Siam, viz. about 14° N. is the isthmus of Darien.

Problem VII. *To find the antipodes of a given place.*

This problem is solved on maps in the same manner as on the globe.

Problem VIII. *Having the hour at any place given; to find what hour it is in any part of the world.*

Find the difference of longitude between the two places, and reduce this to its equal value in time, by

Principles and Practice.

N° 65. Add this value to the given hour, if the place where the time is required be to the eastward of the given place, and the sum is the time required. If the place at which the time is required lie to the westward of the given place, subtract the difference of longitude in time from the given hour, and the difference is the time sought.

Note.—If, after adding, the sum is found greater than 12, 12 must be cancelled, and the hours must be changed from A. M. to P. M. and *vice versa*; and if, on subtracting, the difference in time between the two places happens to be greater than the given hour, 12 must be added to the given hour, and the hours changed as before mentioned.

Ex. Suppose it to be at present 9 A. M. at Lisbon, what time of the day is it at Pekin in China? *Ans.* The difference of longitude between Pekin and Lisbon is 125° 33′, which reduced to time gives 8 hours 22 minutes; and since Pekin lies to the east of Lisbon, this must be added to 9, the given hour, giving a sum of 17 hours, 22 minutes; but as this is greater than 12, we must take 12 away, and the difference, 5 hours 22 minutes, changed from morning to afternoon hours, is the time required. It is therefore 22 minutes past five P. M. at Pekin.

Problem IX. *To find those places in the torrid zone to which the sun is vertical on any given day.*

Find in an ephemeris, or nautical almanack, the sun's declination for the given day; then observe, in the map of the world, all those places which lie under that parallel of latitude, which is the same with the declination, and these will be the places required.

Ex. It is required to find at what places the sun will be vertical on the 20th of March and 23d of September? *Ans.* The sun's declination on the 20th of March, is 19′ S. and on the 23d of September 6′ N. Now the principal places that lie near the parallel of 19′ S. and 6′ N. are the island of St Thomas, the middle part of the islands of Sumatra and Borneo; the Gallipagos isles, and Quito in South America.

123 Analemma for solving geographical problems.

The Analemma, or Orthographic Projection delineated in Plate CCXXXV. will solve many of the most curious problems, and with the assistance of maps will be almost equivalent to a terrestrial globe. The parallel lines drawn on this figure represent the degrees of the sun's declination from the equator, whether north or south, amounting to 23½ nearly. On these lines are marked the months and days which correspond to such and such declinations. The size of the figure does not admit of having every day of the year inserted; but by making allowance for the intermediate days, in proportion to the rest, the declination may be guessed at with tolerable exactness. The elliptical lines are designed to shew the hour of sunrising or sunsetting before or after six o'clock. As 60 minutes make an hour of time, a fourth part of the space between each of the hour-lines will represent 15 minutes; which the eye can readily guess at, and which is as great exactness as can be expected from any mechanical invention, or as is necessary to answer any common purpose. The circles drawn round the centre at the distance of 11¼ each, shew the point of the compass on which the sun rises and sets, and on what point the twilight begins and ends.

In order to make use of this analemma, it is only necessary to consider, that, when the latitude of the place and the sun's declination are both north or both south, the sun rises before six o'clock, between the east and the elevated pole; that is, towards the north, if the latitude and declination are north; or towards the south, if the latitude and declination are south. Let us now suppose it is required to find the time of the sun's rising and setting, the length of the days and nights, the time when the twilight begins and ends, and what point of the horizon the sun rises and sets on, for the Lizard point in England, Frankfort in Germany, or Abbeville in France, on the 30th of April. The latitude of these places by the maps will be found nearly 50° N. Place the moveable index so that its point may touch 50° on the quadrant of north latitude in the figure; then observe where its edge cuts the parallel line on which April 30th is written. From this reckon the hour-lines towards the centre, and you will find that the parallel line is cut by the index nearly at the distance of one hour and 15 minutes. So the sun rises at one hour 15 minutes before six, or 45 minutes after four in the morning, and sets 15 minutes after seven in the evening. The length of the day is 14 hours 30 minutes. Observe how far the intersection of the edge of the index with the parallel of April 30th is distant from any of the concentric circles, which you will find to be a little beyond that marked two points of the compass, and this shews that on the 30th of April the sun rises two points and somewhat more from the east towards the north, or a little to the northward of east-north-east, and sets a little to the northward of west-north-west. To find the beginning and ending of the twilight, take from the graduated arch of the circle 17½ degrees with a pair of compasses; move one foot of the compasses extended to this distance along the parallel of April 30th, till the other just touches the edge of the index, which must still point at 50. The place where the other foot rests on the parallel of April 30th, then denotes the number of hours before six at which the twilight begins. This is somewhat more than three hours and a half, which shews that the twilight then begins soon after two in the morning, and likewise that it begins to appear near five points from the east towards the north. The uses of this analemma may be varied in a great number of ways; but the example just now given will be sufficient for the ingenious reader.

Sect. IV. *Of the Origin and Progress of Maps.*

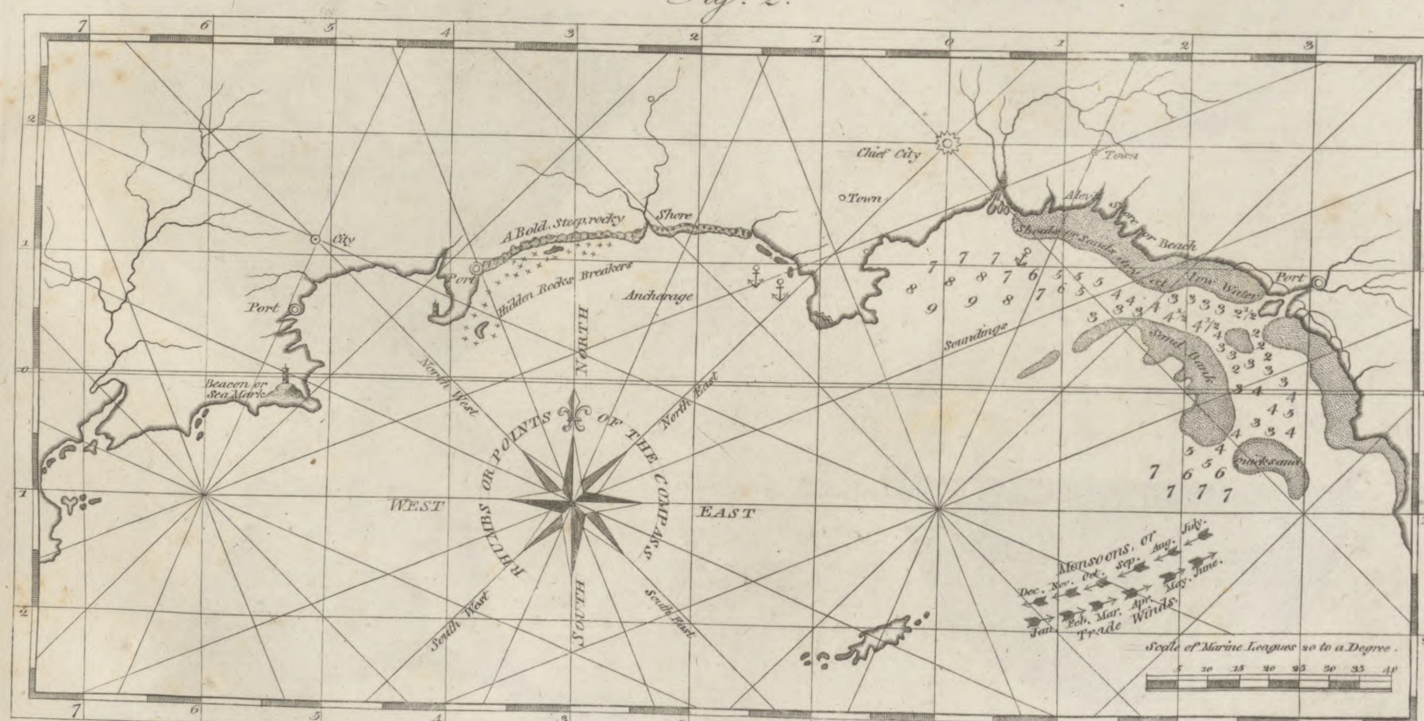
The first map of which we have any certain record, is that of Anaximander, about 560 years before the Christian era. This is mentioned by Strabo, book i. and is supposed to be that referred to by Hipparchus, under the name of the ancient map. 124 Origin of maps.

It has been alleged, that Sesostris, king of Egypt, on his return from his boasted expedition, after having traversed great part of the earth, recorded his march in maps, of which he gave copies, not only to the Egyptians, but to the Scythians, to the great admiration of both people. This is the relation of Eustathius; but M. Montucla considers it as a very improbable story, and thinks that the invention of maps cannot be dated prior to Anaximander *. Some have supposed that the Jews laid down the holy land in a map, when they distributed

* Montucla, Hist. de Mathemat. tom. iv. p. 589.

Fig. 1.

Fig. 2.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 3.

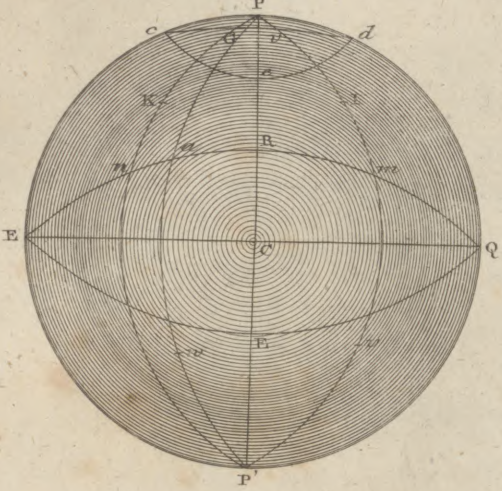


Fig. 4.

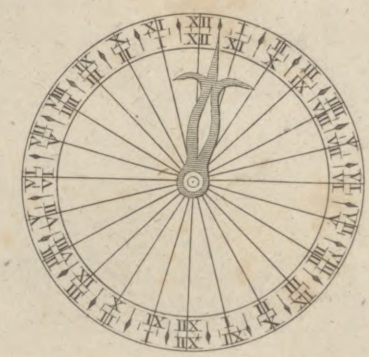


Fig. 6.

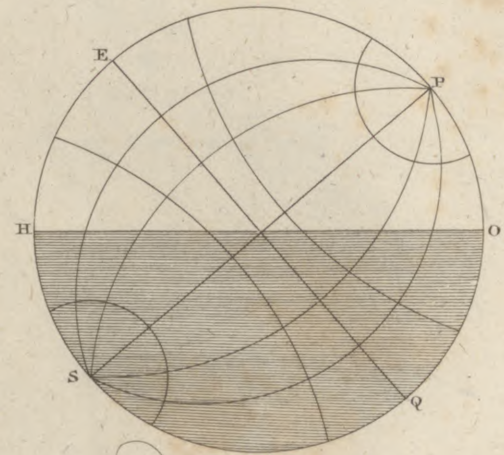


Fig. 7.

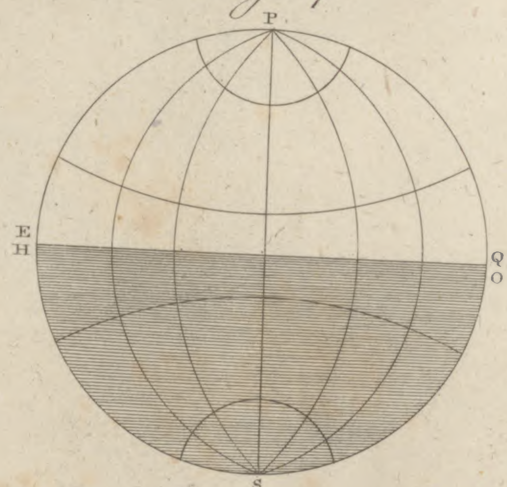
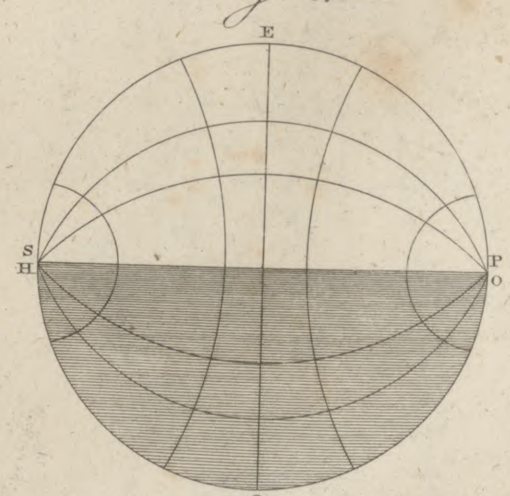


Fig. 5.

Fig. 8.



A.Bell Prin. Wal. Sculptor fecit.

Fig. 9.

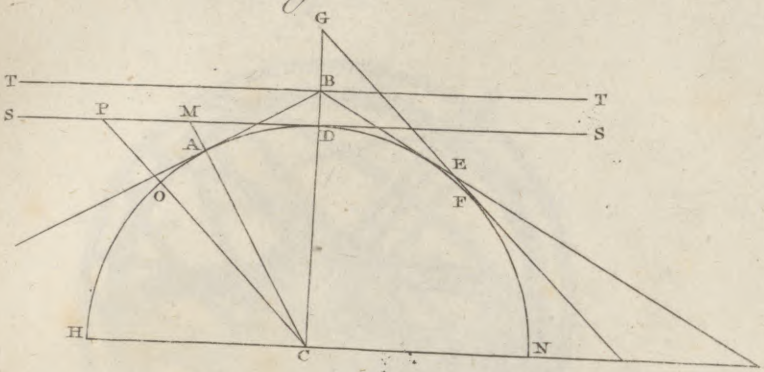


Fig. 10.

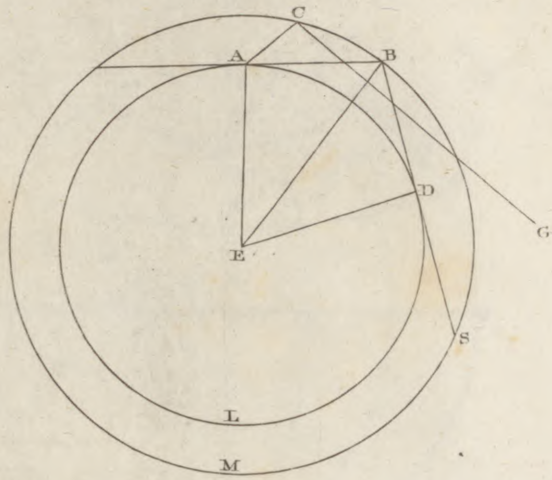


Fig. 11.

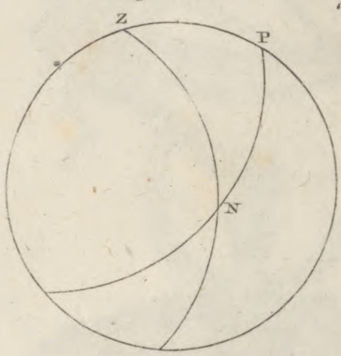


Fig. 12.

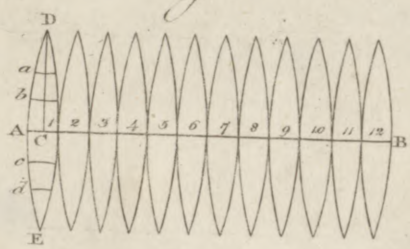


Fig. 13.

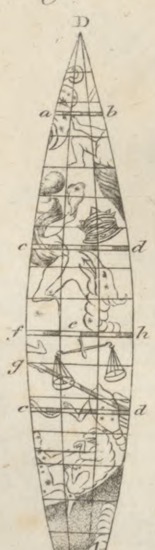


Fig. 14.

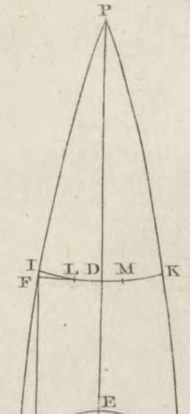
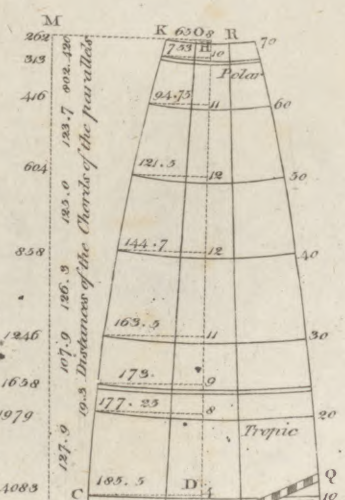


Fig. 15.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 16.

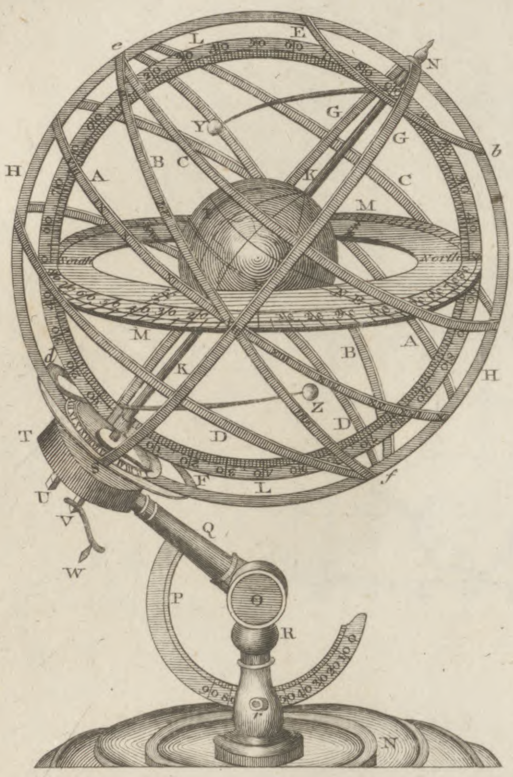


Fig. 17.

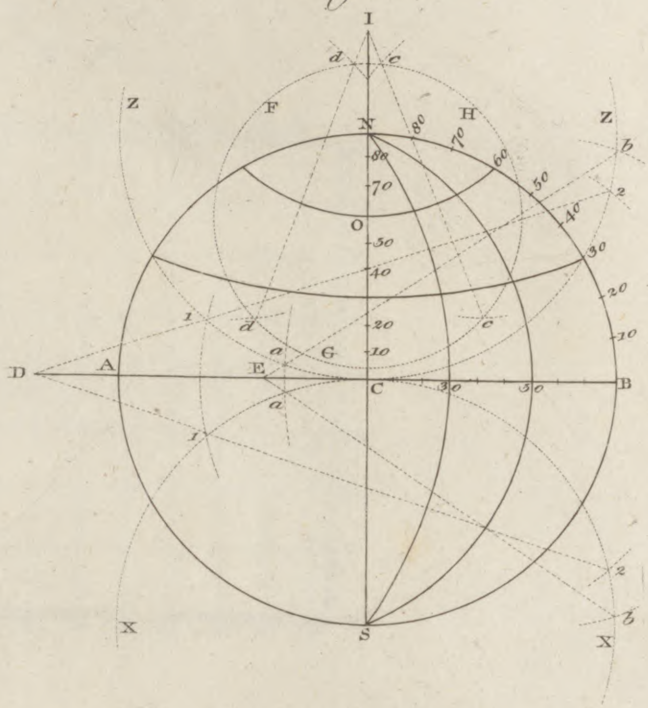


Fig. 18.

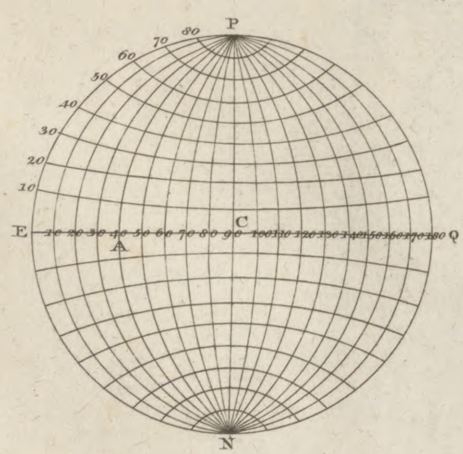
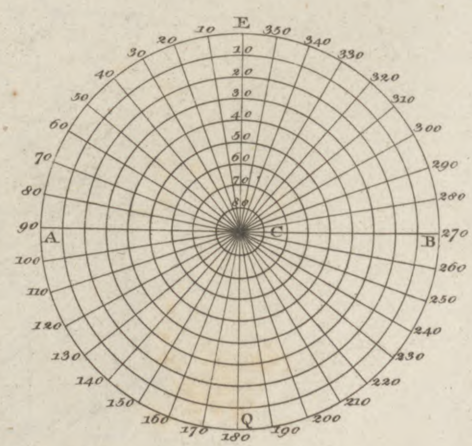


Fig. 19.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 20.

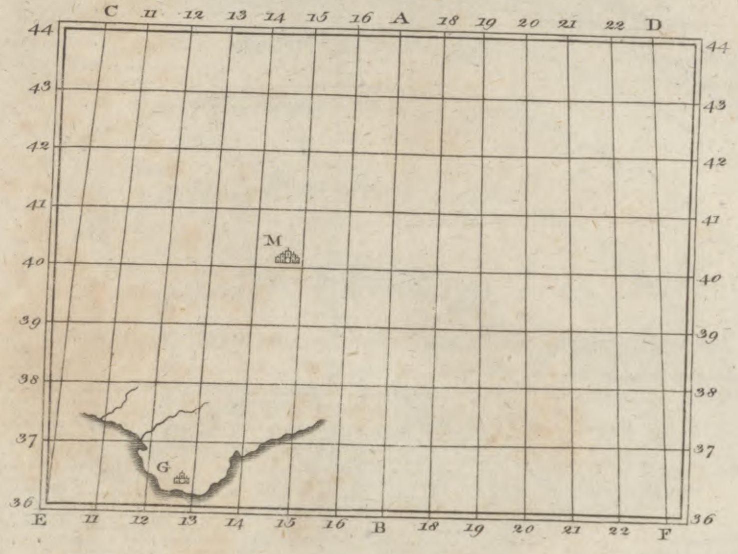
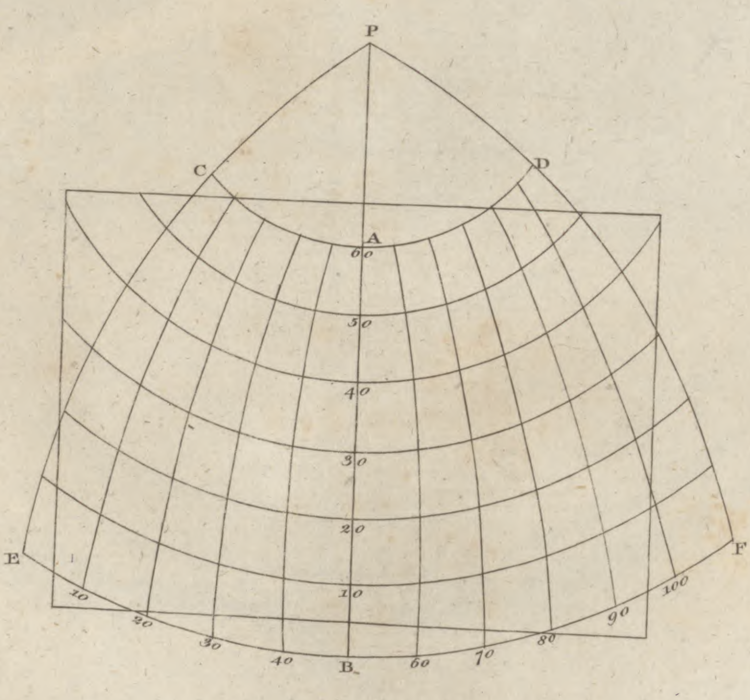
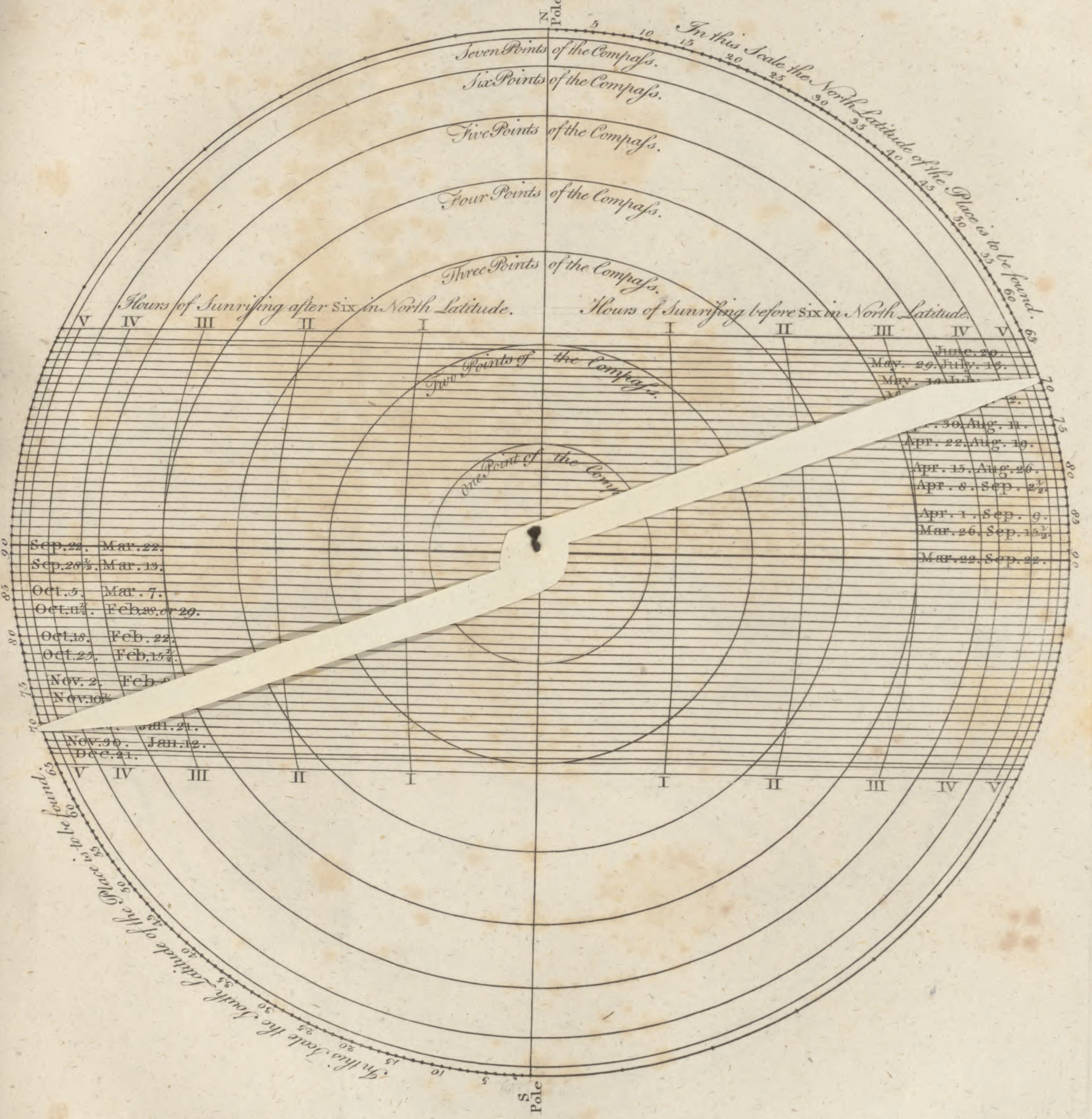


Fig. 21.



A. Bell Prin. Wal. Sculptor fecit.

An Analemma, Shewing the time of Sun rising & Sun setting, the length of the Days & Nights, and the point of the Compass on which the Sun rises & sets, for every Degree of Latitude, and for every Degree of the Suns North & South declination.



A. Bell Prin. Wal. Sculptor fecit.

Plate CCXXXVI.

A. Bell Prin. Wal. Sculptor fecit.

A. Bell Prin. Wal. Sculptor fecit.

A.Bell Prin. Wal. Sculptor fecit.

Principles and Practice. tributed the different portions to the nine tribes at Shiloh; a ſuppoſition which is derived from Joſhua's account, that they were ſent to walk through the land, and that they deſcribed it in ſeven parts in a book. Joſephus alſo relates, that when Joſhua ſent people from the different tribes to meaſure the land of promiſe, he ſent with them men well ſkilled in geometry. All this, however, is no proof that theſe perſons drew a ſketch of the country, according to our idea of a map; but probably only wrote down, for the ſatisfaction of their employers, the extent, boundaries, and general characteriſtics of the diviſions of the land.

Herodotus has given a minute deſcription of a map conſtructed by Ariſtagoras, tyrant of Miletus, an abridgement of which will ſerve to give ſome notion of the maps of thoſe times. It was drawn upon braſs or copper, and ſeems to have been merely an itinerary containing the route through the countries which were to be traverſed in a march which Ariſtagoras propoſed to Cleomenes, king of Sparta, for the purpoſe of attacking the king of Perſia at Suſa, that he might thus aſſiſt in reſtoring the Ionians to their liberty. The rivers Halis, Euphrates, and Tigris, which, according to Herodotus, muſt have been croſſed in that expedition, were laid down in this map; and it contained one ſtraight line, called the royal road or high way, which comprehended all the ſtations or places of encampment, from Sardis, the beginning of the route, to Suſa, a diſtance of 13,500 ſtadia, or $1687\frac{1}{2}$ Roman miles of 5000 feet each. The number of encampments in this whole route was 111.

Ptolemy of Alexandria, the celebrated geographer mentioned in N° 21. conſtructed maps to illuſtrate his deſcription of places, and theſe are the firſt that have regular meridians and parallels, the better to define and determine the ſituation of places. Ptolemy acknowledges that his maps, with the addition of ſome improvements of his own, the principal of which was certainly the introduction of meridians and parallels, were copied from previous maps made by Marianus Tyrius, &c. They are, however, often very inaccurate.

According to Atheneus, a work which ſeems to have contained maps, was written by Baeton, under the title of Alexander's march; and a work on the ſame ſubject is mentioned as the production of Amynthus. We are informed by Pliny, that this Baeton was one of the ſurveyors of Alexander's marches; and he quotes the exact number of miles of theſe marches, according to Baeton's menſuration, and confirms their authenticity by the letters of Alexander. Pliny alſo remarks, that a copy of this conqueror's ſurveys was given by Zenobius, his treaſurer, to the geographer Patrocles, who was admiral of the fleets of Seleucus and Antiochus.

125 Peutingerian table. Among the moſt celebrated of the ancient maps, are the Peutingerian tables, ſo called, becauſe publiſhed by Peutinger of Augſburg. Theſe tables contain an itinerary of the whole Roman empire; all places except ſeas, wood, and deſerts, being laid down according to their meaſured diſtances, though without any mention of latitude, longitude, or bearing. A particular deſcription of this monument of antiquity is given in the 18th volume of the Hiſtory of the Academy of Inſcriptions, and in the Hiſtory of the Academy of Sciences for 1761, from which M. Montucla has drawn up the following account. The map of Peutinger, as it is in the original in the imperial library, is exactly one French foot in height, and 20 feet eight inches in length, according to meaſures taken by Buache, from a copy of the ſplendid edition given by Scheele in 1753. It comprehends the whole extent of the Roman empire, from Conſtantinople to the ocean, and from the ſhores of Africa to the northern parts of Gaul; but the table which it affords of this vaſt extent of country is by no means calculated to give us an idea of its figure, ſince the 35° of longitude which it comprehends, occupy 20 feet 8 inches, while the 13° of latitude are compriſed within the ſpace of one foot; thus the countries repreſented are ſo disfigured, that the Mediterranean appears only like a broad river, and all the countries are ſo diſtorted, towards the north and ſouth, that they cannot be recogniſed.

Moſt of thoſe who have ſeen this ancient map, have conſidered it as the rude and bungling work of a man little converſant with geography, and ſtill leſs ſo with mathematics; but Edmund Brutz conſiders the diſtortion of this map as ſimilar to what we ſee in ſome pieces of perſpective, and that it ought to be examined from ſome certain near point in order to perceive the objects in their natural proportion.

Buache ſuppoſed long ago, that this map was conſtructed with more ſcientific ſkill than it appears to be at the firſt glance; and that the apparent irregularities which we obſerve in it, might have been introduced deſignedly, for the purpoſe of deriving greater advantages as to what was intended for the principal object. In fact, as the Roman routes extended almoſt entirely from eaſt to weſt, they paid more attention to the meaſures in this direction than thoſe between north and ſouth; and the map in this way might have had the greater convenience of being more eaſily rolled up, and conſequently more portable.

Thus far Buache hazarded no more than conjecture; but a labour undertaken by him with a very different view, led him to the true deſign of the map of Peutinger. He had been tracing a ſcale of climates, and of the length of the days and nights, for the purpoſe of attaching it to ſmall maps of the different countries of Europe. As the ſpace occupied by the ſcale was pretty much extended in height, but had very little breadth, he formed the idea of drawing a kind of map upon two ſcales, one pretty much extended for the latitude, and the other very much contracted for the longitudes, preſerving the hollows of the coaſts and boundaries of each ſtate. As this diſpoſition of his map ſtrangely disfigured the countries which it was intended to repreſent, he was led to imagine that this map might be the reverſe of that of Peutinger. This was ſufficient to engage him to conſtruct another map upon the ſame principle; but in which the ſcale of longitudes was much greater than that of the latitudes. He then ſaw that he had been right in his ſuppoſition, and that the map which he had laſt conſtructed had a conſiderable reſemblance to that of Peutinger. This latter is in fact only a plain chart, conſtructed upon two ſcales, of which that of the longitudes is very great, and that of the latitudes much ſmaller.

One difficulty alone aroſe. By ſuppoſing that he obſerved in this map a cuſtom at preſent eſtabliſhed among geographers, of repreſenting the meridians by lines drawn perpendicular to the baſe of the chart, and the parallels

Principles and Practice.

parallels to the equator by straight lines drawn parallel to this same base, Buache found a considerable error. The bottom of the gulf of Venice and Rome did not then appear, as they ought to do, under the same meridian. He soon, however, saw the solution of this difficulty. The method of drawing the meridians parallel to the sides of the chart, is a matter of pure agreement, and had probably not been observed in the map of which we are speaking. The ancient Roman geographers having considered that Italy was naturally divided by the Appenines, according to its length, into two parts that were nearly equal, had therefore delineated the length of Italy from Trent to the end of the peninsula, parallel to the lower margin of the map, and had afterwards arranged the other parts which the map was to contain, conformably to this disposition; and as the length of Italy is not in a direction parallel to the equator, it would happen necessarily that the meridians and parallels, if they had been drawn on this map, would have been parallel neither to the sides nor to the lower margins of the map, and that the vertical line passing through Rome must intersect the gulf of Venice at about the middle: but this line is not a meridian.

Thus, this map is not so rude a work as has been imagined, but has been entirely constructed according to rule; and it even appears that the author had employed pretty good materials in its compilation, as the positions are laid down in a manner that differs little from modern observations *.

* *M. Montucla*, tom. iv. p. 599.

From the time of Ptolemy till about the 14th century, no new maps were published; and the first maps of any esteem among the moderns were constructed by Mercator, to whom we are indebted for the projection according to which marine charts are constructed. Mercator was followed by Ortelius, who undertook to construct a new set of maps with the modern divisions of countries and names of places, for want of which the maps of Ptolemy were become almost useless. After Mercator and Ortelius, many others published maps, which were chiefly copied from those above mentioned, till about the middle of the 17th century, when Blaeu published his large atlas, or *Cosmographie blaviane*, in which is a pretty accurate description of the earth, the sea, and the heavens, comprised in 12 folio volumes. About the same time an atlas in two folio volumes was published in France by M. Sanson, the maps of which are in general very correct, containing many improvements of the travellers of those times. The maps of Blaeu and Sanson were copied with little variation both in England, France, and Holland, till from later observations De Lisle, Robert, Wall, &c. published still more accurate and copious sets of maps.

The works of recent travellers and navigators have considerably improved the construction and accuracy of our maps and charts; but there is still much to be done, especially with respect to trigonometrical surveys, before any high degree of correctness can be acquired. Among the latest maps and charts, those constructed by Mr Arrowsmith are in the greatest estimation.

126 Catalogue of the best maps.

As a collection of good and accurate maps is of the greatest importance in the study of geography and history, we shall here subjoin a list of some of the best modern maps that have been published.

Those maps which may be collected for the purpose of forming an atlas, have been arranged under three heads, according to their size, or the extent of their scale. 1st, Those which consist of more than six sheets, such as De Bouge's map of Europe in 50 half sheets, and Cassini's map of France in 183 sheets. 2dly, Those from six to four sheets, to which class belong several maps of kingdoms. And, 3dly, Those from one sheet to four, which is the smallest size that can answer the purpose of an atlas. We shall briefly notice the best maps of each size.

Planispheres, or *Maps of the World*.—We know of no very large map of the world that can at present be confidently relied on: the best is that of Mr Arrowsmith in four sheets; and Faden has published very good maps in one sheet.

Maps of Europe.—1st size. That of De Bouge, published at Vienna, or that by Sotzmann in 16 sheets, which is the better of the two. 2d Size. Arrowsmith's in four sheets. 3d Size. That by Faden in one sheet.

Maps of England.—I. The trigonometrical surveys of the counties, published by Lindley and Gardner, and by Faden. II. Cary's atlas of the counties, and his England and Wales in 81 sheets. III. Faden's map in one sheet.

Maps of Wales.—I. That of Evans in nine sheets. III. The maps in Pennant's Tours, and Evans's Cambrian Itinerary.

Maps of Scotland.—I. The surveys of the several counties. II. Ainslie's nine sheet map. III. An excellent map by General Roy, and Ainslie's reduced map in one sheet.

Maps of Ireland.—I. Surveys of counties. III. A valuable map by Dr Beaufort in two sheets, or Faden's in one sheet.

Maps of France.—I. Cassini's, mentioned above, and the *atlas nationale* in 85 sheets. III. Faden's one sheet map, and a map, in departments, by Bellycime in four sheets.

Maps of the Netherlands.—I. Ferrari's map in 25 sheets. II. *Atlas de Department Belgique*. III. Ferrari's map reduced by Faden.

Maps of Holland.—II. Kep's maps of the United Provinces. III. Faden's map of the Seven United Provinces in one sheet.

Maps of Germany.—II. Chauchard's map of Germany. III. A map of the Austrian dominions, in one sheet, by Baron Lichtenstern.

Maps of Prussia.—I. Sortzmann's atlas in 21 sheets. III. Sortzmann's reduced, in one sheet.

Maps of Spain.—Lopez's atlas, not, however, very accurate. II. A map of Spain in nine sheets by Montelle and Chanlaire. III. Faden's map in one sheet.

Maps of Portugal.—II. Geoffry's improved by Rainsford, in six sheets. III. De la Rochette's chorographical map in one sheet, published by Faden.

Maps of Italy.—I. The maps of the several states. III. D'Anville's map of Italy improved by De la Rochette, in four sheets, published by Faden.

Maps of Turkey in Europe.—III. Arrowsmith's map of Turkey in two sheets. De la Rochette's map of Greece in one sheet.

Maps of Switzerland.—I. Weiss's atlas, published at Strasburg in 1800. III. Weiss's reduced map in one sheet.

Maps of Denmark.—I. Maps of the provinces, under the direction of Bygge. III. Faden's maps of Denmark, Sweden, and Norway, in one sheet.

Maps

Maps of Sweden.—I. Atlas of the Swedish provinces, by Baron Hermelin. III. De la Rochette's, by Faden, in one sheet.

Maps of Asia.—The best general map of Asia is that by Arrowsmith in four sheets, published in 1801; and D'Anville's, in six sheets, may still be consulted with advantage.

There are few good maps of the individual countries; but the following are esteemed among the best.

Of China.—D'Anville's atlas, and a map by Arrowsmith.

Of Tartary.—A map by Witsen, in six sheets, and one by De Witt in one sheet.

Of Japan.—Robert's map in one sheet.

Of the Birman Empire.—The maps published in Mr Symes's embassy.

Of Hindostan.—Rennell's map in four sheets. His atlas of Bengal, and his map of the southern provinces.

Of Persia there is no good modern map; but La Rochette published a beautiful one, to illustrate the expedition of Alexander the Great.

Of Arabia there are some good partial maps in Niebuhr's journey.

Of the Asiatic Islands there is an excellent chart by Arrowsmith, in four sheets.

Of Australasia, or *New Holland*, the best drawing is contained in Arrowsmith's chart of the Pacific ocean.

Maps of Africa.—The best general map of Africa is still that of D'Anville, though some little additions may be made to it, derived from the journeys of Park and Brown. Major Rennell's partial maps may be consulted with advantage.

Of Abyssinia there is a good map in Bruce's travels.

Of Egypt, the best maps are that of the Delta by Niebuhr, and that of Lower Egypt by la Rochette.

Of the Mahometan States, the best maps are those by Shaw, and a chart of the Mediterranean in four sheets, by Faden.

Of the Cape of Good Hope, the best is Barrow's survey.

Maps of America.—There is no modern general map of America that can be relied on. The best it that of D'Anville, in five sheets, published in 1746 and 1748.

Mr Arrowsmith has published an excellent map of North America, on a very large scale, but has omitted the Spanish dominions.

Of the United States, the best map is Arrowsmith's in four sheets, published in 1802; and there are very good maps of the individual provinces in Morse's American Geography.

Of the British Possessions in America, besides Arrowsmith's map above mentioned, there is a good map of Upper Canada by Smith, in one sheet.

Of the West India Islands, the best map is that of Jefferys in 16 sheets, from which a smaller one in one sheet has been reduced.

Of South America, the best map is that published by Faden in 1799, in six sheets, from an engraving done at Madrid some years before.

APPENDIX.

127 Observations on the study of geography.

BEFORE we conclude this article, we must make a few observations on the method to be followed for acquiring or imparting geographical knowledge.

As some knowledge of geography, as well as of chronology, is absolutely necessary, before history can be properly understood, the rudiments of these sciences should be learned, as soon as the capacity of the pupil will allow. It happens fortunately, that some of the most useful parts of geography, those which consider the relative situations, extent and boundaries of countries, with the manners and customs of their inhabitants, are highly interesting; and provided that a knowledge of them be conveyed to a child in a pleasing manner, they are well fitted to interest his curiosity, and awaken his attention. The more scientific parts of geography, and a detailed account of the minute circumstances respecting each country, though extremely useful, and indeed necessary to the more advanced student, may be withheld for a little without any great loss, till his age and judgement permit him to see their utility and application.

In teaching geography to very young children, their chief attention should be directed to those circumstances which are most interesting; and even with this limited view much may be learned at a very early period. For this purpose the dissected maps that are usually sold at toy shops, may be employed with considerable advantage; but it is to be regretted, that the maps used in preparing these are seldom taken from the most correct copies. Those works also which, under the disguise of fictitious voyages and travels, are intended to convey a geographical knowledge of various countries, afford a very pleasing and profitable method of instruction. A late work of this kind, by M. Jaufret, entitled *the Travels of Rolando*, may be advantageously put into the hands of young people; and, as they are farther advanced, the travels of Anacharsis the younger by the Abbé Barthelemi will give them considerable information respecting the manners, customs, and historical events of ancient Greece.

When the young student is sufficiently advanced to prosecute the study of geography on a more extensive and scientific plan, it would be desirable that he should begin by reading some elementary treatise on astronomy, such as that of Mr Bonnycastle, or the *Spectacle de la Nature;* or, if he has acquired a proper degree of mathematical knowledge, he may read Laplace's *Systeme du Monde*, the astronomical part of *Robison's Mechanical Philosophy*, or the astronomical article in this dictionary.

It may happen, that, from a defect of early education, or want of time, a preliminary course of astronomy cannot be commanded. Still, however, considerable progress may be made in geography, by the mechanical means of maps and globes. The student should, therefore, provide himself with a pair of the best globes, chosen according to the directions laid down in N° 107; and with a few good maps of those countries which are moſt intereſting, particularly maps of Europe, Aſia, Africa, and North and South America, the Britiſh iſlands, France, Germany, Italy, Ruſſia, and Denmark, which may be collected from the liſt given at N° 126.

Being provided with theſe materials, the ſtudent ſhould firſt read over Chap. I. of Part II. of this treatiſe, or a ſimilar part of ſome elementary work in geography. On the elementary principles of geography we would recommend the general principles prefixed to Mr Patteſon's general and claſſical Atlas; and for teaching the uſe of the globes, Bruce's Introduction to Geography and Aſtronomy. For a complete account of modern geography we cannot refer to a better work than that of Mr Pinkerton; and for a combined account of ancient and modern geography, the pupil may have recourſe to a work on that ſubject by Dr Adam of Edinburgh.

After reading over the preliminary part above mentioned, the pupil may go through the ſecond Chapter of Part II. ſolving all the problems as he goes along on the terreſtrial globe; and thus he may proceed progreſſively through the whole article, leaving that part of Part I. which treats of the hiſtory of geography for the laſt object of his enquiry.

In ſtudying the particular circumſtances of each country, the pupil ſhould always have the map of the country before him; and, as he goes along, ſhould trace there the ſituation of each particular place; of the principal mountains, lakes, the ſources and directions of the rivers, the form and bounding of the ſhores, &c. In his progreſſive view of particular geography, it will be proper for the pupil to begin with the country in which he reſides; and, after having made himſelf maſter of that, to proceed ſucceſſively to thoſe which border on it, or whoſe connection with it is the moſt intereſting.

Thus an inhabitant of theſe iſlands, after having taken a view of EUROPE in general, ſhould make himſelf acquainted with BRITAIN and IRELAND (by peruſing the articles ENGLAND, SCOTLAND, and IRELAND in this Dictionary or in other works); whence he may proceed to FRANCE and its dependencies in the NETHERLANDS, SWITZERLAND, ITALY; thence to GERMANY and the AUSTRIAN territories, PRUSSIA, SWEDEN, DENMARK, and RUSSIA; whence he may return to the ſouth of Europe to SPAIN, PORTUGAL, and TURKEY, &c. After Europe, the United States of AMERICA will probably be found the moſt intereſting; the pupil may therefore ſtudy the geography of NORTH AMERICA before that of ASIA. From ASIA he may proceed to AUSTRALASIA and POLYNESIA; thence to AFRICA, and ſo conclude with SOUTH AMERICA. Nothing will contribute more to the advancement of geographical ſtudies than the conſtruction of maps. If the pupil has time therefore he ſhould early be inſtructed in this part of the ſubject by at firſt drawing a map of the world according to the directions laid down in N° 118. then one of Europe, and ſo of other quarters and countries. In conſtructing this map, it will be proper firſt to lay down thoſe places which are near the coaſt, in order to form the outline of the maritime part of the country, and only the moſt remarkable places inland, eſpecially thoſe which are ſituated in the courſe of the principal rivers. In every map the moſt prominent features of the country, as the mountains, lakes, rivers, and principal cities and towns, ſhould firſt be attended to, and from theſe the pupil may be introduced to the other places in the order of their magnitude or importance.

The moſt agreeable and intereſting method of ſtudying particular geography, after having become acquainted with the elementary principles of the ſcience, would be to peruſe the beſt books of voyages and travels; for from thoſe, where the traveller can be depended upon, the moſt correct ſyſtems of geography are compiled. Many of theſe, however, are too prolix and particular to be put into the hands of moſt young people, and a judicious abridgement of the beſt of them will anſwer every purpoſe; and perhaps Dr Mavor's collection may be recommended, as the beſt of the kind in the Engliſh language. For thoſe whoſe time and convenience will admit of their reading the beſt writers of voyages and travels, there is no want of ſuch works; and Mr Pinkerton has given at the end of his excellent work, a liſt of the beſt in moſt languages. We ſhall here only notice a few of the beſt and lateſt.

Pennant's Tours in Britain.
Young's Tours in the Britiſh iſles.
Saintfond's Travels in England and Scotland.
Young's Travels in France.
Holcroft's Tour in France.
Spallanzani's Travels in the two Sicilies.
Coxe's Travels in Ruſſia, &c.
Pallas's Travels in the Ruſſian empire.
Carr's Northern Summer.
Staunton's Account of China.
Barrow's Travels in China.
Percival's Account of Ceylon.
Symes's Embaſſy to Ava.
Collins's account of New South Wales.
Bruce's Travels in Abyſſinia.
Barrow's Travels in Africa.
Park's Travels in the interior of Africa.
Browne's Travels in Africa.
Sonnini's Travels in Egypt.
Percival's Cape of Good Hope.
Mackenzie's Journey in North America.
Davis's Travels in America.
Mackinnon's Tour in the Weſt Indies; with the voyages of Anſon, Byron, Cook, Phipps, Bligh, Wilſon, Wallis, La Peyrouſe, &c. &c.

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Problems

GEOLOGY.

Introduction.

INTRODUCTION.

1 Definition and object of geology.

THAT part of natural hiſtory which treats of the internal ſtructure of the earth, as far as we have been able to penetrate below its ſurface; of the arrangement of the materials of which it is compoſed, and of the changes which have taken place in theſe, is called GEOLOGY, from γη, the *earth*, and λόγος, *a diſcourſe*. This ſcience has been called by Werner, GEOGNOSY, and is by him defined to be *that part of mineralogy which, conſidering minerals as a part of our globe, treats chiefly of their bearings and poſitions with reſpect to each other* (A). Till of late this department of literature was called phyſical geography, but at preſent the terms GEOLOGY and GEOGNOSY are generally adopted; of theſe we have preferred the former, as being equally expreſſive and more familiar; and under this head we propoſe to include every thing that is uſually comprehended under what have been called *theories of the earth*.

* Journ. de Phyſique, tom. lv. p. 444.

GEOLOGY differs from COSMOGONY as a *part* from the

(A) Werner has probably made this trifling change from a deſire of novelty; and ſome of his admiring pupils have attempted to diſplay in very pompous but puerile terms, that it is of great value and importance.

Introduction. the whole; the object of the latter is to give an account of the creation of the *universe*, while the former confines itself to the consideration of the planet which we inhabit.

Geology is intimately connected with mineralogy, and may indeed be said to depend on this as its very foundation. Werner, as we have seen, considers *Geognosy* as a part of *Mineralogy*; but we are disposed to concur with Dr Kirwan, who, speaking of mineralogy with respect to its relation to geology, calls it "the alphabet of the huge and mysterious volume of inanimate nature."

2 Division. Geology may be divided into descriptive and speculative; the former giving a general account of the materials of which the globe is composed, and of their arrangement; while the latter is strictly confined to what may be called a theory of the earth, or an attempt to explain the manner in which the structure and arrangement have been brought about, and the changes that have taken place in the disposition of the component parts of the earth.

3 Importance of the science. The science of geology is of considerable importance in many points of view.

4 to the naturalist; 1. The student of natural history cannot but derive a great fund of profit and advantage from a science, which makes him acquainted with so large a department of nature. Mineral bodies, whether we consider them as individuals of nature, or as collected into those masses which form the strata of the earth, and the mountains that rise above its surface, are peculiarly interesting to the naturalist, as well from the variety of form and beauty of appearance which some of them present, as the useful purposes to which many of them are applied. The other kingdoms of nature delight us with the display of order and design exhibited in their organization, or interest us from the intimate connexion which subsists between many of them and ourselves. These are objects of the *beautiful*; while the stupendous mountain, the awful volcano, the towering cliff, the gloomy mine, and the majestic cavern, are objects of the *grand* and the *sublime*.

5 to the miner; 2. To the miner, and all those who are employed in searching the bowels of the earth for the treasures which they contain, geology, as well as mineralogy, forms an essential qualification. Experience has shewn that certain minerals and metals are found more frequently attached to some of the stony materials of the earth, than to others, and that a few of them are only found in particular strata. Examples of this kind will be given presently. We have also learned that the arrangement of the materials in the earth is so far regular and uniform, that when we know the particular materials near which certain metals and minerals are commonly found, and the usual disposition in these places; and when we find in another situation the same materials disposed in a similar manner, we are pretty certain that the metal or mineral of which we are in search is not far distant. We are therefore encouraged to prosecute the search with every probability of success. Those who undertake to direct an investigation of this kind, or to carry on the operations requisite for the obtaining what is sought, would do well to inform themselves beforehand of such facts as are well established respecting the distribution of the materials of the earth, and the substances usually found connected with them. For want of this necessary information, we often see projectors impose on the credulity, and impoverish the finances, of gentlemen of landed property, who are led to suppose that they possess on some part of their estate a rich vein of metal, seam of coal, &c. the working of which will considerably improve their income.

3. The failure of undertakings of this kind, partly from the villany of the projector, and partly from the ignorance of his employer, shews the advantages that gentlemen of landed estates would derive from the study of geology. An acquaintance with this science would guard them against the artifices of designing men, and prevent them from embarking in uncertain and expensive projects, the issue of which is too often ruin and disappointment. 6 to the landed proprietor;

4. But the study of geology boasts a still higher advantage. Nothing has more contributed to demonstrate the truth of the divine writings, and to clear up many doubtful passages in them, than the discoveries that have lately been made in the structure and formation of the earth. The original state of the globe is so intimately connected with that which it at present exhibits, that we cannot properly understand the latter without referring to the former; and recent experience has shewn that the obscurity in which the philosophical knowledge of this subject was involved, has been highly favourable to those systems of atheism and infidelity which prevailed in the last age. Much of this obscurity is now removed; and the investigations of Whitehurst, Werner, Kirwan, Howard, and some other geologists, by proving that the supposition of a deluge is the only hypothesis on which we can account for the present state of our globe, have contributed as much to the advancement of true religion as of philosophical knowledge. 7 and to the Christian.

"So numerous indeed, and so luminous, have been the more modern geological researches, and so obviously connected with the object we have now in view, that since the obscuration or obliteration of the primitive traditions, strange as it may appear, no period has occurred so favourable to the illustration of the original state of the globe as the present, though so far removed from it. At no period has its surface been traversed in so many different directions, or its shape and extent under its different modifications of earth and water been so nearly ascertained, and the relative density of the whole so accurately determined, its solid constituent parts so exactly distinguished, their mutual relation, both as to position and composition, so clearly traced, or pursued to such considerable depths, as within these last thirty years. Neither have the testimonies that relate to it been ever so critically examined and carefully weighed, nor consequently so well understood, as within the latter half of the 18th century *."

8 Difficulties attending the study not insurmountable. Geological researches seem at first view to be attended with almost insurmountable difficulty. It is evident that the part of the earth which it is in our power to examine, is infinitely small when compared to that which is entirely beyond our reach; and even much of the elevated parts, that appear above the surface, would seem to be so completely cut off from us by inaccessible precipices, and the ice and snow with which the summits

* *Kirwan's Geol. Essays.*

mits of ſome of them are perpetually covered, that our knowledge of their ſtructure and compoſitions muſt for ever remain imperfect. Much of theſe difficulties, however, is rather apparent than real. It is true that our reſearches can extend but a very little way below the ſurface; but ſo far as our experience has yet taught us, any farther inveſtigation would be rather a matter of curioſity than utility. Thoſe metals and minerals which prove of moſt ſervice to mankind, are found at no very great depth in the earth, and ſome of them almoſt on its ſurface; and when we have penetrated beyond theſe, the materials diſcovered are of a nature ſo uniform, and of a texture ſo firm and hard, that it is poſſible they may extend even to the centre. Again, the inveſtigations of Sauſſure, De Luc, Dolomieu, and Humboldt, have proved that the moſt dangerous precipices, and the higheſt ſummits of thoſe immenſe mountainous chains which traverſe the earth in ſo many directions, oppoſe but feeble barriers to perſevering induſtry and philoſophic ardour.

The diverſity which occurs in the ſtructure and local arrangement of ſubterraneous ſubſtances, ſeems to throw another difficulty in the way of the geologiſt; but the farther his reſearches are extended, the more will this apparent diverſity be diminiſhed. The practical ſkill which ſome miners poſſeſs in many parts of the world, proves that the mazes of this labyrinth are not without a clue; and we may ſafely conclude, that when our knowledge of the ſtructure of the earth, and the diſpoſition of its materials, ſhall be ſtill farther extended, the greater part of the obſcurities under which the ſubject is now veiled, will be entirely removed. Multiplied obſervations of later years have enabled us to form certain general concluſions, and lay down certain general laws, which muſt materially aſſiſt future obſervers.

9 Principal improvers of geology.

In the modern improvements of geology the Germans led the way, and Lehmann may be conſidered as the father of the ſcience. Eminently ſkilled in general phyſics, practical mining, mineralogy, and chemiſtry, and fully acquainted with the circumſtances attending the relative ſituation of moſt mineral bodies in very extenſive tracts of different countries which he examined, he was enabled to deduce, from a long ſeries of obſervations, ſome general concluſions, which have, with ſome exceptions, been ſince verified in every part of the world.

Lehmann was followed in his own country by Bergman, Ferber, Gmelin, Cronſtedt, Born, and Werner; in Italy, by Arduini and Tilas; in Switzerland, by Sauſſure and De Luc; in Ruſſia, by Pallas; in France, by Delametherie, Saint Fond, Dolomieu, and Lavoiſier; and in Britain, by Hutton and Kirwan, names which muſt ever be held in the higheſt eſtimation by the cultivators of this part of natural hiſtory.

10 Method of ſtudying geology.

Before entering on the ſtudy of geology, it is neceſſary to acquire a competent knowledge of chemiſtry, and a pretty extenſive acquaintance with mineralogy, as theſe ſciences form an eſſential introduction to the more general reſearches reſpecting the ſtructure of the earth. The former ſupplies the means of aſcertaining the nature of the ſubſtances met with; and the latter muſt be well underſtood, before we can arrange theſe ſubſtances under their proper heads, and before we can comprehend the terms employed by geological writers.

The ſtudy of this ſcience, like that of ſome other parts of natural hiſtory, particularly botany, can be proſecuted with but little advantage in the cloſet. The ſtudent muſt examine the declivities of hills, the beds of rivers, the interior of caverns and of mines, the receſſes of the ravine, and the utmoſt ſummits of the mountain, before he can obtain that degree of knowledge which is neceſſary to conſtitute a ſkilful and philoſophic geologiſt. While making theſe perſonal obſervations, he ſhould ſtudy the works of the beſt writers, and compare the facts related and deſcribed by them, with thoſe which he himſelf has obſerved. The writings on this ſubject may be divided into two principal claſſes, one comprehending thoſe works which contain a ſyſtematic account of the whole, or ſome part of the ſubject; ſuch as Bergman's Phyſical Geography, the Geological Eſſays of Kirwan, the *Theorie de la Terre* of Delametherie, the writings of Werner, &c.: and the ſecond compriſing thoſe works which treat of the geology of particular countries in the familiar ſtyle of travels; as Born's Travels in Hungary, Ferber's Travels through Italy, Sauſſure's *Voyage dans les Alpes*, Pallas's Travels, Jar's *Voyages Metallurgiques*, Saint Fond's Travels in England and Scotland, &c. After having acquired a knowledge of the principles and general facts of the ſcience from the former, the ſtudent will, by means of the latter, increaſe his knowledge in the moſt familiar and agreeable way.

11 Arrangement.

In the ſketch of geology which we are to give in the following article, we ſhall conſider the ſubject under three general heads, which will be the ſubject of as many chapters.

In the firſt chapter we ſhall deſcribe the arrangement and diſtribution of the materials of which the earth is compoſed. Here, after giving ſome general notion of that arrangement, we ſhall conſider each of the principal materials under a ſeparate ſection, in which we ſhall firſt lay down thoſe general marks by which each is diſtinguiſhed, deſcribe its general arrangement, and mention the places, eſpecially in Britain, where the ſubſtance is found in greateſt abundance, and thoſe metallic or mineral bodies which are commonly found in connection with it. After having briefly conſidered each ſubſtance, we ſhall bring the more general diſtribution of them under one view, ſtill directing our attention to the arrangement of theſe materials in the Britiſh iſlands.

In the ſecond chapter we ſhall give a brief outline of the moſt remarkable theories that have been framed in modern times, to account for the diſtribution of mineral bodies, and the manner in which we find them now arranged. In this chapter we ſhall dwell more particularly on the two rival theories which at preſent divide the geological world, and ſhall enumerate ſome of the objections which have been made to each.

In the third chapter we ſhall give ſome account of the derangement of the ſubſtances that compoſe our globe, ſo far as it has originated from known cauſes; and this will lead us to the conſideration of EARTHQUAKES and VOLCANOES.

Chap. I. *Of the Arrangement and Diſtribution of the Materials of which the Earth is Compoſed.*

12 General diſtribution of the materials of the earth.

The materials of which the general maſs of the earth is compoſed, are variouſly diſtributed in different parts. In ſome places they form irregular maſſes or blocks, either buried below the ſurface, or elevated to a greater or leſs height above it. In moſt places, however, the materials are arranged in a more regular manner; thoſe of the ſame kind being collected into extenſive maſſes, lying in layers or ſtrata, above or below a ſimilar maſs of another kind, or theſe alternate with each other to a conſiderable depth. Theſe ſtrata are ſometimes found arranged in a direction parallel to the horizon; at others they are vertical, or perpendicular to the horizon, appearing as if the horizontal ſtrata had been lifted up, and laid upon their edges. More commonly the ſtrata are arranged in a direction inclining to the horizon, when they are ſaid *to dip*.

13 Stratification.

The uppermoſt ſtratum is in moſt places covered to a certain depth with mould that has evidently been formed from the decompoſition of organized ſubſtances. In many parts of the earth this mould extends to a very conſiderable depth, and conſtitutes the ſoil; in other places it is barely ſufficient to form a coating to the ſtrata, and in others it is entirely wanting.

14 Horizontal and vertical ſtrata.

A good inſtance of horizontal ſtrata occurs about two miles to the eaſt of Balleycaſtle in the north of Ireland, of which we ſhall ſpeak more particularly by and by. One of the moſt curious examples of vertical ſtrata in Britain is found in the ſmall iſland of Caldey, on the coaſt of Pembrokeſhire, where the ſtrata of which the whole iſland is compoſed are placed in ſuch a manner, that their edges are all expoſed to view, and they may be ſucceſſively examined from the one end of the iſland to the other. It is ſeldom that an opportunity offers of examining the arrangement of ſtrata ſo eaſily as is afforded in this ſmall iſland. In moſt caſes it is neceſſary to penetrate to great depths before we can acquire an imperfect knowledge of the ſtratification of the earth; and in no inſtance have we yet proceeded a mile below the ſurface. In Caldey iſland, however, the ſtrata may be examined to the extent of more than a mile, beginning at what may be ſuppoſed the uppermoſt ſtratum, which is not more than a foot thick, to that which may be called the loweſt, at the oppoſite end of the iſland, being a maſs of red ſtone of more than a mile in depth.

15 Derangement of the ſtrata.

Sometimes the ſtrata are continued in a regular arrangement, preſerving the ſame inclination to a very conſiderable extent; but more commonly they appear in ſome parts ſeparated, as if they had been broken aſunder. Theſe ſeparations are uſually in a perpendicular direction, and the cavities are found filled with various heterogeneous matters. Sometimes theſe are chiefly compoſed of fragments of the adjacent ſtrata, but for the moſt part they conſiſt of mineral or metallic ſubſtances of a different nature.

When theſe fiſſures are filled up with broken fragments, or rubble, as it is called, it very commonly happens that they become the beds of brooks or rivers. Thus the river Derwent runs for a conſiderable extent in Derbyſhire over a fiſſure of this kind. When the fiſſure is filled up with a ſolid ſtony matter, this forms what in Scotland is called a *dyke*. If a maſs of mineral or metallic matters fill the fiſſure, or be inſinuated between the ſtrata, it forms what is called a vein, and theſe veins ſometimes branch between the ſtrata in various directions.

When a fracture has taken place in the ſtratified maſs, one part of the maſs ſometimes preſerves the ſame poſition as it had before, or ſtill forms a continued line with the other parts of the maſs, or is parallel to it; but more frequently one part is thrown out of its original poſition, and becomes more inclined to the horizon than before. Sometimes one ſide of the maſs is more depreſſed than the other, as is commonly ſeen in many of the ſtrata in Derbyſhire; at others the two parts of the maſs are ſo diſturbed as to incline towards each other, as if they had been broken upwards. When the edges of the ſtrata on each ſide of the fiſſure are thus divided and diſarranged, they are ſaid by the miners *to trap*.

The chaſms thus formed are ſometimes of conſiderable width. Some are found in Cornwall nearly 20 feet acroſs, and almoſt full of metallic and other mineral ſubſtances. It not unfrequently happens, that theſe fiſſures are empty, containing nothing but water in the bottom. A celebrated chaſm of this kind is ſhewn at the Peak in Derbyſhire; and if a ſtone be thrown in, it is heard to ſtrike from ſide to ſide for a conſiderable time, till at length it ſeems loſt in ſubterraneous water.

Plate CCXXXVIII. 16 Strata in general regular.

If the country in which the ſtrata lie runs in a waving direction of hill and dale, the ſtrata uſually preſerve the ſame waving direction, keeping pretty nearly parallel to each other. A curious example of this kind has been deſcribed by Gerhard, as occurring in the diſtrict of Mansfield in Germany. See fig. 1. In thoſe places where ſome remarkable diſlocation of the ſtrata has not taken place, their diſtribution is in general extremely regular, certain materials lying above or below certain others in an uniform manner. The obſervations of later geologiſts have diſcovered pretty nearly the arrangement that takes place in moſt countries; and we ſhall preſently give ſome examples of the ſtratification of ſeveral parts of Europe. Before we attempt this, however, we muſt mention ſome circumſtances in which the materials compoſing the ſtrata differ from each other.

17 Diviſion of the materials.

The general obſervation of all modern geologiſts proves, that all theſe materials may be diſtributed under two general claſſes; one conſiſting of thoſe ſubſtances which are found more or leſs connected with the remains of organized bodies, as the bones, teeth, and ſhells of animals, the trunks of trees, and other parts of vegetable bodies; and the other comprehending thoſe in the ſubſtance of which theſe organic remains are never found. As it is now generally believed that the latter of theſe are of a formation prior to the former, we ſhall here adopt the general diviſion of them into primary and ſecondary. We might go ſtill farther in this diviſion, by arranging them under more heads; one, for example, containing thoſe in which organic remains are ſparingly found, and others containing thoſe ſubſtances which are found only in particular places; but as the firſt of theſe involves in it a particular theory which we ſhall notice fully hereafter, and the others allude to facts which will be mentioned when treating of the ſeparate materials, we ſhall not here extend our

Arrangement, &c. of the Materials of the Earth.

diviſion beyond the diſtribution of the materials into primary and ſecondary.

In the following ſhort detail, many terms will occur which can be underſtood only by the mineralogiſt. They will be fully explained under the article MINERALOGY. The names which we ſhall give to the ſubſtances deſcribed will be ſuch as have been moſt generally adopted in this country; but to prevent ambiguity, we ſhall, where it ſeems to be neceſſary, add the ſynonimous names that occur in the beſt geological writings.

A. Primitive Compounds.

SECT. I. *Of Granite.*

18 Granite deſcribed.

THE name *granite* has long been applied to all ſtones which are compoſed of an aggregate of quartz, feldſpar, and mica, diſtributed in ſuch a manner as that each of them appear in a ſeparate ſtate; but as this definition has been conſidered as too looſe, and comprehending too many varieties, the name is at preſent reſtricted to that kind of granitic ſtone in which the quartz, feldſpar, and mica, are found in grains or cryſtals. Of the three ſubſtances, the feldſpar is generally the moſt abundant, and the mica the leaſt ſo.

Granite is found in the loweſt and the higheſt ſituations of the earth that have yet been examined. It forms the baſis of all the other ſtrata; and though theſe are ſometimes found below it, this ſituation ſeems to have been the conſequence of ſome accident, by which the inferior ſubſtances were thrown below the granite. Many mountains ſeem almoſt entirely compoſed of granite, as Gefrorn one of the Rhætian Alps; and there is a high hill of white granite about ſix miles to the weſt of Strontian in Scotland. Sometimes large maſſes of granite are found in a detached ſituation at ſome diſtance from the mountains to which they appear to belong; and theſe maſſes ſeem in ſome inſtances to have been broken off, and rolled down the mountain, and in others to have been carried away by irreſiſtible torrents, or diſlodged by earthquakes. On the ſummits of the mountains near Port Sonnachin in Scotland, are found large quantities of detached pieces of granite, ſome of them of amazing ſize *.

* *Mawe's Derbyſhire*, p. 152.

19 Its different ſtates.

Granite is moſt commonly found in vaſt blocks, ſeparated from each other by rifts or chaſms, irregularly diſpoſed. This is the caſe in moſt mountains, eſpecially in thoſe which have high, pointed ſpires. The ſtructure of theſe blocks is pretty uniform, there occurring ſeldom more than two varieties, one called porphyritic granite, in which the baſis is of a fine grain, containing large cryſtals of feldſpar. Of this variety many inſtances occur in the north of Scotland, and near Carlſbad in Bohemia. The other principal variety is that in which the granite is found in diſtinct globular concretions, compoſed of concentric lamellæ. This variety was obſerved by Mr Jameſon, on the road between Dreſden and Bautzen; and Mr Barrand, in his deſcription of the Cape of Good Hope, mentions ſeveral globular concretions of immenſe ſize. The iſle of Arran in Scotland alſo affords inſtances of the ſame variety. It is alſo found in Corſica, and is often called Corſica granite.

20 Stratified.

It has been doubted by ſome geologiſts, whether the true granite is ever found ſtratified; but numerous inſtances of its ſtratification have been lately adduced, that leave no room to doubt that this is ſometimes the caſe. Pallas takes notice of ſome ſtratified granite on the banks of the river Berda, where what he conſidered as perfect primitive granite, compactly cryſtallized, is diſpoſed in layers of various degrees of thickneſs, ſome not exceeding one-eighth of an inch, and bounded both above and below by blocks of ſolid granite †. Again, on the banks of the Gromoklea, he obſerved ſimilar layers of granite running in a direction from north to ſouth, each bed being from one ſpan to three feet ſix inches in breadth, and conſiſting of the moſt perfect primitive granite, which he conſiders as a continuation of that mineral tract which produces the cataracts of the Dnieper ‡. Mr Playfair mentions an example of ſtratified granite which he ſaw in Chorley foreſt in Leiceſterſhire, where real granite is diſpoſed in beds on the eaſtern border of the foreſt, eſpecially near Mount Sorrel. Another inſtance of real granite diſpoſed in regular beds, is alſo mentioned by Mr Playfair as occurring near the village of Prieſtlaw in Berwickſhire ‖. Mr Jameſon obſerved the Rieſengebirge, which, ſeparates Sileſia from Bohemia, to be for 150 miles compoſed of granite diſpoſed in horizontal ſtrata, and he obſerved a ſimilar ſtratification in Saxony and Luſatia §.

† *Pallas's Trav.* vol. i. p. 521.

‡ *Ibid*, vol. ii. p. 503.

‖ *Playfair's Illuſtrations*, p. 328.

§ *Nich. Jour.* 8vo. vol. ii. 227.

21

Granite conſtitutes the baſe of moſt of the Britiſh mountains, but is more commonly met with in the north and weſtern parts of the iſland. There is a conſiderable maſs of granite which runs longitudinally through Cornwall, from Dartmore to the Land's End *. Conſiderable maſſes are found in Scotland, but their extent has not been accurately aſcertained. According to Mr Playfair, there is no maſs of any magnitude in the ſouthern parts, except that of Galloway, which occurs in two pretty large inſulated tracts. Mr Playfair thinks that Dr Hutton greatly underrated the quantity of granite in Scotland, which, eſpecially in the north, he conſiders as extending over a large diſtrict. If we ſuppoſe a line to be drawn from a few miles ſouth of Aberdeen, to a few miles ſouth of Fort William, it will, according to Mr Playfair, mark out the central chain of the Grampians, along which line there are many granite mountains, and large tracts in which granite is the prevailing rock †.

* *Playfair*, 310.

† *Illuſtrations*, p. 346.

It is remarkable that in the mountainous regions of Peru, eſpecially in the environs of the volcanoes, no granite is found, except in very low ſituations, at the bottom of valleys ‡.

‡ *Annal. de Muſ. Nat.* tom. iii. 399.

22 Decay of granite.

Several varieties of granite are ſubject to decay, from the decompoſition of the feldſpar which they contain. This circumſtance will probably explain a curious fact. It is found that the granite exiſting in the interior of mountains is much ſofter than that near the ſurface, probably from the decay of the feldſpar in the latter, while it remains in its original ſtate in the former (B).

Granite

(B) The decompoſition of granite appears to go through ſeveral ſtages, from the ſolid rock to the looſe ſand. Theſe

Arrangement, &c. of the Materials of the Earth.

23 Metals found in granite.

Granite is by no means abundant in metallic and the richer mineral ſubſtances; it, however, contains a conſiderable variety, ſome of which have as yet been found in no other ſubſtance, eſpecially molybdena. Iron ores are very commonly found in granite, eſpecially the compact brown iron ſtone. It ſeems to be owing to the preſence of iron that granite aſſumes that fine reddiſh colour with which we ſometimes ſee it tinged. One of the moſt remarkable inſtances of this kind is afforded by the rocks to the ſouth-eaſt of the valley of Chamouni, at the foot of the Alps. Theſe rocks, from their red appearance, are called *Les Aiguilles Rouges*, or the red needles. Theſe rocks were mentioned by Sauſſure, but he had not aſcertained their compoſition. This has ſince been done by M. Berger, who found them to be compoſed of granite, with a conſiderable quantity of oxide of iron *. Biſmuth, cobalt, blende, galena (an ore of lead), and ſeveral ores of copper, are alſo ſometimes met with; but the metal moſt frequently found in granite is tin, eſpecially in the great mining field in Cornwall.

* *Jour. de Phyſ.* tom. lvii. p. 277.

Sect. II. *Gneiſs.*

24 Gneiſs deſcribed.

Gneiss, by ſome writers called *kneiſs*, is not unfrequently confounded with granite, from which it differs rather in the arrangement than in the nature of its component parts. Theſe in gneiſs are arranged in a ſchiſtoſe or ſlaty form, whereas in granite, they are in diſtinct grains or cryſtals, the layers being generally in the direction of the mica. It ſometimes is intimately incorporated with maſſes of granite, but, in moſt inſtances, it repoſes on the granite, being generally the ſecond layer. In deſcending into the valley of Chamouni, Sauſſure obſerved a fine bed of true granite incorporated with a rock of gneiſs, which was arranged in very fine leaves †. Sometimes the gneiſs lies entirely below the granite; but this is uncommon. More generally there is found a vertical maſs of granite, with ſtrata of gneiſs on each ſide of it. Very frequently granite and gneiſs alternate with each other.

† *Voyage aux Alpes*, p. 676.

25 Where found.

Sometimes whole mountains are compoſed of gneiſs. Thus, Ben Lomond ſcarcely contains any other ſubſtance, and the Schaw, which is the moſt northern point of the northernmoſt of the Shetland iſlands, is entirely gneiſs. Mountains of this kind are, in general, neither ſo high nor ſo ſteep as thoſe of granite, though Mount Roſa in Italy, and a few others, muſt be excepted. The ſummits of theſe mountains are alſo generally more rounded than thoſe of granite mountains. The baſes of all the Shetland iſlands ſeem chiefly compoſed of gneiſs, and the middle part of the Pyrenees is almoſt wholly formed of this and granite.

It is curious that where gneiſs is contiguous to granite, its quartz and feldſpar are more apparent, and the mica leſs ſo; while, where it is more diſtant from granite, the contrary happens ‡.

26 Metals found in gneiſs.

Several metallic ores are found in gneiſs, particularly thoſe of iron, as the magnetic iron ſtone, and martial pyrites; lead ores, tin ores, blende, cobalt, copper, and arſenical pyrites, and not unfrequently ſilver ores.

‡ *Kirwan's Eſſays*, p. 175.

Sect. III. *Micaceous Schiſtus.*

27 Micaceous ſchiſtus.

This is otherwiſe called *ſchiſtoſe mica*, and *mica ſlate*. It is alſo compoſed of the ſame materials with granite and gneiſs, except that it contains little or no feldſpar; the quartz and mica being arranged in layers as in gneiſs.

This ſubſtance alſo is very abundant in moſt rocks and mountains. It generally compoſes the third layer or ſtratum, being immediately above or without the gneiſs. It not uncommonly appears to be the only ſubſtance compoſing the hill or mountain, from the gneiſs and granite being probably ſo completely covered as to be out of ſight.

28 Where found.

Micaceous ſchiſtus compoſes the rocks that are found immediately to the north of Dunkeld in Scotland, and it is here penetrated in every direction by veins of quartz. The ſouthern ſhores of Loch Tay, the mountains of Glen Lochy, the vale of Tumel between Loch Tumel and Loch Rannoch, contain much of the ſame ſubſtance; and the lower part of Glen Tilt is chiefly compoſed of it. In the weſtern Highlands towards Ben Lomond, micaceous ſchiſtus alſo abounds, and ſome of it is found in the north of Argyleſhire. The Shetland iſlands are moſtly compoſed of micaceous ſchiſtus, in thick layers above the gneiſs, with a few maſſes of granite interſperſed.

It not unfrequently happens that a bed of micaceous ſchiſtus is interſected by veins of granite. Mr Jameſon obſerved an example of this in Glen Drummond in Badenoch, of which he has given a plate. The veins are very large, and run acroſs the ſtrata of ſchiſtus in a direction nearly parallel to each other *.

* *Min. of the Iſles.* vol. ii. p. 173.

29 Metals in it.

The metallic ores found in micaceous ſchiſtus, are chiefly thoſe of iron, copper, tin, lead, cobalt, and antimony.

Sect. IV. *Quartz.*

30 Quartz.

Quartz is not unfrequently found diſtinct from feldſpar and mica, and ſometimes whole mountains are found compoſed of it. In particular, the mountain of Kultuc, at the ſouth-eaſt end of the lake of Baikal, among the Altaiſchian mountains, which is 4800 feet long, 350 high, and above 4000 broad, conſiſts entirely of milk-white quartz; and the mountain of Flinzberg

Theſe are thus marked by Mr Jameſon. In its beginning diſintegration it ſplits into maſſes, having a greater or leſs tendency to the quadrangular form; but theſe maſſes have ſtill a degree of connexion amongſt themſelves, as is the caſe upon the mountain top. The next ſtep is the enlargement of the fiſſures, by which the maſſes are looſened from their connexion, and tumble down from their elevated ſituations, upon the ſummits of the neighbouring mountains, or are hurried with impetuous velocity down the mountain ſide, covering the bottom of the glens with their ſtupendous ruins. Laſtly, Theſe detached maſſes, by the action of the weather, are completely diſintegrated, forming a looſe ſand, which is left upon the tops or ſides of the mountains, or is carried in great quantities to the ſea ſhore by the torrents. *Jameſon's Mineralogy of the Scottiſh Iſles*, vol. i. p. 82.

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berg in Luſace, is almoſt wholly compoſed of it. There is alſo an extenſive ridge of quartz, ſome miles long, in Bavaria, and Monnet mentions a rock of it 60 feet high. Mountains of it are alſo found in Thuringia, Sileſia, and Saxony. It ſometimes forms layers between gneiſs and micaceous ſchiſtus. A conſiderable ſtratum of this kind, conſiſting of granular quartz, is found between granite and micaceous ſchiſtus in the iſland of Iſlay, ſee fig. 4. *b*. It is often found forming ſpires on the tops of mountains, and appearing like ſnow.

Quartz is found in ſeveral parts of Britain; but there is very little of it in the ſouthern part of the iſland. Williams found it very common in the Highlands of Scotland, where he has ſeen it regularly ſtratified, with other regular ſtrata immediately above and below it; and ſometimes compoſing high mountains entirely of its own ſtrata. Theſe ſtrata are ſometimes moderately ſolid; but often are naturally broken into ſmall irregular maſſes, with ſharp angles, and of a uniformly fine granulated texture, reſembling the fineſt loaf ſugar.

There are large and high mountains of this ſtone in the ſhires of Roſs and Inverneſs; and in a clear day theſe appear at a diſtance as white as ſnow, being quite bare of vegetation, except a little dry heath around the baſe of the hill †.

† *Williams' Mineral Kingdom*, vol. ii. p. 52.

The mountain of Swetlaia Gera, one of the Uralian chain, conſiſts of round grains of quartz, white and tranſparent, and of the ſize of a pea, united without any cement.

31 No metals in quartz.

No metals are found in quartz, though it ſometimes contains petroleum.

SECT. V. *Argillaceous Schiſtus.*

32 Argillaceous ſchiſtus deſcribed.

THIS ſtone, which is otherwiſe called *clay ſlate*, is the *thonchieffer* of Werner, and the *argillite* of Kirwan. It is of the ſame nature with gneiſs and micaceous ſchiſtus; but in this the ſtratification is ſtill more complete, and all traces of cryſtallized granite entirely diſappear. Doubts have ariſen whether this ſtone is primitive; but theſe are now cleared up, as it is frequently found alternating with gneiſs and micaceous ſchiſtus, eſpecially in Saxony, and with other primitive ſtrata. It ſometimes happens, too, that both gneiſs and granite reſt upon it.

There are two varieties of this ſtone, one hard, and the other ſoft; but the hard often graduates into the ſofter.

33 Where found.

Sometimes this ſtone is found forming whole mountains; but more commonly it enters into them only partially. In ſome, however, there are entire ſtrata of it, as at Zillerthal, in the Tyrol. The famous mountains of Potoſi conſiſt entirely of argillaceous ſchiſtus, and Sauſſure found it on the ſummit of Mont Blanc.

In Britain it is not very common; but is ſometimes found on the higher parts of mountains. Thus it forms the ſummit of Skiddaw in Cumberland.

Argillaceous ſchiſtus, eſpecially the ſofter variety, is remarkably rich in metals. We have ſaid that it forms the greater part of Potoſi, one of the richeſt ſilver mines. The ores of copper and lead, ſulphur, pyrites, blende, and calamine, are alſo found in it. The great belly of copper ore in the Parrys mountain in Angleſea, is found below this ſubſtance. It alſo ſometimes contains antimonial and mercurial ores. 34 Metals found in it.

SECT. VI. *Jaſper.*

IT was ſuppoſed, by the earlier mineralogiſts of the laſt century, that jaſper was only pure quartz, ſo much penetrated by a colouring metallic oxide as entirely to deprive it of its tranſparency; but Sauſſure and Dolomieu, with their uſual accuracy, diſcovered that it conſiſts of flint, and not of pure quartz, having in combination a quantity of argillaceous matter, more or leſs mixed with oxide of iron. 35 Jaſper deſcribed.

Primitive jaſper is always opaque. It is commonly found imbedded in other ſtony matters. In colour it varies from red to green, and frequently conſiſts of alternate ſtripes of red and green, ſometimes perfectly diſtinct, at others running together. There is a beautiful variety figured by Patrin, in which a dark-red ground is croſſed in every direction with curved white lines, leaving here and there circular ſpaces of red ſurrounded with white, forming eyes.

Striped jaſper is ſometimes ſo abundant, as to be the chief material of ſome mountains, in which it is mixed with broken fragments of granite and other primary compounds (c). Mountains of red and green jaſper alſo occur. Generally, however, it appears in ſtrata, interpoſed between layers of micaceous ſchiſtus, or alternating, and ſometimes mixed with compact red iron ſtone. It is found in the ſouth of France, repoſing on granite; and in the Altaiſchan mountains, it ſometimes lies below argillaceous ſchiſtus, but has there never been found in contact with granite. A coarſe kind of jaſper is ſometimes found in the hills near Edinburgh; and ſome fine ſpecimens are met with in the northern mountains. 36 Where found.

SECT. VII. *Hornſtone.*

THIS ſtone is conſidered by Dr Kirwan as the ſame with *petroſilex*, but Patrin and ſome others diſtinguiſh them. 37 Hornſtone deſcribed.

(c) There is often found interpoſed between the ſtrata of rocks, or ſometimes above the upper ſtratum, a bed of fragments that have been broken off from the principal ſtrata. When theſe fragments chiefly conſiſt of limeſtone and calcareous compounds, whether they be of an angular form, or conſiſt of rounded pebbles, they are generally called by the name of *breccia;* but when the fragments are of a ſiliceous or quartzy nature, eſpecially if they are agglutinated together, ſo as to form a ſolid maſs, they have uſually been called *puddingſtone*. From the uncertain manner in which theſe terms were employed, much confuſion aroſe, till Romé de l'Iſle, and other later naturaliſts, have given the name of breccia to every ſtony maſs that is compoſed of angular fragments, of whatever nature they be; and they call by the name of puddingſtone every agglutinated maſs that is compoſed of round pebbles, whether they be calcareous, quartzoſe, or of any other nature. Theſe compounds will be ſpoken of preſently in a ſeparate ſection.

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them. According to Patrin, hornſtone is a compound primitive rock, compoſed of the ſame elements with granite, in which ſchorl is very abundant, communicating to the ſtone a dull, gray, or ſometimes blackiſh, colour, and containing a pretty large quantity of the argillaceous matter of mica. Petroſilex, according to him, is purer than hornſtone, and commonly of a grayiſh or greeniſh colour, ſemitranſparent, and very hard, ſo as to give fire with ſteel. They are often found united, and ſometimes form entire mountains, containing fragments of feldſpar interſperſed. They are commonly found in large thick maſſes or blocks, though they are ſometimes ſtratified like the ſchiſtoſe ſtones. Dolomieu is miſtaken, when he aſſerts that petroſilex is only found in primitive mountains, as it will appear hereafter, that it is ſometimes a ſecondary compound. At Tuhumas, in the iſle of Rona, Mr Jameſon found a maſs of rock chiefly compoſed of hornſtone and quartz, from 12 to 15 feet wide, and of conſiderable length, lying between two beds of gneiſs.

Sect. VIII. *Pitchſtone.*

38 Pitchſtone deſcribed.

THE Germans have given the name of *pitchſtone*, or *pechſtein*, to a ſtony matter, which is found in large maſſes of an irregular form, and of different colours, as yellow, brown, red, green, &c. having ſometimes the appearance of roſin, and ſometimes that of an enamel, or of glaſs imperfectly tranſparent. It is never cryſtallized.

39 Where found.

It is found, either in large maſſes, or in veins. At Miſnia, it is found forming entire mountains; and in other countries there are mountains containing ſtrata of pitchſtone, ſometimes alternating with granite, at others with porphyry. Mr Jameſon deſcribes a large vein of it of a green colour, ſeveral feet wide, traverſing a maſs of red argillaceous ſandſtone, at Tormore in the iſle of Arran. This vein is extremely curious, and contains ſtratulæ of different ſubſtances depoſited in the ſame fiſſure *. Another curious vein of pitchſtone is deſcribed by him as traverſing a baſaltic rock, together with a vein of hornſtone, in the iſland of Eigg †. Mr Jameſon conſiders this as the firſt example of pitchſtone traverſing baſalt, diſcovered in Europe, though ſimilar appearances have been found on the top of the peak of Teneriffe.

* *Jameſon's Mineral. of the Iſles*, vol. i. p. 102.

† *Id.* vol. ii. p. 44.

Pitch ſtone is only conſidered as a primitive rock, when it is nearly allied to porphyry.

Sect. IX. *Hornblende, and Hornblende Slate.*

40 Hornblende ſlate.

HORNBLENDE is ſometimes found exiſting ſeparately from the compounds in which it uſually occurs, as is the caſe in Siberia, where there are mountains of black horn blende. It is often found mixed with quartz, mica, feldſpar, or ſchorl, of a greeniſh or black colour. More commonly, however, it occurs in immenſe ſtrata, ſometimes in layers of gneiſs, argillaceous ſchiſtus, or primitive limeſtone. A ſtratum of it above primitive limeſtone has been found at Miltiz. It is ſometimes ſeen below granite, or granite is even found imbedded in it. A rock of hornblende, repoſing on granite, has been ſeen by Mr Jameſon in the iſle of Arran; and on the ſide of Loch Fine he found it alternating with ſtrata of micaceous ſchiſtus ‡.

‡ *Min. of Iſles*, vol. i. p. 74—144.

41 Metals found in it.

The principal metallic ſubſtances found in hornblende ſlate, are native ſulphuret of iron and copper ore.

Sect. X. *Serpentine.*

42 Serpentine deſcribed.

SERPENTINE is a ſtone of a ſimilar nature with reſpect to its ingredients with thoſe we have been deſcribing. It takes its name from its appearance, being generally of a greeniſh ground, marked with white, yellow, brown, or reddiſh ſpots, ſo as to bear ſome reſemblance to the ſkin of a ſnake. Its green colour is owing to a quantity of ſlightly oxidated iron which it contains. It is uſually opaque; but ſometimes parts of it are ſemitranſparent, and though not very hard, is capable of receiving a good poliſh.

43 Where found.

Serpentine is by no means uncommon, and is often found in layers alternating with primitive limeſtone, or below gneiſs. The hill of Zobtenbeg in Lower Sileſia, conſiſts almoſt entirely of ſerpentine, diſpoſed in nearly vertical ſtrata, with a little hornblende interſperſed. Whole mountains of green ſerpentine are alſo found in Siberia, and near Genoa, where it is called *gabbro* or *pulverezza*. It is alſo found near the White ſea, and the mountain of Regelberg in Germany is chiefly compoſed of it. Rocks of it are found near the Lizard Point, on the coaſt of Cornwall; and hills of it occur in ſome of the Shetland iſlands.

Metals are ſeldom found in ſerpentine, except a magnetic ore of iron, which not unfrequently forms a part of the ſerpentine rocks, imparting to them its magnetic power. Veins of copper ſometimes traverſe it.

Sect. XI. *Porphyry.*

44 Porphyry deſcribed.

PORPHYRY generally conſiſts of the ſame materials as granite, but in different proportions, and having altogether a different appearance; for inſtead of being cryſtallized as in granite, we find in the true porphyries an uniform compact maſs, in which are diſſeminated ſmall cryſtals of feldſpar, and ſometimes of ſchorl. There are, however, many varieties forming ſhades between granite and true porphyry, ſeveral of which are deſcribed by mineralogiſts.

45 Where found.

Porphyry is very abundant in many ſituations, forming a conſiderable part of hills, and even mountains. It ſometimes alternates with gneiſs, and has been found below it. Gneiſs has alſo been found in the midſt of porphyry. It ſometimes occurs in the midſt of micaceous ſchiſtus, and ſometimes forms an external covering to other primitive ſtrata. Whole mountains of porphyry, arranged in immenſe ſtrata, ſometimes repoſe on a baſe of granite or gneiſs. This ſtone is found in the greateſt abundance in ſeveral places between the tropics, eſpecially in South America, where it is ſometimes met with at immenſe heights *.

* *Ann. de Muſ. Nat.* vol. iii. p. 400.

Porphyry is very common in moſt parts of Scotland, and, in particular, forms a conſiderable ſtratum at the top of the Calton hill at Edinburgh, being in ſome places 12 or 15 yards thick, covering a bed of breccia.

Porphyry is found in conſiderable quantity between Newcaſtle and Wooler, and blocks of it of conſiderable ſize may be every where ſeen ſcattered about in the fields. The feldſpar of theſe porphyries being leſs durable than the reſt of the ſtone, is partly deſtroyed in ſome

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ſome blocks, and appears corroded in others; from which circumſtance the porphyries are ſo porous, as to appear as if they had been burnt. Porphyries of a ſimilar appearance are found in the mountain of Eſterele in Provence, on the road from Frejus to Antibes *.

There is a variety of porphyry mentioned by Charpentier, a great part of whoſe compoſition is indurated clay, and nodules of clay of different colours are found in its ſubſtance. Specimens of a ſimilar nature occur in the weſtern iſlands of Scotland. There is alſo a ſpecies of porphyry nearly allied to hornſtone.

* Saint-fond's Travels, vol. i. p. 164.

46 Metals found in it. The two varieties laſt mentioned are rich in metallic ores; in the former there being formed ores of ſilver, copper, iron, lead, and antimony; and, in the latter, ſparry iron ore, native ſulphuret of iron, galena, black blende, and ores of biſmuth.

47 Schiſtoſe porphyry. A ſtone of a porphyritic nature is deſcribed by Werner under the name of *ſchiſtoſe porphyry*, and is conſidered by Kirwan as the ſame with the horn ſlate of Charpentier. It is found among the primitive rocks of Altai, and on the borders of the lake of Baikal, in which latter place it is mixed with granite and hornblende. It is alſo found in Siberia, and in Bohemia. Sauſſure found it near Pſaffenſprung, intercepted between ſtrata of gneiſs.

48 Puddingſtone and breccia.

Sect. XII. *Puddingstone and Breccia.*

49 Examples of breccia. The diſtinction between theſe two ſtony matters was mentioned in note c: they are both ſufficiently common, conſiſting of different materials. The breccia uſually lies in bodies, almoſt at the top of the other primitive ſtrata, with ſome of which it ſometimes alternates. Stratified breccias, conſiſting of fragments of flints and jaſper, cemented by hardened clay, are frequently found in Siberia, and ſometimes alternate ſtrata of breccia, porphyry, jaſper, and other primary compounds, compoſe a conſiderable part of mountains. Some mountains in the north of Scotland contain maſſes of breccia, compoſed of fragments of red granite, micaceous ſchiſtus, and quartz, in a baſe of ſandſtone. Mount Scuraben contains ſtrata of this kind, ſurmounted by a rock of white quartz. Similiar appearances take place at Cromarty, at Murray frith, and two or three miles to the ſouth of Aberdeen; but in many of theſe inſtances the breccia muſt be conſidered as ſecondary. Much of the northern coaſt of Scotland abounds with breccia.

50 Of puddingſtone. Puddingſtone is alſo extremely common. A mountain of it is found in Siberia, near the rivulet of Tulat, being compoſed of fragments of jaſper, chalcedony, aigue marine, and cornelian, cemented by a quartzoſe matter. Immenſe heaps, and even a mountain of puddingſtone, are found at Meiſenheim, in the palatinate. Puddingſtone is found in conſiderable abundance in paſſing from Loch Neſs to Oban, in Scotland, and between Inverneſs and Dunolla. Large detached rocks of puddingſtone were ſeen by Pallas in the village of Temirdſki, in the Crimea. Some of theſe maſſes are ſeven or eight fathoms long, lying one above another *.

* Pallas's Trav. in Crimea, vol. ii. p. 197.

Sect. XIII. *Sienite.*

51 Sienite. This name has been introduced by Werner, to denote a primary rock, eſſentially compoſed of grains of feldſpar and hornblende, intimately blended together, in which the hornblende is generally moſt predominent. He firſt called it *greenſtone*, but afterwards gave it the name of *ſienite*, as he ſuppoſed it ſimilar to a ſtone deſcribed by Pliny, as found at Syene in Upper Egypt, where it was dug in great quantities, and from thence carried to Rome, for the purpoſe of building public edifices.

Sienite ſometimes contains a few grains of quartz and mica; but theſe ſeem to be accidental, and are always in very ſmall quantity. This ſtone is not commonly ſtratified.

Sienite uſually overlays moſt of the other primary rocks, and has often a bed of breccia interpoſed between it and the inferior ſtrata. It is very commonly found repoſing on porphyry.

It is found in Saxony, in the environs of Dreſden; at Meiſſen in Thuringia; in Hungary, and in general in almoſt all primitive chains of mountains, eſpecially in the Alps. It is doubtleſs the ſame which Sauſſure found in the ſummit of Mont Blanc, and which he calls *granitelle*. 52 Where found.

Metallic veins are not unfrequently found in ſienite. At Scharffenberg, veins of ſilver and lead are found in it; and it is ſaid, that the veins of ſtrontian in Argyleſhire run in a ſimilar rock. 53 Metals in it.

Sect. XIV. *Primitive or Granular Limeſtone.*

It was long doubted whether limeſtone was ever to be found unmixed with organic remains, or primitive; but the obſervations of late mineralogiſts and geologiſts have fully proved, that primitive limeſtone exiſts in conſiderable quantity. This ſtone is of a granular ſtructure, and of a whitiſh gray colour, though frequently of a dark iron gray, or reddiſh brown. It is ſometimes ſcaly or lamellar; at others nearly compact, and is now and then found to have a ſplintery fracture. It is generally unmixed with other primary compounds; but ſometimes particles of mica, quartz, hornblende, &c. occur in it. 54 Primitive limeſtone.

This ſtone is always found alternating with the primary ſtrata, eſpecially with gneiſs, micaceous, and argillaceous ſchiſtus. It ſometimes forms whole mountains, as in Stiria, Carinthia, and Carniola, in Switzerland and in the Pyrenees, being often found ſeven or eight thouſand feet high. Three mountains in Switzerland, all exceeding 10,000 feet in height, are chiefly compoſed of it In theſe ſituations it commonly forms immenſe blocks, without any regular dip or direction; but it is ſometimes ſtratified, as at Altenberg near the lake of Neuenberg. It is ſometimes interpoſed between ſienite and hornblende ſlate. One of the moſt ſingular mountains of granular limeſtone is that of Filabres in Spain, conſiſting of a block of white marble three miles in circumference, and 2000 feet high, without any mixture of other earths or ſtones, and with ſcarcely any fiſſure. 55 Where found.

A conſiderable part of Mont Perdu in the Pyrenees is compoſed of alternate vertical bands of granite, porphyry, limeſtone, hornblende, and petroſilex.

Granular limeſtone is found in various parts of Britain, eſpecially in the north of Scotland. One of the moſt remarkable examples of it occurs in the iſland of

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Islay; the central part of which is formed of a compact bed of it of considerable extent. See fig. 4. *d*. It also occurs in some other of the Western isles.

56 Metals in it.

Primitive limestone often contains veins of metallic ore, especially those of galena, magnetic iron ore, blende, and pyrites.

SECT. XV. *Primitive Trap*.

57 Primitive trap described.

TRAP is a name that was long ago given by the Swedish mineralogists, to distinguish certain stones that are of a compact texture, and a dark colour, composing part of several mountains. The word originally signifies a staircase, and was given to mountains containing this stone, because their strata retire one behind the other like the steps of a staircase. But as many rocks of a very different kind, both in their nature and formation, have received the common name of *trap*, considerable confusion arose among mineralogists, with respect to what particular stones should receive this appellation. Most of the French mineralogists, as Saussure, Dolomieu and Saintfond make trap to signify a primitive rock, but they do not always mean the same rock. Other mineralogists, especially the Germans, understand by the name of trap, certain secondary rocks, and especially what are commonly called *basalts*.

Werner comprehends under the name of trap, several series of rocks, which are principally characterised by their containing hornblende, which is found almost pure in those which he considers as the most ancient, or what generally lie the lowest; and it degenerates gradually in the succeeding strata into a kind of blackish, ferruginous, hardened clay. He distinguishes three series or formations of traps; primitive traps, transition or intermediate traps, and stratiform or floetz traps. We shall here consider the first of these.

Primitive trap is almost wholly composed of horn blende, though it is sometimes mixed with feldspar, or more rarely with mica and some other substances. Under this general description Werner comprehends four stony substances; hornblende and hornblende slate, which we have already noticed in Section IX. primitive greenstone, and schistose greenstone.

Primitive greenstone is a mixture of hornblende and feldspar; under this there are several varieties, according as its texture is more or less granular, or compact. 1. Common greenstone, in which the hornblende and feldspar are intimately blended, is granular, and bears considerable resemblance to sienite, in which the hornblende is predominant. 2. A second variety has smaller grains, in which are imbedded crystals of feldspar, being of a structure between the granular and porphyritic. 3. A third variety has the grains of hornblende and feldspar extremely small, so as to be scarcely distinguishable. This stone loses its granular appearance, and becomes entirely porphyritic. 4. Lastly, when the mass becomes quite homogeneous, and of a complete green colour, it forms what was once called *green porphyry*, and constitutes the fourth variety *.

* *Brochant. Mineral.* tom. ii. p. 582.

Schistose greenstone is composed of compact feldspar, hornblende, and a little mica, of which the hornblende and feldspar are nearly in equal quantity, and it now and then contains a little quartz. Its structure is schistose.

We have been thus particular in describing what Werner understands by primitive trap, as whatever may be thought of his theoretical opinions, his talent for mineralogical distinctions and characters cannot be called in question.

Dr Kirwan has given a long section on the distinguishing characters of trap, and its relation to basalt, &c. in his Geological Essays. He thinks that there might be formed a natural series of stones of a trap nature, taking in not only the composition but also the texture, grain, and specific gravity, as something of this kind has been conceived and done by Werner.

Primitive trap is often found in vast strata in the midst of gneiss, and veins of it running through gneiss, have been found in Knobsdorf in Silesia, and in Bohemia. It is also sometimes found in granite, and it is found passing through granite and micaceous schistus in the Western isles of Scotland. Saintfond found it alternating with granite, near St Malo; and Charpentier, with gneiss. It sometimes forms entire mountains, as in the territory of Deux Ponts; and in Norway it is found reposing on granite. It sometimes alternates with argillaceous schistus, as at Leidenburgh. 58 Where found.

Primitive trap frequently contains metals, especially the ores of iron and copper. 59 Metals found in it.

SECT. XVI. *Topaz Rock*.

THIS stone is composed of quartz, schorl, topaz, and lithomarga (a kind of hardened clay), the three former substances constituting small layers or plates alternating with each other. It sometimes contains cavities or geods, lined on the inside with crystals of quartz and topazes. The texture of this stone is between the schistose and the granular; that is, it is composed of plates or laminæ; but these laminæ are of a granular structure. 60 Topaz rock.

Topaz rock is very rare. It forms part of a mountain near Averbach, in the metallic mountains of Saxony; but no metallic matter has hitherto been discovered in it.

SECT. XVII. *Siliceous Schistus*.

SILICEOUS schistus, or flinty slate, is the kieselschiefer of Werner; but there seems some dispute between his disciples, whether it be a primitive or a secondary rock; on which account we have placed it last in the former series. Brochant does the same; but Mr Jameson, in his sketch of the Wernerian geognosy, places it among the transition formations, or those which immediately succeed the primitive. It is thus described by Mr Jameson. Its colour is bluish gray; it is internally dull; its fracture in the great is imperfectly slaty; in the small, large splintery, passing into flat conchoidal; its fragments are indeterminately angular, and pretty sharp edged; it is strongly translucent on the edges; it is hard and brittle, difficultly frangible, and not particularly heavy *. 61 Siliceous schistus described.

* *Jameson's Min. of Dumfries*, p. 48.

An entire mountain formed of this stone is found in Lusatia, in which there are no petrifactions. It is also found in the Alps, interposed between gneiss and hornstone. Schlendgenberg, a mountain in Saxony, is for the most part composed of it, mixed with hornblende and feldspar. Kirwan considers it as the same substance 62 Where found.

ſtance which Sauſſure calls *palaiopetre*, which is commonly conſidered as petroſilex.

Flinty ſlate is deſcribed by Mr Jameſon as among the mineral ſubſtances found in Dumfriesſhire. He particularly notices an immenſe rocky maſs of it at the entrance of the valley at Leadhills, by which the metallic veins are completely interrupted *.

No metals have been found in it.

* *Mineralogy of Dumfries*, p. 64.

B. Secondary Compounds.

63 Secondary compounds.

The ſubſtances which we are now to notice are diſtinguiſhed from thoſe which we have been deſcribing, in containing more or leſs the remains of organized beings. As the inferior ſtrata of theſe ſecondary compounds uſually contain fewer organic remains than thoſe above them, they are ſometimes ſubdivided into two orders, one of which is conſidered to be intermediate between the primary and ſecondary ſtrata. This is Werner's claſſification, of which we ſhall give an account in the next chapter.

Sect. XVIII. *Secondary Limeſtone.*

64 Secondary limeſtone deſcribed.

Under this title we ſhall comprehend what Werner calls tranſition limeſtone, floetz limeſtone, and limeſtone. Secondary limeſtone is a calcareous maſs, ſometimes granular, and ſometimes compact, the former approaching to primitive limeſtone. Its fracture is ſcaly, and it is ſometimes ſemitranſparent. In colour it is very various, ſometimes red, or rather blackiſh, with white veins, conſiſting of calcareous ſpar. It is often of a grayiſh caſt. It ſometimes forms vaſt blocks, without any appearance of ſtratification; at other times it is evidently ſtratified. It abounds with remains of marine animals, and often contains nodules of agate, and other ſimilar ſtones.

A variety of calcareous ſtone is deſcribed by mineralogiſts under the name of ſwineſtone. It is either compact, ſlaty, or porous, and is ſaid in general to contain no petrifactions, though ſome found in the mountain of Kinneculla contains many. It is conſidered by Kirwan as primeval limeſtone, impregnated with petroleum.

Limeſtone is ſometimes found in oviform balls, commonly containing a grain of ſand in them.

There is a variety of limeſtone that is very porous, and abounds in remains of vegetable matter, as impreſſions of leaves, &c.

65 Where found.

Secondary limeſtone is very abundant in moſt parts of the world, forming a conſiderable part of many mountains, and being often the principal ſtratum to a conſiderable depth below the ſurface. The mountain Iberg, in the Hartz, is compoſed of vaſt maſſes of it, irregularly rifted; and mountains of a ſimilar kind are found in Siberia and in the Vivarais. In ſome of thoſe mountains vaſt caverns have been formed. Secondary limeſtone mountains always repoſe on ſome primitive ſtone; thus, in Siberia their baſe conſiſts of granite, porphyry or hornblende; in Saxony, of granite, or granular limeſtone, and ſometimes of argillaceous ſchiſtus; in Switzerland, theſe mountains repoſe on argillaceous ſchiſtus or gneiſs, or ſometimes on calcareous puddingſtone. In the Crimea, there is an immenſe extent of ſecondary limeſtone, between Roſlof and Perekop, which is minutely deſcribed by Pallas. Great part of the ſummit of Mont Perdu, the higheſt of the Pyrenees, is compoſed of ſecondary limeſtone, arranged in nearly vertical ſtrata, and ſo full of the remains of marine animals as in ſome places to appear as if compoſed of nothing elſe. Here it ſeems to repoſe on granular limeſtone.

The baſe of Mount Ingleborough in Weſtmoreland, which is near 30 miles in circuit, conſiſts entirely of limeſtone, containing vaſt quantities of ſea ſhells. This ſtone alſo forms the principal inferior ſtrata through the greater part of Derbyſhire, being arranged in beds of various degrees of thickneſs, from a few inches to about 200 fathoms in ſome places, not having been perforated; and abounding with ſhells, and other marine remains.

It is found in many quarries in Scotland diſtinctly ſtratified. Mr Jameſon notices quarries of limeſtone at Cloſeburn, and Barjarg, and at Kellhead in Dumfriesſhire.

66 Metals found in it.

Secondary limeſtone often contains metallic veins, eſpecially in Derbyſhire, where it abounds with galena, blende, ſulphur pyrites, and copper pyrites. Sulphur is alſo ſometimes found in it. Kirwan remarks, that in the reſt of Europe limeſtone is ſeldom metalliferous.

67 Alabaſter.

The ſtone commonly called *alabaſter*, employed in making ſtatues and ornaments, is properly a carbonated lime, nearly allied to marble; though it is uſually ſuppoſed to be a variety of gypſum or plaſter ſtone. There is a gypſeous alabaſter that will be noticed preſently.

Calcareous alabaſter is not often white (though *as white as alabaſter* is a common proverb), but generally tinctured with iron of a yellow, brown, or reddiſh caſt. It is ſemipellucid, and uſually ſo ſoft as to be ſcratched by the nail.

It is commonly found in blocks, in marble quarries, as in the iſland of Paros, and in ſeveral parts of Italy, particularly in the territory of Volterra in Tuſcany, in Malta, &c. A variety is found in the form of ſtalactites of a conical or cylindrical form.

Sect. XIX. *Gray Wacke.*

68 Gray wacke deſcribed.

Gray wacke is a ſtone compoſed of fragments of quartz and argillaceous ſchiſtus, cemented by an argillaceous matter ſimilar to the ſchiſtus, varying in ſize, from that of a hen's egg, till they are ſo minute as to be no longer viſible. It ſometimes contains a matter ſimilar to ſiliceous ſchiſtus.

There is a variety of this ſtone, called by Werner gray wacke ſlate, which is a ſimple ſlaty ſtone, which bears a conſiderable reſemblance to argillaceous ſchiſtus. From this, however, it is to be diſtinguiſhed, according to Mr Jameſon, by the following characters.

" It has ſeldom a greeniſh or light yellowiſh gray colour, as is the caſe with primitive ſlate, but is uſually aſh and ſmoke gray. It does not ſhew the ſilvery continuous luſtre of primitive clay ſlate, but is rather glimmering, which originates from intermixed ſcales of mica. Quartz ſcarcely occurs in it in layers, but uſually traverſes it in the form of veins. Further we do not find cryſtals of feldſpar, ſchorl, talc, chlorite ſlate, or magnetic iron ſtone are to be obſerved in it. It contains petrifactions, particularly thoſe varieties that border on gray wacke. It alternates with gray wacke *."

Theſe ſtones are diſtinctly ſtratified, but the direction of

* *Mineralogy of Dumfries.*

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of their ſtrata is not parallel to that of the other rocks on which they lie. They are very commonly found covering limeſtone, eſpecially at the foot of mountains.

69 Where found.

Gray wacke is found in Erzgebirge, at Braunſdorf, Rieſberg, and Averbach, in Voegtland, in Tranſylvania, on the banks of the Rhine, in Lahnthal, and ſome other places in Germany. It is alſo found in Britain; and Mr Jameſon notices it among the minerals of Dumfriesſhire, where the gray wacke ſlate is found near Moffat, in the vicinity of Langholm, in the higher parts of the valley of Eſk, and behind Burnſwark. The ſtrata found in theſe places yield a very good ſlate, nearly free from mechanical mixture, and well adapted to the roofing of houſes.

70 Metals found in it.

This ſpecies of ſtone is rich in metals; the greater part of the veins of lead and ſilver in the Hartz, eſpecially thoſe of Clauſthal and Zellerfeld, are in gray wacke. In Tranſylvania, in Voreſpath, it contains even rich mines of gold. The gray wacke ſtrata on the banks of the Rhine are alſo traverſed by ſome metallic veins, but thoſe of Saxony contain nothing but blind coal.

Sect. XX. *Secondary Trap.*

71 Secondary trap.

Several varieties of trap occur among the ſecondary ſtrata, and muſt be here enumerated. They all conſiſt principally of greenſtone, or that mixture of hornblende and feldſpar, which conſtitutes the primitive traps, noticed in Section XV. but in the traps we are now to mention, the mixture is much more intimate, the grains conſiderably finer, and the maſs appears homogeneous. We ſhall here notice only three principal varieties; the amygdaloid or toadſtone, the globular trap, and the greenſtone, called by the Wernerians tranſition greenſtone.

72 Amygdaloid or toadſtone.

1. The amygdaloid, called in Derſbyſhire toadſtone, and ſometimes *cat dirt*, appears to conſiſt of hornblende ſlate in a ſtate of decompoſition, and appears very ſimilar to a kind of wacke, of a very fine grain. It is of a blackiſh colour, and very hard, and often contains a number of bladder holes, which are ſometimes entirely empty, at others are partially or wholly filled with ſpar.

It runs in immenſe ſolid beds, without any appearance of ſtratification or fiſſure, of unequal thickneſs, having been ſeen from 6 feet to 600 thick. It commonly alternates with the ſtrata of ſecondary limeſtone, as in Derbyſhire, and ſometimes ſeems to penetrate the inferior ſtratum of limeſtone to a very conſiderable depth. It contains no metallic veins, and it is ſaid entirely to intercept thoſe which it paſſes in the limeſtone ſtrata. Saintfond affirms that lead ore is ſometimes found in cat dirt; but he ſeems to have been deceived by the vagueneſs of the term, as the miners of Derbyſhire give the ſame name to a greeniſh variety of limeſtone, which is ſometimes traverſed by veins of lead ore.

73 Globular trap.

2. Globular trap. This is a ſchiſtoſe greenſtone, partially decompoſed, and alſo reſembles a fine-grained wacke; but it appears in the form of large balls, compoſed of concentric layers, with a hard nucleus. It is found at Altenzulze in Voegtland, and ſome other places. It ſometimes contains veins of copper and iron.

74 Greenſtone.

3. Greenſtone. This is almoſt entirely compoſed of feldſpar, uſually of a pale fleſh-red colour, having ſometimes imbedded in it grains of grayiſh quartz, ſcales of iron, blackiſh mica, and cryſtals of pale fleſh-coloured feldſpar. This rock may be confounded with porphyry, or with feldſpar; but is generally conſidered as different from both. Mr Jameſon found it in beds from three to twelve feet thick on the upper ſide of the Suſanna vein in the valley of Leadhills, and in the mountain between Wamphray and Eſkdalemuir.

Sect. XXI. *Sandſtone, or Grit.*

These terms, like many others which we meet with in mineralogy, are very vague and indefinite, and are uſed to denote three or four kinds of ſtone; a calcareous, an argillaceous, and a ſiliceous ſandſtone. We ſhall here conſider only two of them, the argillaceous and the ſiliceous. 75 Sandſtone.

1. Argillaceous ſandſtone. This is the *ſandſtein* of Werner, and the argillaceous grit of the ordinary miners. It is compoſed of grains of quartz, and ſometimes of ſiliceous ſchiſtus; more rarely of feldſpar. Theſe grains are of various ſizes, and are cemented in an argillaceous matter, commonly containing iron; whence this ſtone is ſometimes called *ferruginous* ſandſtone. From the coarſeneſs or fineneſs of the grains, it receives the names of coarſe and fine ſandſtone. There is a very coarſe kind found in Derbyſhire, containing a conſiderable quantity of quartz pebbles. 76 Argillaceous ſandſtone.

This ſpecies of ſandſtone is found in immenſe beds, ſometimes above 100 yards thick.

It is very diſtinctly ſtratified, and is commonly divided by fiſſures, into the ſhape of parallelopipeds. It ſometimes alternates with layers of compact limeſtone, and often lies above a ſtone which we are immediately to mention, *ſhale* or *ſhiver*.

Sandſtone is ſometimes formed into globular concretions, compoſed of concentric lamellæ.

Sandſtone is one of the moſt abundant products of nature, occurring in almoſt every country. In Britain it forms the uppermoſt ſtratum in many parts of Derbyſhire; and in the iſle of Arran there is an immenſe ſeparate maſs of it, forming what is called *the cock* *. In the ſame iſland it is found in Glenranza, repoſing on ſecondary limeſtone. 77 Where found.

The globular concretions of ſandſtone are uncommon. Mr Jameſon obſerved them in the iſle of Skye, near the harbour of Portree †; and Reuſs obſerved the ſame in Bohemia ‡.

This ſpecies of ſandſtone uſually contains many petrifactions, but is generally not very abundant in metals; it however ſometimes contains veins of cobalt.

* *Jameſon's Min. of the Iſles*, vol. i. p. 76

† *Mineral. of the Iſles*, vol. i. p. 87.

‡ *Mineral. Geograph. von Bohmen*, vol. ii. ſ. 46.

2. Siliceous ſandſtone. This is a ſtone of a ſimilar nature with the laſt, except that the cementing maſs is alſo of a ſiliceous nature. It is found in the ports of Domica and Campara, in the iſle of Arbe, and on the coaſt of Dalmatia, where it contains petrifactions. The hill of Platinburg conſiſts of ſandſtone, with a chalcedony cement. Some fine ſpecimens of ſiliceous ſandſtone are found in Saliſbury Craigs at Edinburgh, containing ſhells which have aſſumed the nature of chalcedony. It does not appear to contain metals. 78 Siliceous ſandſtone.

Sect. XXII. *Gypſum, or Plaſterſtone.*

This is native ſulphate of lime, and it appears in ſeveral forms. Six varieties are uſually enumerated; com- 79 Gypſum.

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mon gypsum, lenticular gypsum, crystallized gypsum, fibrous gypsum, stalactitic gypsum, and gypseous alabaster.

80 Common. 1. *Common gypsum* is a compact, granulated stone, commonly of a grayish colour, and mixed with impurities, containing a considerable quantity of carbonate of lime. Its texture is seldom laminated, but it appears like coarse loaf sugar. This kind is very abundant, many hills being entirely formed of it. Of these the most remarkable are the plasterhills in the neighbourhood of Paris, those in the canton of Bern in Switzerland, and others among the Alps. Hills of gypsum occur also in Spain and Poland; near the White sea; in Asia, where they are mostly in horizontal strata; in the north Archipelago, between Asia and America. Saussure found a mountain in Switzerland composed of gypsum, sand, and clay *. This kind sometimes contains petrifactions, and often abounds with the impressions of animal and vegetable matters; some very curious examples of which will be mentioned in a future section. It contains few metals, although copper is sometimes found in it, as are rock-salt and sulphur.

* *Voyage aux Alpes*, tom. ii. p. 528.

81 Lenticular. 2. *Lenticular gypsum* is a curious variety, which seems peculiar to Montmartre near Paris. In one of the banks in this mountain, specimens of it are found containing little lenticular bodies, distinct and disseminated through the stony matter, so as to form a great part of its mass. A specimen of this kind is figured by Patrin, in his natural history of minerals.

82 Crystallized. 3. The *crystallized gypsum* is also found chiefly in the environs of Paris, in crystals that are decaedral, or sometimes like a rhomboidal octaedron, with the pyramids truncated near the base.

83 Fibrous. 4. *Fibrous gypsum*, composed of short brittle threads dispsed in bundles, is found in Derbyshire, and near Riom in Auvergne. A very beautiful variety of a silky feel, and reticulated texture, is described by Patrin, as found in Poland, in the salt mines of Wielitska; in Russia, near the junction of the river Oka with the Wolga; in Spain; and in China.

A variety of gypsum with the appearance of vegetation is found in caverns near the baths at Matlock in Derbyshire. A beautiful specimen of it is figured by Patrin *.

* *Hist. Nat. de Miner.* tom iii. p. 218.

84 Stalactitic. 5. Gypsum is sometimes found hanging from the sides and roof of caverns in the form of stalactites, a transverse section of which shews their internal structure to be radiated. This variety is commonly called *schlot* †.

† *Patrin ut supra*, p. 222.

85 Gypseous alabaster. 6. *Gypseous alabaster* is very similar to true alabaster, except that it does not, like that, effervesce with acids, and is in general not so strong. It is found in great abundance in Derbyshire in large masses, filling up cavities in argillaceous grit. It never forms a stratum, but is generally attended with gravel, red clay, and shells. Mr Mawe represents the lower portions as being very strong and compact, so as to form columns and pilasters ‡. This kind is also found in Franche Comtè, and on the Marne about six leagues from Paris at Lagny.

‡ *Mineral. of Derbysh.* p. 84.

Though from the ordinary form or situation of gypsum, and the organic remains so commonly found in it, there can be no doubt of its being in most cases a secondary rock; yet from its having been found mixed with mica in St Gothard, it is enumerated by some among the primary compounds.

Sect. XXIII. *Fluor Spar.*

86 Fluor spar described. This beautiful substance, which is native *fluat of lime*, is found either in large unformed masses or blocks, or crystallized in cubes or octaedrons. It is of different colours: but the most prevailing varieties are that in parallel zones or bands of green, blue, yellow, and white; and that in which a white ground is veined with a reddish brown. Some specimens are so shaded as to represent a geographical map; but these are very rare. It is so soft as to be easily turned in a lathe into those vases and other ornaments which are so commonly seen on chimneypieces.

87 Where found. Fluor spar is found in several countries of Europe, but especially in France and Britain. According to Patrin, there are mines of it in the primitive mountains of Gyromagny, in the Vosges, in the neighbourhood of Langeac in Auvergne, and at Forez near Ambierle, that are inexhaustible §. It is also found in the mountain of Pilat not far from Lyons; among the rocks that skirt the valley of Chamouni in the Alps; in the Altaischian mountains of Asia; and in Greenland.

§ *Hist. Nat. de Miner.* tom. iii. p. 288.

The most productive mines of this substance in Britain are in a mountain near Castleton in Derbyshire. Here there are two mines producing the beautiful compact fluor, called *Blue John*, which is found in pipe veins running in various directions. The fluor commonly rests upon limestone, and it frequently has this stone for a nucleus, round which it appears to have crystallized. Frequently, however, the centre is hollow. In several parts of the mine the fluor is found in detached masses, in caves filled with clay and loose adventitious matter, having the appearance as if it had been broken off from the limestone on which it had been formed; for every piece, in one part or other, seems as if it had adhered to something, and been broken off.

Some of the pieces of fluor are a foot thick, and have four or five different veins or zones: such large pieces are however very rare, and in general they are only three or four inches thick *.

* *Mawe's Mineral.* sect. vii.

Saintfond, who has given an interesting account of the curiosities near Castleton, says, that fluor spar would be the most beautiful substance in nature, if it were but a little harder.

It is also found in Northumberland, in a vein among the granite mountains of Aberdeenshire †, and in one of the Shetland isles, in a vein of basalt ‡.

† *Jameson's Min. of the Isles*, vol. i. p. 153.

‡ *Ib.* ii. 277.

Fluor appears in some cases to be primitive. Thus it is found forming whole strata in the mountains of the forest of Thuringia, and in a vein of quartz in Upper Hungary.

Sect. XXIV. *Chalk.*

88 Chalk. Chalk is too well known to require a description. It is not always white, but is frequently coloured. It is disposed in horizontal beds that are often many yards in thickness, and which always repose on layers of other calcareous stone of a harder structure. These beds are often of considerable extent, and very commonly

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ly contain flints, oviform limeſtone, and vaſt quantities of ſhells.

89 Where found.

Chalk, which is ſo abundant in ſome countries, is ſcarcely found in others. It is well known that the ſouth and ſouth-eaſtern parts of England, and the ſouth and ſouth-weſt of France contain vaſt cliffs and beds of it; much of it is alſo found in Zealand. It is, we believe, a rare production in Scotland, and in moſt mountainous tracts. It has been remarked by Pennant, that if a line be drawn from Dorcheſter in the county of Dorſet, to the county of Norfolk, it would form the boundary of the great chalky ſtratum of England; no quantity having been found to the north or weſt of that line.

There is a mountain of chalk between Tor and Iſium on the banks of the Donetz in Ruſſia, in which ſome Greek monks have excavated apartments to the length of fifty fathoms ‡.

‡ *Pallas's Travels*, vol. ii. p. 84.

No metals are found in chalk, though it is ſaid that in France *martial pyrites* has been diſcovered in it.

Sect. XXV. *Clay.*

90 Clay.

Clay is found in various ſtates with reſpect to hardneſs or ſolidity, from the ſoft ductile clay uſed by the potters and pipemakers to the perfect ſlate (clay ſtate, or *argillaceous ſchiſtus*) already deſcribed.

Soft clay is found in beds of various degrees of thickneſs, commonly not far below the ſurface, and alternating with harder clay, ſlates, ſand, or limeſtone. It is generally very abundant, eſpecially in thoſe places where coal or rock-ſalt is found.

91 Indurated clay.

Clay of a harder conſiſtence, commonly called indurated clay, or in the language of the miners *clunch*, is uſually found below the ſofter clay, or there is ſometimes a ſtratum of ſlate or ſimilar argillaceous matter interpoſed. It often alternates with limeſtone, ſandſtone, or gypſum. Petrifactions and ſhells are often found in it, as are quartz, ſulphur pyrites, martial ochre, common ſalt, vitriol and alum.

92 Lithomarga.

A harder ſtate of clay forms that ſubſtance which is called by mineralogiſts *lithomarga* (ſtone clay.) This is found in beds or ſtrata often alternating with the former, with ſlate or with limeſtone, eſpecially in coal mines. It alſo forms neſts or balls in toadſtone and ſimilar rock. It ſometimes bears the impreſſions of reeds and other vegetable bodies.

93 Slate clay.

The next degree of hardened clay, forms ſlate clay, (*ſchiefer thon* of the Germans.) This ſubſtance, however is not very hard, but is eaſily broken into angular tabular fragments. Its internal appearance is uſually dull, but ſometimes glimmering from a ſlight intermixture of ſcales of mica. Its colour is uſually a yellowiſh gray, with ſpots or clouds of a pearl gray, or a cherry red, but ſometimes it inclines to black. It uſually lies between beds of ſandſtone, and almoſt always below the ſofter clays.

94 Slate.

A kind of clay, of a ſtill harder conſiſtence, forms ſlate or ſchiſtus. This is uſually of a dark brown or blackiſh colour, and a laminated texture. It lies in beds, ſometimes of immenſe thickneſs, uſually below ſandſtone, or alternating with this and limeſtone. It often contains impreſſions of organic remains, and there are ſometimes found in it veins of lead ore. It is a very common ſtratum in the coal countries.

95 Rubble-ſtone.

Nearly allied to this is what the miners call rubble ſtone, which is a common variety of ſlate found in ſimilar ſituations with ſlate; but often very rich in metallic ores, eſpecially iron, galena, biſmuth, and cobalt. It alſo abounds with petrifactions. It is ſometimes found in primitive rocks.

Sect. XXVI. *Marl.*

96 Marl.

Marl is a ſubſtance chiefly compoſed of ſand, clay, and calcareous matter, which is found in many places, and forms one of the moſt valuable natural manures uſed in agriculture. This is alſo found of various degrees of hardneſs, from a ſoft powder to a ſtony conſiſtence, in which laſt ſtate it forms what Kirwan calls *marlite*. In colour it is uſually of a reddiſh white, ſometimes verging upon red, and it is not unfrequently found of a yellowiſh brown or blackiſh caſt. Marl is uſually diſpoſed in conſiderable beds of various degrees of thickneſs, in valleys and other low lands, eſpecially among the coal ſtrata. Indurated marl occurs in the coal ſtrata of Mid Lothian*, and it is alſo found in the iſland of Iſlay. Powdery marl is ſeen in Skye.

* *Jameſon's Dumfries*, p. 106.

Stony marl, or *marlite*, is found in Bavaria, alternating with ſand and ſandſtone. Hills of it occur in Carniola, Carinthia, and the Venetian territory. It is alſo found between ſtrata of limeſtone and argillaceous ſchiſtus.

Sect. XXVII. *Argillaceous Ironſtone.*

97 Argillaceous ironſtone.

This is ſometimes called metal ſtone, and is very common in the coal countries. It is very heavy and compact, and of various colours, from a dark brown to a blood red; the latter forms the *hæmatites* or bloodſtone, one of the richeſt iron ores. It often contains in it ſpherical balls like iron bullets. It is diſpoſed in ſtrata alternating with indurated clay, ſlate clay, marl, or ſandſtone, ſeldom far below the ſurface. It ſeldom forms very extenſive beds, but is often confined to particular ſpots.

Ironſtone is found in great abundance in Cumberland, and in moſt parts of Scotland. It may be ſeen in the cliffs all along the coaſt of Fife, from Dyſart to St Andrews.

Sect. XXVIII. *Wacke and Baſalt.*

98 Whinſtone.

We have already ſpoken of ſeveral ſtones under the name of *traps*, that are found both among primitive and ſecondary compounds. The two ſubſtances which we are now to notice are nearly allied to the traps, and have been claſſed with them under the general name of *whinſtone*. This is a favourite term among the mineralogiſts of Scotland, of whom Sir James Hall employs it as a generic name to denote trap, baſalt, wacke, grunſtein, and porphyry.* The term is convenient, but Profeſſor Jameſon and others of the Wernerian ſchool object to it as too vague and indefinite.

* *Edinburgh Phil. Tranſ.* vol. v. p. 46.

99 Wacke.

Wacke, or wacken, differs from trap only in being more compact and of a finer grain. It is heavy and very hard, ſo as often to ſtrike fire with ſteel; it is dull and opaque, and breaks with an even fracture. Its colour is uſually a reddiſh brown or gray of various ſhades,

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shades, and sometimes it has a greenish cast. It has usually an earthy smell, when breathed on. It is sometimes highly impregnated with iron, and often contains crystals of *hornblende*, and very commonly those of hexagonal black mica.

It often forms a considerable part of mountains, either in vast blocks, as in the hill on which Edinburgh castle stands, or in strata lying above limestone or sandstone, or alternating with these. A great part of the Calton-hill, of Salisbury craigs, and Arthur's seat at Edinburgh, is composed of strata of this kind; and similar appearances take place in the bed of the water of Leith near the town, and in the cliffs on the coast of Fife, especially at St Andrews. To the eye of the volcanic Saintfond, all these beds appeared to be lava. We are disposed to think, with Mr Playfair, that the curious instance of alternate strata of basalt (as Saintfond calls it) and limestone, near Villeneuve de Berg, described and figured by that author, affords an example of whinstone alternating with limestone, such as are seen in Scotland †. Several varieties of wacke are found in the hills near Edinburgh, and are described by Dr Townson ‡. Mr Jameson observed wacke alternating with porpyhry in Skye.

† *Recherches sur les Volc.* p. 328.

‡ *Townf. Tracts*, p. 204.

100 Basalt.

Basalt has a finer grain, and is more compact, than even wacke, and is the most dense of all the whins or traps. It is found either in large blocks, covering the other strata, sometimes in the form of tables, or in regular prismatic columns, either straight or bended. We have already treated so fully of the nature, properties, and chief habitats of basalt (see BASALTES), that little remains to be added here.

It is principally distinguished from wacke, where it is not in regular prisms, by very rarely containing crystals of mica, which are so common in the latter.

Saintfond in his splendid work *Sur les Volcans eteints du Vivarais*, &c. has figured some examples of basaltic pillars which rival those of Staffa and the Giants Causeway. A more romantic situation is scarcely to be conceived than that drawn in his eleventh plate, of a village placed in the front of a bold hill covered with bundles of small pillars lying in every direction, and having detached perpendicular columns standing at each end, with a large cave directly behind the houses. Large masses of basalt are seen in the north of Shetland, standing insulated, and assuming a very grotesque appearance. Mr Jameson describes one of these in the isle of Jura, that forms a natural arch. We remember seeing two curious insulated rocks on the shore at the foot of Kinkeld braes at St Andrews, but do not recollect whether they are of a basaltic nature.

Several other substances, as sand, gravel, peat, &c. might here be noticed, but their structure and situation are too well known to render a particular notice necessary.

Many of the stones which we have described among the primitive rocks, are also sometimes found among the secondary strata, as argillaceous schistus, hornstone, hornblende, jasper, and especially puddingstone; but they are not so important as to require a second examination.

Before we conclude this general account of the materials which compose our globe, we must briefly notice two of the most valuable mineral productions, viz. rock salt and coal, and must say something of fossils and petrifactions.

SECT. XXIX. *Rock Salt.*

101 Rock salt described.

ROCK salt or sal gem, (the *steinsal* of the Germans) is the purest muriate of soda that is found in nature, it being much less impregnated with foreign matters than what is procured from sea water. It is very hard, and generally very transparent, being sometimes as clear as crystal. It is usually white, but often yellowish, blue, red, or violet, and now and then it is quite opaque. This salt forms in the bowels of the earth horizontal beds or banks, more or less thick, from a few inches to many hundred fathoms; and sometimes extending several miles round. It commonly alternates with clay or gypsum. The beds are sometimes without any break for a great extent. It is generally found a few fathoms below the surface, and in some places is found continued to the depth of 1000 feet.

102 Where found.

It is found in some mountains; and in Algiers, near the lake called *Marks*, there is a mountain almost wholly composed of it. The famous salt mine of Wielitska in Austrian Poland, about eight miles to the south-east of Cracow, is in the northern extremity of a branch of the Carpathian mountains. The salt found here is of an iron gray colour, intermingled with white cubes; and sometimes large blocks of salt are found imbedded in marl. This famous mine has been worked ever since 1251, and it is pretended that its excavations extend more than a league from east to west *. About five leagues to the south-east of Cracow are the salt mines of Boschnia, the depth of which is nearly equal to those of Wielitska (1000 feet); but the salt procured from them is less pure †. Mines of salt, in horizontal undulated beds, occur at Thorda in Transylvania, and in Upper Hungary. In the side of a mountain, about two leagues from Halle, on the banks of the Inn, to the north-east of Inspruck, rock salt is found imbedded in layers of a slaty rock; but there is one part of the mountain in which there occurs an immense body of salt, without any mixture of rock, to which they pass by a gallery 260 toises in length, closed at the end with a locked door. This salt is very impure ‡. There are three important salt mines in Spain; the first near Mingranella, in a mountainous tract, between Valentia and Castile, imbedded in layers of gypsum; the second in Spanish Navarre, in a ridge of hills composed of limestone and gypsum; and the third that of Cardona in Catalonia, about 16 leagues to the north-east of Barcelona, which is one of the most curious natural productions with which we are acquainted. It consists of an immense solid rock of salt, elevated 500 feet above the earth, and extending to a depth that has not been ascertained. It is without crevices or clefts, and has no appearance of strata, and is near a league in circuit. There is no plaster or gypsum found in the neighbourhood, and the salt rock is as high as any of the adjacent hills ||.

* *Townson's Travels in Hungary*, p. 388.

† *Journ des Mines*, n° 47.

‡ *Jar's Voy.* tom. iii. p. 328.

|| *Bowles's Nat. Hist. of Spain.*

103 Salt mines at Northwich.

Rock salt is found in several places in England, particularly at Northwich in Cheshire, at Droitwich in Worcestershire, and near Weston in Staffordshire; but the mines in Northwich are the most productive. Salt mines, in this situation, were known to the Romans;

but

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but the principal mine that is at preſent wrought, was diſcovered in the beginning of laſt century. It forms immenſe quarries, extending over ſeveral acres, which, with their huge cryſtal pillars and glittering roof, preſent a moſt beautiful ſpectacle. The ſalt found here is of a dark-brown colour, like brown ſugarcandy, and is ſo hard that it is blaſted with gunpowder to get it from the maſs. It is diſpoſed in beds, alternating with beds of clay, gypſum, and ſlaty ſtone. Salt is procured at the greateſt depth hitherto explored; and wherever a ſhaft is ſunk in the neighbourhood, there is a certainty of finding ſalt *.

* *Mawe's Mineralogy of Derbyſh.* ſect. xv.

Beſides theſe extenſive mines, rock ſalt is found in the canton of Berne in Switzerland, in Siberia, in Arabia, in Tibet, and even in New Holland. It is alſo found in many parts of America, at a great height in the mountains, eſpecially thoſe of Peru.

SECT. XXX. *Coal.*

104 Coal.

WE have already, in the articles COAL and COALERY, treated of the nature of this ſubſtance, of the ſtrata that are uſually found connected with it (according to the phraſeology of the miners), and of the method of procuring it from the pits; and, in MINERALOGY, we ſhall give a particular account of the ſeveral varieties, and the diſtinguiſhing characters of each. A few obſervations reſpecting the principal collieries, with the appearance of the coal found in them, and the correſponding ſtratification, fall to be made in this place.

There are certain general circumſtances that attend the depoſitions of coal in almoſt every place where it is found, and which we muſt mention before noticing the particular collieries. Theſe are as follows:

105 General circumſtances attending coal ſtrata.

1. The beds in which coal is diſpoſed, uſually have their extremities near the ſurface of the ground, from which they bend obliquely downwards, the middle part of the bed being nearly horizontal, ſo that a vertical ſection of the bed nearly reſembles the keel of a boat. This figure is well expreſſed in the firſt and third plates to Mr Jameſon's Mineralogy of Dumfries. The loweſt part of the bed is uſually the thickeſt (D).

2. A bed of coal is ſeldom found ſingle; but, in general, ſeveral ſtrata occur in the ſame place, of various thickneſs, the upper being uſually very thin, and the lower very thick, with ſeveral ſtony ſtrata between each two. Where there is only one bed, this is generally of very conſiderable thickneſs. At Whitehaven there are found at leaſt 20 coal ſtrata below the ſurface; and at Liege, in France, there are no leſs than 60.

3. The ſtrata that ſeparate the layers of coal are nearly the ſame in every colliery, and will be ſeen by referring to the table given under COALERY, and by thoſe which will immediately be added. Thoſe ſtrata which are in immediate contact with the coal, are either whinſtone, or more commonly an argillaceous ſlaty maſs; and near this is ſandſtone, in layers that are ſeparated by ſlaty clay, mixed with particles of coal.

4. It is an obſervation which holds, almoſt without exception, that the ſlaty ſtrata, and eſpecially thoſe next the coal, bear the impreſſion of vegetables, and often of exotic or unknown plants.

Coal, in a greater or leſs quantity, but of very different qualities, has been found in moſt countries, and perhaps exiſts in all. It is found in France, Holland, Britain, Germany, Saxony, Portugal, Switzerland, and Sweden; in China, Japan, and in New Holland; and much of it is worked in Virginia in America. But France and Britain may be conſidered as the favourite ſeats of this invaluable commodity, which may juſtly be put in competition with the treaſures of Potoſi and Peru. 106 Where found.

It is ſtated by Buffon, that there are no fewer than 400 collieries worked in France; and yet Saintfond regrets that his countrymen are not ſo far advanced in the uſe of this mineral as the inhabitants of Britain *. The moſt conſiderable coal mines in France, are thoſe in the Lyonnois, at Forez, Burgundy, Auvergne, Languedoc, Franche Comté, and Liege. 107 Coal mines of France.

* *Saintfond's Travels*, tom. i. p. 114.

The mines in the Lyonnois, and thoſe of Forez, are among the moſt important in France. They are ſituated in a valley, extending from the Rhone to the Loire, in a direction from north-eaſt to ſouth-weſt, between two chains of primitive mountains, and they occupy in length a ſpace of ſix or ſeven leagues, from Rive-de-Gier to Firmini. In one part of the valley, in the neighbourhood of Saint-Etienne, the ſtrata are nearly horizontal, and the medial thickneſs of the coal ſtratum is from three to ſix feet; and near the Loire there are from 15 to 20 of theſe. At Rive-de-Gier the ſtrata are almoſt vertical, and their thickneſs is very unequal, being ſeldom leſs than three feet, and ſometimes amounting to 40 or even 60. All the coal produced by theſe mines is of an excellent quality, and its quantity is immenſe. Patrin ſtates, on the moſt undoubted authority, that there are in the neighbourhood of Rive-de-Gier, no leſs than 40 mines at work, which produced in one year 1,600,000 quintals of coal †.

† *Hiſtoire Nat. de Miner.* tom. v. p. 223.

The next in importance are the coal mines of Liege. The beds of coal in that country have a direction from eaſt to weſt; they commence about a league to the eaſt of the town, and extend to about a league and a half to the weſt of it. Here, after meeting with ſome interruption, they extend for ſeveral leagues farther. Their breadth, from north to ſouth, is about three-fourths of a league. At Verbios, which is to the north-weſt of the city, there are, according to Jars, more than 40 ſtrata of coal, which are ſeparated from each other by beds of different kinds of ſandſtone, of from 30 to 100 feet in thickneſs ‡. Gennetè has counted 61 of theſe beds, placed one above another; and he is of opinion, that the loweſt penetrates to the depth of 4000 feet perpendicular. Though theſe mines have been wrought from the 12th century, they have not yet reached to more than the twenty-firſt bed, at the depth of a little more than 1000 Engliſh feet §.

‡ *Jars' Voy. Metal.* Mem. xiv. p. 283.

§ *Patrin*, tom. v. p. 330.

The

(D) Saintfond, in the ſection which he has of the coal ſtrata at Newcaſtle, deſcribes them as if they were convex towards the upper ſurface. (See p. 134. of vol. i. of the Engliſh Tranſlation of his Travels in England, &c.) Surely this is a miſtake.

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The principal collieries of Britain are those of Newcastle and Whitehaven.

108 Principal collieries of England.

Newcastle is surrounded by collieries to the distance of six or seven leagues, and may, perhaps, be considered as the richest coal district in the world. There are in several of the Newcastle mines not fewer than 16 beds of coal, two of which are considerably thicker than the rest, being each about a fathom in thickness. These are called the *main coal*, and are distinguished into the *high main coal*, and the *low main coal*, separated from each other by a considerable number of stony strata. Good coal, in sufficient quantity, is generally found at the depth of little more than 100 feet. The bed is five feet thick in some places, and less in others; but, in general, it is easily wrought, and large pieces are brought up. This last circumstance is of considerable advantage, as these pieces are most proper for chamber fires, and easily transported, which makes this kind of coal sell at a higher price. Where the bed of black and bituminous clay is penetrated, the coal is found adhering to it: but this is not always the case, for there are other mines in the neighbourhood where freestone is recovering, which, in the points of contact, is mixed with coal to the thickness of two or three inches; the latter running, as it were, in splinters into the stone, and having a ligneous appearance, when attentively examined †.

† *Saintfond's Travels*, v. i. p. 140.

At Whitehaven, the beds of coal lie in a direction parallel to each other. Their inclination or dip is nearly to the west, and is from one yard in eight, to one in twelve. The strata are frequently interrupted by large fissures, or dykes, some of which remove the strata upwards or downwards, 120 feet. The course of these fissures is almost east and west. In a depth from the surface of 165 and a half fathoms, there are, in these collieries, seven large beds of coal, and 18 thin beds, which cannot, at present, be rendered profitable.

The strata superincumbent on the large beds of coal are, 1st bed, Blue slate. 2d, Gray freestone. 3d, Hard, white freestone. 4th, Blue slate, striated or speckled with freestone. 5th, Gray slate. 6th, Hard, white freestone.

The strata immediately beneath these large beds of coal, are from one and a half to six inches thick, and consists of a species of argillaceous earth, or *shale*. As this earth is of a very soft or friable nature, the weight of the superincumbent strata presses the pillar of coal through it. If the pillar descends a few inches, the roof not equally yielding at the same time, crushes, or breaks into small pieces. When, under these circumstances, the thickness of the bed does not exceed six feet, nor the depth 30 fathoms, the surface of the earth is sensibly affected *.

* *Dixon's Life of Dr Brownrigg*, p. 107.

There appear to be two principal belts of coal in this island, extending from the eastern to the western coast; one from Newcastle to Whitehaven; the other from the east coast of Scotland, across the vale of Forth and Clyde, to Ayrshire. Coal is indeed found in many other parts of the island; but the quantity is very trifling.

The similarity of situation, and the similar nature of the coal at Whitehaven and Newcastle, would naturally lead us to infer, that the coal at both places is from the same seam. But this is placed beyond dispute, by a comparative examination of the strata in both situations. We shall here give two tabular views of the strata, one taken from Saintfond's Travels, and the other from Dr Joshua Dixon's account of the Whitehaven mines, in his literary life of Dr Brownrigg. Allowing for the different names given by different miners to the same substances, and Dr Dixon's greater minuteness, there is a wonderful similarity between the two tables.

TABLE I. Strata in Restoration Pit, St Anthon's Colliery, Newcastle, to the depth of 135 fathoms.—From *Saintfond*.

N°	Stratum.	Fath.	Feet.	Inch.
1	Soil and clay,	5	–	–
2	Brown freestone,	12	–	–
3	Coal, I.	–	–	6
4	Blue metalstone,	2	5	–
5	White girdles,	2	1	–
6	Coal, II.	–	–	8
7	White and gray freestone,	6	–	–
8	Soft blue metalstone,	5	–	–
9	Coal, III.	–	–	6
10	Freestone girdles,	3	–	–
11	Whin,	1	4	6
12	Strong freestone,	3	1	–
13	Coal, IV.	–	1	–
14	Soft blue thill,	1	5	–
15	Soft girdles mixed with whin,	3	5	–
16	Coal, V.	–	–	6
17	Blue and black stone,	3	4	–
18	Coal, VI.	–	–	8
19	Strong freestone,	1	3	–
20	Gray metalstone,	1	4	–

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N°	Stratum.	Fath.	Feet.	Inch.
21	Coal, VII.	–	–	8
22	Gray poſt mixed with whin,	4	1	–
23	Gray girdles,	3	1	–
24	Blue and black ſtone,	2	2	–
25	Coal, VIII.	–	1	–
26	Gray metalſtone,	2	–	–
27	Strong freeſtone,	6	–	–
28	Black metalſtone, with hard girdles,	3	–	–
29	High main coal, IX.	1	–	–
30	Gray metal,	4	3	–
31	Poſt girdles,	–	2	–
32	Blue metal,	–	4	–
33	Girdles,	–	1	2
34	Blue metalſtone,	5	–	–
35	Poſt,	–	1	–
36	Blue metalſtone,	3	–	–
37	Whin and blue metal,	–	1	6
38	Strong freeſtone,	3	3	–
39	Brown poſt with water,	–	–	7
40	Blue metalſtone with gray girdles,	2	2	–
41	Coal, X.	–	3	–
42	Blue metalſtone,	3	–	3
43	Freeſtone,	–	4	–
44	Coal, XI.	–	–	6
45	Strong gray metal, with poſt girdles,	2	–	6
46	Strong freeſtone,	1	1	–
47	Whin,	–	1	–
48	Blue metalſtone,	1	2	7
49	Gray metalſtone, with poſt girdles	2	4	5
50	Blue metalſtone, with whin girdles,	1	4	3
51	Coal, XII.	–	1	6
52	Blue gray metal,	–	3	8
53	Freeſtone,	2	–	7
54	Freeſtone mixed with whin,	2	–	–
55	Freeſtone,	1	2	–
56	Dark blue metal,	–	2	2
57	Gray metalſtone and girdles,	2	2	–
58	Freeſtone mixed with whin,	3	–	7
59	Whin,	–	1	–
60	Freeſtone mixed with whin,	1	–	6
61	Coal XIII.	–	3	3
62	Dark gray metalſtone,	–	3	6
63	Gray metal and whin girdles,	1	4	10
64	Gray metal and girdles,	1	3	–
65	Freeſtone,	–	3	–
66	Coal XIV.	–	3	2
67	Blue and gray metal,	–	4	2
68	Coal XV.	–	–	9
69	Blue and gray metal,	2	–	–
70	Freeſtone mixed with whin,	–	4	6
71	Gray metal,	–	–	6
72	Gray metal and girdles,	1	–	9
73	Low main coal, XVI.	1	–	6

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TABLE

Arrangement, &c. of the Materials of the Earth.

TABLE II. Strata in Croft Pit at Prefton-Hows near Whitehaven, to the depth of 107 Fathoms. From *Dixon*.

N°	Stratum.	Fath.	Feet.	Inch.
1	Soil and clay,	1	1	–
2	Brown foft limeftone,	1	3	–
3	Dark coloured limeftone, harder,	1	–	–
4	Yellowifh limeftone mixed with fpar,	–	4	–
5	Reddifh hard limeftone,	–	3	6
6	Hard dark-coloured limeftone,	–	1	4
7	Yellowifh limeftone mixed with fpar,	–	4	–
8	Soft brown limeftone,	–	4	2
9	Soft brown and yellow limeftone mixed with freeftone,	–	2	6
10	Limeftone mixed with yellow freeftone,	–	2	–
11	Reddifh foft freeftone,	–	1	6
12	Red flate, ftriated with freeftone in layers,	–	2	6
13	Red freeftone,	7	–	6
14	Soft red ftone,	–	–	6
15	Red flate ftriated with red freeftone,	4	1	–
16	Red flate ftriated with freeftone,	4	3	–
17	Strong red freeftone, rather grayifh,	4	5	9
18	Lumpy red freeftone fpeckled with white freeftone,	–	–	9
19	Blue argillaceous fchiftus fpeckled with coal,	–	–	9
20	Red foapy flate,	2	1	–
21	Black flate with a fmall appearance of coal,	–	1	–
22	Afh-coloured friable fchiftus,	–	4	6
23	Purple-coloured flate,	3	5	3
24	The fame, and under it black flate,	–	4	–
25	Coal I.	–	1	–
26	Soft whitifh freeftone,	1	4	2
27	Blackifh flate, a little inclined to brown,	–	4	11
28	Coal II.	–	1	10
29	Blackifh fhale intermixed with coal,	–	2	6
30	Whitifh freeftone,	1	2	6
31	Strong bluifh flate mixed with freeftone,	–	3	–
32	White ironftone,	–	1	–
33	Freeftone ftriated with blue flate,	–	1	8
34	White freeftone in thin layers,	1	3	3
35	Dark-blue flate,	2	1	6
36	Coal III.	–	–	9
37	Dark-gray fhale,	–	5	8
38	Coal IV.	–	2	–
39	Gray freeftone mixed with ironftone,	1	2	–
40	Hard white freeftone,	2	3	6
41	Coal V.	–	1	–
42	Shale mixed with freeftone,	1	2	–
43	Olive-coloured flate adhering to black flate fuperincumbent on coal,	–	2	4
44	Coal VI.	–	1	1
45	Black fhale mixed with freeftone,	1	2	8
46	White freeftone mixed with flate,	1	2	–
47	Dark-blue flate,	3	4	4
48	Coal VII.	–	1	3
49	Black fhale mixed with freeftone,	1	1	6
50	Srong white freeftone,	1	–	–
51	Brown ironftone,	–	3	–
52	Dark-gray flate,	1	–	–
53	Dark-gray fhale with an intermixture of coal VIII,	–	5	6
54	Light-coloured flate mixed with freeftone,	–	5	6
55	Blue flate ftriated with freeftone,	1	4	–
56	Strong white freeftone a little tinged with iron,	–	2	6

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N°	Stratum.	Fath.	Feet.	Inch.
57	Very black ſhivery ſlate,	1	4	3
58	Strong coal of a good quality, IX.	–	–	4
59	Soft gray ſlate,	–	–	3
60	Very black coal X. burns well	–	–	8
61	Hard black ſlate,	–	1	7
62	Coal mixed with pyrites, XI.	–	1	2
63	Argillaceous ſchiſtus, gray and brittle,	–	3	–
64	Blue rough argillaceous ſchiſtus,	–	4	6
65	Fine blue ſlate,	–	3	–
66	Freeſtone mixed with ironſtone,	–	3	–
67	Black ſhivery ſlate,	1	–	–
68	Dark-blue ſlate, very fine,	–	5	6
69	Dark-blue ſlate, very brittle,	–	–	6
70	Coal, XII.	–	2	6
71	Soft gray argillaceous ſchiſtus,	–	–	6
72	Argillaceous ſchiſtus mixed with freeſtone,	–	2	–
73	White freeſtone with fine particles,	1	1	–
74	Blue ſlate ſtriated with white freeſtone,	–	4	7
75	Light-blue ſlate,	–	3	–
76	Blue ſlate a little mixed with ironſtone,	2	–	–
77	Black ſhivery ſlate,	–	1	–
78	Coal, XIII.	–	–	6
79	Browniſh hard ſlate,	1	3	–
80	Strong blue ſlate tinged with ironſtone,	4	4	6
81	Dark-blue ſlate rather inclined to brown,	–	1	6
82	Blue brittle ſlate,	–	–	6
83	Coal, XIV.	–	1	–
84	Lightiſh-gray, brittle ſoapy ſchiſtus,	–	4	–
85	Freeſtone ſtriated with blue ſlate,	1	1	–
86	Fine blue argillaceous ſchiſtus ſtriated with freeſtone,	–	4	–
87	Black ſlate, with hard, ſharp, and fine particles,	–	3	–
88	Very light blue ſlate, remarkably fine,	4	3	–
89	Coal, XV.	–	5	4
90	Soft gray argillaceous ſchiſtus,	–	4	3
91	Black ſhivery ſlate,	–	2	2
92	Coal, XVI.	–	1	3
93	Strong lightiſh-coloured ſhale,	–	3	4
94	Blue ſlate ſtriated with white freeſtone,	–	3	4
95	Ironſtone,	–	–	4
96	Gray ſlate,	–	3	9
97	Strong white freeſtone,	–	5	6
98	Freeſtone ſtriated with blue ſlate,	–	–	10
99	White freeſtone,	–	1	3
100	Freeſtone ſtriated with blue ſlate,	–	3	11
101	Black ſlate,	–	–	5
102	Freeſtone ſtriated with blue ſlate,	–	1	4½
103	Strong white freeſtone,	–	–	4
104	Freeſtone mixed with blue ſlate,	–	2	4
105	Strong white freeſtone,	–	–	5
106	Grayiſh ſlate of a ſhivery nature,	1	–	–
107	Freeſtone mixed with blue ſlate,	–	4	–
108	Very ſtrong white freeſtone,	–	5	3
109	Fine blue ſlate,	–	2	3
110	White freeſtone ſtriated with blue ſlate,	–	–	7½
111	Fine blue ſlate,	–	–	4
112	White freeſtone,	–	2	1
113	Freeſtone ſtriated with blue ſlate,	–	–	10
114	White freeſtone,	–	–	4
115	White freeſtone in thin layers,	–	–	5
116	Fine blue ſlate,	–	2	1
117	Coal, XVII.	1	1	10

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An interesting and valuable memoir on the subject of coal, written by M. Duhamel the younger, was presented a few years since to the Academy of Sciences at Paris, who adjudged it the prize that had been offered for the best essay on the subject. An ample abstract of this memoir appeared in the *Journal des Mines*, N° vii. In this paper is given a table of the number of veins, their direction and inclination, and the nature of the strata next the coal, and in the neighbourhood, in all the principal mines in Europe.

Sect. XXXI. *Of Fossils and Petrifactions.*

109 Fossils.

Those organic remains of vegetable and animal matter which are found below the surface of the earth, mixed with the stony matters which are properly the component parts of the earth, are generally called *fossils*, or *extraneous fossils*. If they have entirely lost all traces of vegetable or animal matter, and have assumed a stony earthy nature, they are called *petrifactions*.

Some of these organic remains, particularly those of the vegetable kind, are found penetrated with a bituminous substance, so as to be rendered highly inflammable. One of the most curious circumstances attending these fossil bodies is, that they are very commonly natives of a different country from that in which they are found, or are the remains of species that are now no longer known.

We may properly divide these substances into those of the vegetable and those of the animal kingdom.

1. *Vegetable fossils.* Almost every part of vegetables, the trunks, branches, leaves, and fruits, have been found in a fossil state, or impressions of some of them are seen in various mineral substances, especially in the slaty stone which accompanies coal.

Fig. 6. represents a curious example of this, that was found in the mines at Saint Etienne in France.

A, is a fruit resembling that of coffee.

B, is a portion of an unknown vegetable, apparently of the verticillate tribe.

C, is a species of fern, which is very remarkable, as it is furnished with fructifications.

D, is part of a plant with verticillate leaves, probably a species of *gallium*.

E, is some exotic fruit.

Whole trees are often found below the surface of the earth, especially in bogs and mosses, sometimes retaining much of their vegetable nature, but more commonly either impregnated with bitumen or completely petrified. Subterraneous trees are frequently dug up in the isle of Anglesea; and in the isle of Man there is a marsh six miles long and three broad, in which fir trees are found in great quantities; and though they are 18 or 20 feet below the surface, they appear as if standing firmly upon their roots. Subterraneous trees, in various states, are frequently found in Ireland, especially in the neighbourhood of Lough Neagh. Much has been written on the subject of these petrifactions of Lough Neagh, by Dr Boate, in his Natural History of Ireland; by Mr Molyneux, in the Philosophical Transactions, N° clviii. and Dr Barton in his Lectures on Natural Philosophy. Some of these trees are represented as of an immense size *. One of the most curious instances of vegetable fossils, is that related by Rammazzini, as seen by him at Modena in Italy. At the bottom of wells, that are dug there below stony masses, which appear to have been the foundation of a former city, at the depth of near 30 feet, they find heaps of wheat entire, filbert trees, with their nuts, briars, &c. They find, likewise, every six feet, a layer of earth, alternating with branches and leaves of trees.

* Parkinson's Organic Remains, Letter vii.

At the depth of 28 feet, or thereabouts, they find a chalk that cuts very easily. It is mixed with shells of several sorts, and makes a bed of about 11 feet. After this they find a bed of marshy earth, of about two feet, mixed with rushes, leaves, and branches. After this bed comes another chalk bed, of nearly the same thickness with the former, which ends at the depth of 49 feet.

That is followed by another bed of marshy earth like the former; after which comes a new chalk bed. These successive beds of marshy earth and chalk are to be found in the same order, in whatever parts of the earth they dig. The auger sometimes finds great trees, which give the workmen much trouble. They see also sometimes at the bottom of these wells, great bones, coals, flints, and pieces of iron †.

† Ray's Discourses, p. 223.

These vegetable fossils are generally of a flinty structure, being sometimes rough and sandy; at others so hard and compact as to admit of a fine polish. Some beautiful specimens of petrified wood, of the appearance of agate, are to be seen in the cabinet of natural history. That of Bisson at Paris contains two examples of this kind, which are figured at fig. 7 and 8. Fig. 7. is a transverse section of a piece of agatized wood, in which the ligneous texture is most completely preserved. Fig. 8. is another more compact, and which has the additional singularity of containing several worms. The white oval spots are supposed to have been eggs, from which the worms had issued.

110 Bovey coal.

Among the bituminous vegetable fossils, none have attracted more attention than what is called *bovey coal*, a substance of an intermediate nature between wood and pitcoal, which is dug up in a common near Chudleigh in Devonshire. It is of a laminated texture, of a chocolate, or sometimes of a shining black colour, like deal boards that had been half charred. It burns heavily, and consumes to light gray ashes. It is regularly stratified among beds of sand and clay, and the beds of coal are sometimes of considerable thickness. Mr Parkinson has collected much information respecting the former and present state of this coal, in his entertaining work on fossils ‡.

‡ Organic Remains, vol. i. Letter xii.

111 Animal fossils.

2. *Animal fossils.* Fossils of animal matters are still more common than those of vegetables. Shells and bones are found in almost every bed of limestone, and in almost every country, at the bottom of the deepest valleys, and at the tops of very considerable mountains.

In the limestone strata in Derbyshire are found many of those fossils, which are called *star-stones* and *screw-stones*, which appear to be the remains of marine animals called *encrini*. These are described by Whitehurst, who has given figures of similar animals brought entire from the West Indies §. Fig. 9. represents one of these stones.

§ Theory of the Earth, chap. xvii.

The isle of Cherea in Dalmatia contains caverns in which are found prodigious quantities of fossil bones of oxen,

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oxen, horſes, and ſheep. Similar examples occur in many places; but human bones are, we believe, never found in a foſſil ſtate.

Foſſil ſhells are found on the Alps, on the top of Mount Cenis, on the Apennines, on the mountains of Genoa, and in moſt of the quarries of ſtone and marble in Italy; in moſt parts of Germany and Hungary, and indeed generally in all the elevated places in Europe. We alſo find them in the ſtones whereof the moſt ancient edifices of the Romans were conſtructed.

In Switzerland, Aſia, and Africa, travellers have obſerved petrified fiſh, in many places; for inſtance, on the mountains of Caſtravan, there is a bed of white laminated ſtone, and each lamina contains a great number and diverſity of fiſhes; they are, for the moſt part, very flat, and extremely compreſſed, in the manner of foſſil fern; yet they are ſo well preſerved, that the minuteſt marks of their fins and ſcales are diſtinguiſhable, and every other part, whereby one ſpecies of fiſh is known from another.

There are likewiſe many *echenites* and petrified fiſh between Iver and Cairo, and on all the hills and heights of Barbary, moſt of which exactly correſpond with the like ſpecies taken in the Red ſea.

The long chain of mountains which extend from eaſt to weſt, from the lower part of Portugal to the moſt eaſtern parts of China, thoſe which ſtretch collaterally to the north and ſouth of them, together with the mountains of Africa and America, which are now known to us, all contain *ſtrata* of earth and ſtone, full of ſhells.

The iſlands of Europe, Aſia, and America, wherein Europeans have had occaſion to dig, whether in mountains or plains, all furniſh us with ſhells, and convince us that they have this particular in common with their adjacent continents.

The *gloſſoptra*, or the teeth of ſharks and other fiſhes, are found in the jaws, poliſhed and worn ſmooth at the extremities, conſequently muſt have been made uſe of during the animal's life; and in ſhells the very pearls are found, which the living animals of the ſame kind produce.

It is well known that the *purpura* and *pholades* have a long-pointed proboſcis, which ſerves them as a kind of gimblet or drill, to pierce the ſhells of living fiſh, on whoſe fleſh they feed. Now, ſhells thus pierced are found in the earth, which is another inconteſtable proof that they heretofore incloſed living fiſh, and that theſe fiſh inhabited places where the *purpura* and *pholades* preyed on them.

In Holland ſea ſhells are found 100 feet below the ſurface; at Marly-la-Ville, ſix leagues from Paris, at 75; and in the Alps and Pyrenean mountains they are found under beds of ſtone of 100, nay even 1000 feet.

Shells are likewiſe found in the mountains of Spain, France, and England, in all the marble quarries of Flanders, in the mountains of Guelders, in all the hills round Paris, in thoſe of Burgundy and Champagne; and, in ſhort, in all places where the baſis of the ſoil is neither freeſtone nor ſandſtone.

By ſhells we would be underſtood to mean, not only thoſe which are merely teſtaceous, but the relics of the cruſtaceous fiſhes alſo; and even all other marine productions; and we can venture to aſſert, that, in the generality of marbles, there is ſo great a quantity of marine productions, that they appear to ſurpaſs in bulk the matter whereby they are united.

Among the many inſtances of the multiplicity of oyſters, there are few more extraordinary than that immenſe bed which M. de Reaumur gives an account of, which contains 130,630,000 cubic fathoms. This vaſt maſs of marine bodies is in Touraine in France, at upwards of 36 leagues from the ſea. Some of theſe ſhells are found ſo entire, that their different ſpecies are very diſtinguiſhable.

Some of the ſame ſpecies are found recent on the coaſt of Poictou, and others are known to be natives of more diſtant parts of the world. Among them are likewiſe blended ſome fragments of the more ſtrong parts of ſea plants, ſuch as *madripores*, *fungi marini*, &c. The canton of Touraine contains full nine ſquare leagues in ſurface, and furniſhes theſe fragments of ſhells wherever you dig.

Near Reading in Berkſhire, a continued body of oyſter ſhells has been found: they lie in a ſtratum of greeniſh ſand, about two feet in thickneſs, and extend over five or ſix acres of ground; they are covered by ſtrata of ſand and clay, upwards of 14 feet deep. Several whole oyſters are found with both their valves or ſhells lying together, as oyſters before they are opened; the ſhells are very brittle; and in digging them up, one of the valves will frequently drop from its fellow. Several are dug out entire; nay, ſome double oyſters with their valves united.

In a quarry at the eaſt end of Broughton in Lincolnſhire, innumerable fragments of the ſhells of ſhell fiſh, of various ſorts, are found under a ſtratum of ſtone imbedded in clay, with pieces of coral, and ſometimes whole ſhell fiſh, with their natural ſhells and colours: ſome are moſt miſerably cracked, bruiſed, and broken; others totally ſqueezed flat by the incumbent weight of earth.

Sharks teeth are dug up in the iſle of Sheppey, retaining their natural colour, not petrified.

The teeth of ſharks have likewiſe been taken out of a rock in Hinderſhelf park, near Malton in Yorkſhire.

In the iſle of Caldey, and elſewhere about Tenby in Pembrokeſhire, marine foſſils have been found in ſolid marble, on the face of the broken ſea cliffs, 200 fathoms below the upper ſurface of the rocks. Nor were they only obſerved upon the face of theſe rocks, but even more or leſs throughout the whole maſs or extent of them. This is manifeſt from divers rocks hewn down by workmen for making of lime, and other pieces caſually fallen from the cliffs.

Thouſands of foſſil teeth, exactly anſwering to thoſe of divers ſorts of ſea fiſh, have been found in quarries and gravel pits about Oxford.

At Tame in Oxfordſhire, the *belemnites*, or *thunderbolt ſtones*, are found in a ſtratum of blue clay, which ſtill retain their native ſhelly ſubſtance.

The *belemnites* found in gravel pits, have ſuffered much, by their being rubbed againſt each other in the fluctuation of waters.

The *nautili* and *belemnites* are frequently found at Gorſing near Oxford *.

One of the moſt extraordinary collections of ſhells is that

* *Phil. Tranſ.* vol. liv. p. 5.

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that lately discovered by Ramond on the summit of Mont Perdu, the highest of the Pyrenees, where there are found vast quantities of sea shells and other marine spoils, and even skeletons of animals, in a fossil state.

Whole skeletons of very large animals have been discovered in a fossil state. Those of elephants have been found buried in the plains of Siberia; and bones of the rhinoceros, the hippopotamus, and the tapir, have been found in other places. A very large skeleton, nearly complete, of an immense animal, similar to the rhinoceros, is preserved in the cabinet of Madrid. It was dug up at Paraguay in South America, at the depth of 100 feet, in a sandy bed, on the banks of the river de la Plata. A description and engraving of it are given by Cuvier, in the Annals of the National Museum, N° 29. It appears to be at least 12 feet long, and the bones are of an immense size.

A prodigious quantity of fossils, both of marine animals, and of quadrupeds, are found in the plaster hills of Montmartre near Paris. An account of these has lately appeared in several numbers of the Annals of the National Museum, by M. Lamarck, accompanied with the anatomical illustrations of Cuvier. These papers are extremely curious, and contain engravings of most of the fossils described, some of which are the remains of unknown animals. Our limits do not permit us to present our readers with even an abstract of these accounts. We shall therefore select only one example.

Fig. 10. represents a block of gypsum, on the surface of which is the skeleton of an animal resembling a mouse, or, according to Cuvier, one of the opossum tribe. The skeleton is nearly entire, and the head, the neck, the spine, the pelvis, one of the fore and hind legs, and part of the tail, are very distinct. There were two pieces of gypsum found together, which appear to have divided the skeleton between them. The animal seems to have been crushed or imbedded in his natural situation *.

* *Ann. de Muf. Nat.* N° xxix. p. 277.

We have now enumerated the principal materials that compose the external crust of our earth, and have mentioned some of the most material circumstances respecting each. The metallic ores still remain to be considered, and they shall be noticed in describing metallic veins.

General Distribution of the Materials of the Earth.

Chap. II. *General Distribution of the Materials of the Earth.*

The uppermost stratum of the earth, in low situations, is, for the most part, composed of sand or clay, or a mixture of these, forming beds that are either composed of the same mixture, or of alternate layers of the two substances. These beds vary in thickness, in different places; but, in the same place, they usually preserve nearly the same thickness for a considerable extent. Sometimes these beds of clay, sand, and earth, with shells, extend to the depth of some hundred feet. See the annexed table, 1. (E).

This table exhibits a view of the arrangement of strata in several countries of Europe; and, with the tables of coal strata, in the last chapter, will give the reader more information on this subject than an elaborate detailed account.

(E) The following works are referred to in the table of strata.

* Varenii Geogr. Gener. lib. i. prop. vii.
† Buffon, Nat. Hist. vol. i. art. vii.
‡ Bergman, Descript. Phys. de Terre, sect. viii.
|| Kirwan, Geolog. Essays, p. 259.
§ Guettard, Atlas Mineral. de la France,
¶ Whitehurst's Theory of the Earth, sect. xvi.
** Ib. sect. xix.

TABLE of the order of Strata in Various Parts of Europe.

Nº of Strata.	1 * Strata at Amſterdam.	Feet.	2 † At Marly la Ville, France.	Ft. In.	3 ‡ Graveſend in Kent.	Ft. In.	4 ‖ Mansfield in Germany.	Ft. In.	5 § Hills near Etampes in France.	Ft. In.	6 ¶ Strata of Derbyſhire.	Ft. In.	7 ** At Balleycaſtle, Ireland.	Ft. In.
1	Soil,	7	Earth, mud & ſand,	13 0	Sand and flints,	1 3	Vegetable earth,		Vegetable earth,	4 0	Coarſe ſand-ſtone,	360 0	Whinſtone,	
2	Turf,	9	Earth and gravel,	2 6	Red ſand,	0 10	Swineſtone,	36 0	Marl and turf cut by dykes,	135 0	Slate clay,	360 0	Fireſtone,	
3	Soft clay,	9	Mud and ſand,	3 0	Sand and flints,	1 8	Gypſum,	24—180 0	Offreeſtone, marl, and ſhells,	12 0	Shelly lime-ſtone,	150 0	Shale,	
4	Sand,	8	Hard marl,	2 0	Red ſand,	0 10	Clay, chalk, and and ſand,	72—120 0	Brown pebbles,	4 0	Amygdaloid,	48 0	Stony clay,	
5	Earth,	4	Marly ſtone,	4 0	Sand and flints,	2 6	Compact limeſtone,	12 0	Marl and ſhells,	0 6	Compact lime-ſtone,	150 0	Shale,	
6	Clay,	10	Powdery marl with ſand,	5 0	Pure ſand in beds,	1 8	Argilliferous lime-ſtone,	3 0	Sand and grit,	45 0	Amygdaloid,	138 0	Freeſtone,	
7	Earth,	4	Sand,	1 6	Blackiſh clay,	0 4	Indurated clay,	0 1	Sand and round-ed pebbles,	18 0	Lamellar lime-ſtone,	180 0	Stony clay,	
8	Sand,	10	Marl and ſand,	3 6	Chalk and flints,	1 0	Calciferous clay,	4 6	Sand and ſhells,	6 0	Amygdaloid,	66 0	Shale,	
9	Clay,	2	Hard marl and flint,	3 6	Clay, ſand, flints, and ſhells,	1 3	Clay ſlate,	1 4	Sand & gravel,	16 0	Limeſtone not cut through,		Limeſtone,	
10	White ſand,	4	Gravel or marl in powder,	1 0	Fine yellow ſand,	4 4	Marlite,	1 0	Tuf and ſhells,	4 0	. . .		Coal,	
11	Earth,	6	Eglantine,	1 6	. . .		Sand,	0 1	Soft ſhale,	4 0	. . .		Indurated clay,	
12	Sand,	14	Marly gravel,	1 6	. . .		Gravel,	3 0	Marly clay,	8 0	. . .		Stony clay,	
13	Clay and ſand,	8	Stony marl,	4 6	. . .		Blue clay,	2 in. to 8	. . .		. . .		Not aſcertained,	
14	Sand & ſhells,	4	Sand and ſhells,	1 6	. . .		Sandſtone, clay, & mica,	6 0	. . .		. . .		Coarſe ſandſtone,	
15	Clay,	102	Gravel,	2 0	. . .		Red ſemiprotolite,	360 0					See fig. 1.	
16	Sand,	31	Stony marl,	3 6	. . .		Siliceous ſandſtone,	96 0						
17	. .		Powder marl,	1 6	. . .		Cragg-ſtone,	10 6						
18	. .		Hard ſtone,	1 0	. . .		Wacken,	156 0						
19	. .		Sand and ſhells,	18 6	. . .		Clay ſlate,	4 6						
20	. .		Brown freeſtone,	3 0	. . .		Coal,	4 6						
21	. .		Sand,	22 6	. . .		Clay ſlate,	3 0						
22							Slaty trap,	90 0						
23							Red ſemiprotolite,	180 0						
24							Primitive rock,	0 0						
Total Nº of Feet.		232		100 0		15 0				256 6				

General Distribution of the Materials of the Earth.

In our subsequent view of the distribution of the stony matters that compose the earth, we shall consider,

1. The nature, disposition, and structure, of mountains.

2. The nature, direction, &c. of dykes.

3. The nature, direction, &c. of metallic veins.

Sect I. *Of Mountains.*

112 Definition of mountains.

There are no objects on the surface of the earth which are so well calculated to excite the attention of mankind in general, and that of geologists in particular, as those stupendous elevated masses which we call *mountains*. The term mountain has in general been applied to those parts of the earth which are elevated to a very considerable height above the level surface; and a mountain is in common language distinguished from a hill only by its superior elevation. But as it is found necessary in a scientific point of view to render this distinction more accurate and precise, various geologists have given more correct definitions. By Pini and Mitterpachter every elevation whose declivity makes with the horizon an angle of at least 13°, and whose perpendicular height is not less than one-fifth of the declivity is called a *mountain*. Werner distinguishes mountains according to their height, into *high*, *middle-sized*, and *low*. A *high* mountain according to him is that whose perpendicular height exceeds 6000 feet; when the height is not above 6000 nor below 3000 he calls it *middle-sized;* and when its height is below 3000 feet, he calls it *low*.

113 Mountains are either single or in groups; and these groups either consist of several mountains standing near each other so as to occupy nearly the centre of a certain space of ground, or they follow each other so as to form a ridge or chain running across a country, or along its shores. Sometimes these chains run in a longitudinal direction, as is the case with Mount Caucasus and the Uralian mountains in Asia, the Cordilleras in South America, &c. but often they run in a curvilineal direction like a crescent, as the Carpathian mountains, which separate Hungary from the rest of the Austrian territories. It has been supposed by some theoretic writers, that chains of mountains always run in nearly the same direction, which has been conceived to be from east to west; but this is by no means exact, as later observations have shewn that they assume different directions according to the form of the country where they are situated. Some writers have laid it down as a general rule, that chains of mountains always extend in a direction nearly parallel to the length of the country; but to this there are also many exceptions. Thus the Uralian mountains, the Carpathians, the Pyrenees, the Grampians in Scotland, and many others, run rather across the country. It often happens that mountains occupy nearly the central parts of a country; and the land generally slopes with a gentle declivity towards one side of the chain, while towards the other it is considerably steeper. This circumstance of one side of a chain of mountains being steeper than the other, has been lately extended to mountains and hills in general; and Dr Kirwan has written an excellent paper on the subject, from which we shall here extract the most important observations.

" That one part of almost every high mountain or hill is steeper than another, could not have escaped the notice of any person who had traversed such mountains; but that nature in the formation of such declivities had any regard to different aspects or points of the compass, seems to have been first remarked by the celebrated Swedish geologist Mr Tilas, in the 22d vol. of the Memoirs of Stockholm for 1760. Neither Varenius, Lulolph, nor Buffon in his natural history published in 1748, have noticed this remarkable circumstance. 114 Kirwan's observations on the declivities of mountains.

" The observation of Tilas, however, relates only to the extreme ends, and not to the flanks of mountains; with respect to the former, he remarked that the *steepest* declivity always faces that part of the country where the land lies lowest; and the gentlest, that part of the country where the land lies highest: and that in the southern and eastern parts of Sweden they consequently face the east and south-east; and in the northern the west. The essential part of this observation extends therefore only to the general elevation or depression of the country, and not to the bearings of their declivities. 115 The steep side faces the low country.

" The discovery that the different declivities of the flanks of mountains bear an invariable relation to their different aspects, seems to have been first published by Mr Bergman in his Physical Description of the Earth, of which the second edition appeared in 1773. He there remarked, that in mountains that extend from north to south, the western flank is the *steepest*, and the eastern the *gentlest*. And that in mountains which run east and west the southern declivity is the steepest, and the northern the gentlest. Vol. II. § 187. 116 Western side the steepest.

" This assertion he grounds on the observations related in his 1st vol. § 32, namely, that in Scandinavia, the Suevoberg mountains that run north and south, separating Sweden from Norway, the western or Norwegian sides are the steepest, and the eastern or Swedish, the most moderate; the verticality or steepness of the former being to that of the latter as 40 or 50 to 4 or 2.

" That the Alps are steeper on their western and southern sides than on the eastern and northern.

" That in America the Cordilleras are steeper on the western side, which faces the Pacific ocean, than on the eastern. But he does not notice a few exceptions to this rule in particular cases which will hereafter be mentioned.

" Buffon, in the first volume of his Epochs of Nature, published in 1778, p. 185. is the next who notices the general prevalence of this phenomenon, as far as relates to the eastern and western sides of the mountains that extend from north to south; but he is silent with respect to the north and south sides of the mountains that run from east to west; nay, he does not seem to have had a just comprehension of this phenomenon; for he considers it conjointly with the general dip of the regions in which these mountains exist. Thus he tells us, vol. i. p. 185, that in all continents the general declivity, taking it from the summit of mountains, is always more rapid on the western than on the eastern side; thus the summit of the chain of the Cordilleras is much nearer to the western shore than to the eastern; the chain which divides the whole length of Africa, from the Cape of Good Hope to the mountains of the Moon, 117 Remarks of Buffon.

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Moon, is nearer, he says, to the western than to the eastern seas; of this, however, he must have been ignorant, as that tract of country is still unknown.

"The mountains which run from Cape Comorin through the peninsula of India are, he says, much nearer to the sea on the east than on the west; he probably meant the contrary, as the fact is evidently so, and so he states it in vol. ii. p. 295; the same he tells us may be observed in islands and peninsulas, and in mountains.

"This remarkable circumstance of mountains was notwithstanding so little noticed, that in 1792 the author of an excellent account of the territory of Carlsbad in Bohemia, tells us he had made an observation, which he had never met with in any physical description of the earth, namely, that the southern declivity of all mountains was much steeper than the northern, which he proves by instancing the Erzgebirge of Saxony, the Pyrenees, the mountains of Switzerland, Savoy, Carinthia, Tyrole, Moravia, the Carpathian and Mount Hæmus in Turkey. 2. *Bergm. Jour.* 1792. p. 385, in the note.

118 Of Herman.

"Herman in his geology, published in 1787, p. 90. has at least partially mentioned this circumstance; for he says that the eastern declivities of all mountains are much gentler and more thickly covered with secondary strata, and to a greater height than the western flanks, which he instances in the Swedish and Norwegian mountains, the Alps, the Caucasian, the Appenine, and Ouralian mountains; but the declivities bearing a southern or northern aspect he does not mention.

119 Of Delametherie.

"Lametherie, in vol. iv. of his theory of the earth, of which the second edition appeared in 1797, a work which abounds in excellent observations, p. 381, produces numerous instances of the inequality of the eastern and western declivities, but scarce any of the northern and southern, whose difference he does not seem to have noticed; but he makes a remark which I have not seen elsewhere, that the coasts of different countries present similar declivities.

"With regard to eastern and western aspects, he thinks that a different law has obtained in Africa from that which has been observed in other countries; for in that vast peninsula he imagines the eastern declivities of mountains are the steepest, and the western the gentlest. Of this, however, he adduces no other proof, but that the greatest rivers are found on the western side: this proof seems insufficient, as, if mountains be situated far in land, great rivers may flow indiscriminately from any side of them, and sometimes few rivers flow even from the side whose descent is most moderate; for instance, from the eastern side of the mountains of Syria. The Elbe and the Oder, two of the greatest rivers in Germany, take their course from the western sides, the first of the Bohemian and the other of the Moravian mountains, which yet are the steepest. Many originate from lakes, as the Shannon with us; many take such a winding course, that from a bare knowledge of the place of their disemboguement it is impossible to judge from what side of a mountain they issue, if from any; their course at most discovers the depression of the general level of the country.

"In 1798, the celebrated traveller and circumnavigator, John Reinhold Foster, published a geological tract which merits so much more attention, as all the facts were either observed by himself, or related to him by the immediate observers. In this he states as a fact universally observed, that the south and south-east sides of almost every mountain are steep, but that the north and north-west sides are gently covered and connected with secondary strata, in which organic remains abound, which he illustrates by various instances, some of which have been already, and others will presently be mentioned.

120 South and south-east sides of mountains steepest.

At present this fact attracts the greatest attention, being obviously connected with the original structure of the globe, and clearly proving that mountains are not merely fortuitous eruptions unconnected with transactions on the surface of the earth, as has of late been confidently advanced.

121 Account of mountains.

"I shall now state the principal observations relative to this object, that have been made in different parts of the world.

In Europe.

122 In Europe.

1. The mountains that separate Sweden from Norway extend from north to south, their western sides are *steep*, and the eastern *gentle*. 1. *Berg. Erde Beschreib.* p. 157.

2. The Carpathian mountains run from east to west; their southern sides towards Hungary are steep, their northern towards Poland moderate. *Foster*, § 46.

3. Dr Walker, professor of natural history at Edinburgh, observed that the coasts and hills of Scotland are steeper and higher on the western side than on the eastern. Jameson's Mineralogy of Scotland, p. 3. However, Jameson observed, that the south side of the isle of Arran is the lowest, and the north side the highest, p. 51.

4. The mountains of Wales are gentle on the eastern and steep on the western sides.

5. The mountains of Parthery, in the county of Mayo, are steep on the western side.

6. The mountains which separate Saxony from Bohemia, descend gently on the Saxon or northern side, but are steep on the Bohemian or southern side. *Charpente*, p. 75. The southern declivity is to the northern as six to two. 2. *Bergm. Journ.* 1792, p. 384. and 385.

7. The mountains which separate Silesia from Bohemia run nearly from east to west, yet are steeper on the northern or Silesian side than on the opposite Bohemian. *Assemanni Silesia*, 335. Such branches as run from north-east to south-west, have their western covered with primordial strata, and consequently less steep. 4. *New Roz.* p. 157.

8. The Meissener in Hessia is steeper on the north and east sides, which face the Warra, than on the south and western. 1. *Bergm. Journ.* 1789, p. 272.

9. The mountains of the Hartz and Habischtswald are steep on the south, and gentle on the northern sides. *Foster*, § 46.

10. The Pyrenees, which run from east to west, are steeper on the southern or Spanish side. *Carbonieres*, xiii.

11. The mountains of Crim Tartary are gentle on the northern, and steep on the southern sides. *Foster*, ibid.

In

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123 In Aſia.

In Aſia.

12. The Ourals, which ſtretch from north to ſouth, are far ſteeper on the weſtern than on the ſouthern ſides. *Herman Geologie*, p. 90.; and, 2. *Ural. Beſchreib*, p. 389.

13. The mountain of Armenia, to the weſt of the Ourals, is ſteep on its eaſt and north ſides; but gentle on the ſouthern and weſtern. 1. *Pallas Voy.* p. 277.

14. The Altaiſchan mountains are ſteep on their ſouthern and weſtern ſides, but gentle on the northern and eaſtern. *Foſter*, ibid. and *Herman*. 2. *Ural Beſchreib*, p. 390. in the note.

15. So alſo are the mountains of Caucaſus. 3. *Schrift. Berl. Gelaſch.* 471.

16. The mountains of Kamtſchatka are ſteep on the eaſtern ſides. *Pallas*, 1. *Act. Petropol.* 1777. p. 43.

17. The Ghauts in the Indian peninſula are ſteep on the weſtern ſide.

18. The mountains of Syria, which run from north to ſouth, ſkirting the Mediterranean, are ſaid to be ſteeper on the weſtern ſide, facing the Mediterranean. 4. *La Metherie*, p. 380.

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124 In America.

In America.

"The Cordilleras run from north to ſouth; their weſtern flanks towards the Pacific are ſteep, their eaſtern deſcend gradually.

"In Guiana there is a chain of mountains that run from eaſt to weſt; their ſouthern flanks are ſteep, their northern gentle. *Voyages de Condamine*, p. 140." *.

The theory according to which Dr Kirwan attempts to explain the appearances of mountains which are enumerated above, will be given in the next chapter.

* *Nicholſ. Journ.* 8vo. vol. iv. p. 256.

125 Height of mountains.

We have already, under the article BAROMETER, N° 44. ſhewn the method of computing the height of mountains by means of that inſtrument. The following table ſhews the height of the principal mountains in the globe, chiefly according to this computation.

In this table the ſecond column ſhews the height as eſtimated by the barometer, and the third the ſame by geometrical calculation. Where the numbers are placed in the middle of theſe two ſpaces, it denotes an uncertainty by what method the computation has been made.

TABLE of the Heights of Mountains, according to the lateſt computations.

<table>
<tr><th>Mountains.</th><th>Height by Barom.</th><th>Height by Geometry.</th></tr>
<tr><td>In Britain.</td><td>Feet.</td><td>Feet.</td></tr>
<tr><td>Ben Nevis,</td><td>4350</td><td></td></tr>
<tr><td>Whirn,</td><td>4050</td><td></td></tr>
<tr><td>Ben Lawers,</td><td colspan="2">4015</td></tr>
<tr><td>Ingleborough,</td><td>3987</td><td></td></tr>
<tr><td>Do.</td><td>2377</td><td>2380</td></tr>
<tr><td>Ben More,</td><td colspan="2">3903</td></tr>
<tr><td>Pennygent,</td><td>3930</td><td></td></tr>
<tr><td>Croſsfell,</td><td colspan="2">3839</td></tr>
<tr><td>Skiddaw,</td><td>3380</td><td>3530</td></tr>
<tr><td>Snowden,</td><td>3456</td><td></td></tr>
<tr><td>Mount Battock,</td><td colspan="2">3465</td></tr>
<tr><td>Pendlehill,</td><td>3411</td><td></td></tr>
<tr><td>Schehallion,</td><td colspan="2">3564</td></tr>
<tr><td>Helvellyn,</td><td>3324</td><td></td></tr>
<tr><td>Hartfell,</td><td>3300</td><td></td></tr>
<tr><td>Ben Wevis,</td><td colspan="2">3700</td></tr>
<tr><td>Ben Lomond,</td><td>3240</td><td></td></tr>
<tr><td>Saddleback,</td><td>3048</td><td></td></tr>
<tr><td>Ben Ledy,</td><td colspan="2">3099</td></tr>
<tr><td>In Ireland.</td><td></td><td></td></tr>
<tr><td>Slieve Donard,</td><td>3150</td><td></td></tr>
<tr><td>Croagh Patrick,</td><td>2666</td><td></td></tr>
<tr><td>Nephin,</td><td>2640</td><td></td></tr>
<tr><td>Knock Meledown,</td><td>2700</td><td></td></tr>
<tr><td>Mangerton,</td><td></td><td>2500</td></tr>
<tr><td>Cumeragh,</td><td>2160</td><td></td></tr>
<tr><td>In France.</td><td></td><td></td></tr>
<tr><td>Puy de Sanſi,</td><td colspan="2">6300</td></tr>
<tr><td>Plomb de Cantal,</td><td colspan="2">6200</td></tr>
<tr><td>Puy de Dome,</td><td colspan="2">5000</td></tr>
</table>

<table>
<tr><th>Mountains.</th><th>Height by Barom.</th><th>Height by Geometry.</th></tr>
<tr><td>Pyrenees.</td><td>Feet.</td><td>Feet.</td></tr>
<tr><td>Mont Perdu,</td><td>11,000</td><td></td></tr>
<tr><td>Canigou,</td><td>9,000</td><td></td></tr>
<tr><td>Alps.</td><td></td><td></td></tr>
<tr><td>Mont Blanc,</td><td>15,662</td><td></td></tr>
<tr><td>Schrekhorn,</td><td colspan="2">13,000+</td></tr>
<tr><td>Finſteraar,</td><td colspan="2">12,000+</td></tr>
<tr><td>Mount Titlis,</td><td colspan="2">10,818</td></tr>
<tr><td>Mont Roſa,</td><td colspan="2">15,000</td></tr>
<tr><td>Mont Cenis,</td><td colspan="2">9,760</td></tr>
<tr><td>In the Tyrole.</td><td></td><td></td></tr>
<tr><td>Glochner,</td><td colspan="2">11,500 Fr.</td></tr>
<tr><td>Ortele,</td><td colspan="2">13,000 Fr.</td></tr>
<tr><td>Plaley Kogel,</td><td colspan="2">9,748 Fr.</td></tr>
<tr><td>Germany.</td><td></td><td></td></tr>
<tr><td>Stuben,</td><td colspan="2">4692</td></tr>
<tr><td>Brenner,</td><td colspan="2">5109</td></tr>
<tr><td>Lomnitz peak, } Carpath.</td><td colspan="2">8640</td></tr>
<tr><td>Keſmark peak, } Carpath.</td><td colspan="2">8508</td></tr>
<tr><td>Krivan, } Carpath.</td><td colspan="2">8343</td></tr>
<tr><td>Sicily.</td><td></td><td></td></tr>
<tr><td>Ætna,</td><td colspan="2">10,032</td></tr>
<tr><td>In Denmark, Norway, and Sweden.</td><td></td><td></td></tr>
<tr><td>Swukku,</td><td colspan="2">9000</td></tr>
<tr><td>Areſkutan,</td><td colspan="2">6162</td></tr>
<tr><td>Kinneculla,</td><td colspan="2">931</td></tr>
<tr><td>Rœtack,</td><td colspan="2">6000</td></tr>
</table>

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TABLE of the Heights of Mountains, Continued.

Mountains.	Height by Barom.	Height by Geometry.	Mountains.	Height by Barom.	Height by Geometry.
In Russia.	Feet.	Feet.	*South America.*	Feet.	Feet.
Pauda,		4512	Chimborazo,		20,280
			Do.	20,910	
Canary Islands.			Cotopaxi,		18,600
Peak of Teneriffe,	11,424		Tunguragas,	16,170	
In North America.			*In Jamaica.*		
Stony Mountains,	3000		Blue Mountains,	7431	
White Mountains,	4000				
Blue Mountains,	2000				

126 Course of mountains. The course of mountains is that direction of their length in which they descend and grow lower; or if a river runs parallel to them, they are said to have their course in the direction of the stream of the river. The course of mountains is seldom uniform. It has been laid down as a general maxim by Buffon, that when there are two parallel chains of mountains, the salient angle of one of the chains always corresponds with the internal angle of the other; but later geologists have ascertained that this circumstance does not generally hold, except when a river runs between the two chains.

127 Composition of mountains. It generally happens, that one particular mountain, or chain of mountains, is composed of those stony materials which we have denominated primitive; while the rest is made up of the secondary compounds. The primitive substances occupy the base and central parts of the mountain, and often extend to its very summit: the secondary cover these, and are generally found on the flanks or sides of the mountain, though sometimes they cover the top of the mountain. In a chain of mountains there are commonly three, and often five parallel ridges, of which the central ridge is composed of primitive compounds, and those on each side of it, chiefly or entirely of secondary compounds. Hence mountains are usually divided into primary or primeval, and secondary or epizootic; the latter term being given to the secondary mountains from their being replete with shells and other remains of animal beings. The secondary mountains are also sometimes divided into original and derivative, for a reason that will appear hereafter.

128 Distinction of primary and secondary mountains. The primary mountains, besides their being in the centre, and destitute, or nearly so, of organic remains, may generally be distinguished by the ruggedness and angular appearances arising from the different nature and hardness of the substances of which they are composed; the quartz and harder granite resisting the attacks of the air and weather, while the other substances being softer, gradually decay, and leave the harder in the form of spires and angles. Where, however, the primitive compounds have been completely covered with secondary strata, these angular appearances seldom take place; and the mountain is only to be distinguished by its position and the structure of its internal parts. The secondary mountains generally have their tops rounded, and much smoother than those of the primary mountains.

In some cases a number of mountains appear united at their tops into an extensive plain or platform, from which they seem to diverge and branch in every direction. The most remarkable instance of this kind occurs in Tibet. (See GEOGRAPHY, N° 41.)

It is difficult to acquire a knowledge of the interior structure of mountains. The greater part of them is hid from our view, and nature only exposes them in a few points by means of fissures, caverns, and intermediate valleys.

"The materials of which mountains consist are disposed either in irregular heaps, or piles variously interfected by rifts, or in beds or strata separated from each other by rifts, often horizontal, or varying from that direction by an angle of from 5 to 40 degrees, and sometimes much more considerably, approaching even to a vertical position. The strata of mountains are most frequently in the direction of their declivity, yet sometimes their course is directly opposite, or countercurrent: the best manner of determining the angles of their course is by discovering that of their rifts. It chiefly depends on the unevenness of the fundamental ground that supports them. According to 1 Sauss. 502. most of the elevated granitic mountains in Swisserland are formed of immense vertical pyramidal laminæ, parallel to each other, that is, piles somewhat inclining from the unequal distribution of their weight, a disposition that may well be expected from collateral crystallizations; but this disposition is not universal, for they have been found in Saxony, and in the Pyrenees, horizontally stratified; much less can it be said, that this vertical position is general, for the strata of gneiss are generally horizontal, and commonly very regular, discovering no traces of a violent shock. Mount Rosa, next to Mount Blanc, the highest in Europe, consists also of gneiss, which M. Saussure found horizontally stratified.

"Shangin, who lately (1786) travelled over the Altaischan mountains, being consulted by Pallas, whether he found any vertical layers or strata therein, answered, he had not; but that he found them perfectly horizontal on the banks of the river Tschary.

"Mountains of primitive limestone are frequently in irregular piles, but often also horizontally stratified. Siliceous schistus is also often horizontally stratified.

 Many

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Many argillites, particularly roof ſlates, are generally ſaid to have nearly a vertical poſition: but Voight has ſhewn that it is only their lamellæ that are ſo ſituated; their horizontal ſeams, and their walls, diſcovering their true poſition; their verticality ariſing only from the drain of the water, and, conſequently, their contraction in that direction: hence thoſe that are moſt ſilicited, as they contract leſs, diſcover leſs verticality. Sometimes horizontal ſtrata overlap on both ſides. Sometimes they are flanked on both ſides with vertical ſtrata.

"Much confuſion prevails in the ſtructure of the Pyrenees, and of the Griſon mountains, and thoſe on the borders of the Baikal, and other great lakes.

"The perturbed ſtate of the ſtrata often proceeds from the decompoſition of internal beds of pyrites, to which water has had acceſs; this appears to be the cauſe of the alterations obſerved in the mountain of Rabenberg, on the frontiers of Saxony. In this mountain a double direction of the ſtrata of gneiſs is obſerved; between both the ſtrata are vertical, and a large intermediate ſpace is filled with iron ore: but this mountain contains beds of pyrites and vaſt ſwallows; moſt probably then the pyrites ſwoll, uplifted the whole, and the diſſolved iron flowed into the vacuity, from which the water afterwards drained off on the ſides.

"In ſecondary mountains, particularly the calcareous, the greateſt diſorder often prevails, though in general their ſtratification is horizontal.

"The calcarecous mountains of Savoy are often arched like a *lambda*, probably from the ſinking of the intermediate ſtrata, the intermediate remaining horizontal. Sometimes they aſſume the form of the letters Z. S. C. or of a disjointed ƆC, the convexities facing each other. So alſo in the Pyrenees, they ſometimes overlap, from an unequal diſtribution in their original formation, and bend various ways. They aſſume a ſpiral form, or that of a horſe-ſhoe placed horizontally.

"According to Lehman, moſt ſecondary ſtrata preſent hollows or *moulds*, (as they are called,) from internal depreſſion. But ſometimes alſo *elevations*, from an original elevation in the fundamental ſtone.

"In Scotland, all the ſecondary ſtrata in the vicinity of primeval mountains, are nearly vertical; but at a greater diſtance they approach more to an horizontal direction *."

* *Kirwan's Geological Eſſays*, p. 281.

We ſhall now trace the courſe of the principal mountainous chains on the globe, and in accompanying us, the reader may have before him a good map of the world.

129 Equatorial mountains not the higheſt.

M. Buache places the moſt elevated points of the great chains of mountains under the equatorial line: but, according to Pallas, the fulleſt and moſt continuous lands, and perhaps likewiſe the moſt elevated, are to be found at a diſtance from the equator, and towards the temperate zones. If, in fact, we ſurvey the globe's ſurface, we ſhall not be able to perceive that chain of mountains, which running from eaſt to weſt, and dividing the earth into two portions, ought again to meet. On the contrary, extenſive plains ſeem to accompany the line through almoſt its whole extent. In Africa, the deſerts of Nigritia and thoſe of Upper Ethiopia, are on the one ſide of the line; and on the other are the ſandy plains of Nicoco, Caffraria, Monemugi, and Zanguebar. From the eaſtern ſhores of Africa to the Sunda iſlands, is a ſpace of 1500 leagues of ſea with almoſt no iſlands, except the Laccadive and Maldive iſlands; moſt part of which have little elevation, and which run from north to ſouth. From the Molucca iſlands and New Guinea, to the weſtern borders of America, the ſea occupies a ſpace of 3000 leagues. Though Chimboraço and Pichincha in America, the two higheſt mountains which have been meaſured, are near and even under the line, yet from this no concluſion can be drawn; becauſe on one ſide theſe mountains run in a direction not parallel to the equator; the Andes or Cordilleras attain a greater elevation as they remove from the equator towards the poles; and a vaſt plain is found exactly under the line, between the Oroonoko and the river of the Amazons. Beſides, the latter river, which takes its riſe in the province of Lima about the 11th degree of ſouth latitude, after croſſing the whole of South America from weſt to eaſt, falls into the ocean exactly under the equator. This ſhows that there is a deſcent for the ſpace of 12 degrees or 300 leagues. From the mouth of the river of the Amazons, to the weſtern ſhores of Africa, the ſea forms another plain of more than 50 degrees.

From the few certain facts and accurate obſervations which we have received from well informed travellers, we might almoſt affirm that the moſt elevated land on our globe is ſituated without the tropics in the northern and ſouthern hemiſpheres. By examining the courſe of the great rivers, we in fact find that they are in general diſcharged into three great reſervoirs, the one under the line, and the other two towards the poles. This, however, we do not mean to lay down as univerſally true; for it is allowed, that, beſides the two elevated belts, the whole ſurface of the earth is covered with innumerable mountains, either detached from one another or in a continued chain. In America, the Oroonoko and the river of the Amazons run towards the line, while the river St Lawrence runs towards the 50th degree of north latitude, and the river de la Plata towards the 40th degree of ſouth latitude. We are ſtill too little acquainted with Africa, which is almoſt all contained within the tropics, to form any accurate concluſions concerning this ſubject. Europe and Aſia, which form only one great maſs, appear to be divided by a more elevated belt, which extends from the moſt weſterly ſhores of France to the moſt eaſterly of China, and to the iſland of Sagaleen or Anga-hata, following pretty nearly the 50th degree of north latitude. In the new continent, therefore, we may conſider that chain where the Miſſiſſippi, the river St Lawrence, the Ohio, and and the river de los Eſtrechos, take their riſe, as the moſt elevated ſituation in North America; whence the Miſſiſſippi flows towards the equator, the river St Lawrence towards the north-eaſt, and the reſt towards the north-weſt. In the old continent, the belt formerly mentioned, and to which we may aſſign about 10 degrees of breadth, may be reckoned from the 45th to the 55th degree of north latitude: for in Europe the Tagus, the Danube, the Dnieper, the Don, and the Volga, and in Aſia the Indus, the Ganges, the Meran, the Mecon, the Hoang-ho, and the Yang-tſe-Kiang, deſcending as it were from this elevation, fall into the great reſervoir between the tropics; whilſt towards the north

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north the Rhine, the Elbe, the Oder, the Viſtula, the Oby, the Jeniſei, the Lena, the Indigirka, and the Kowyma, are diſcharged into the northern reſervoir.

Judging from thoſe mountains the height of which has been calculated, and from the immenſe chains with which we are acquainted, we may infer that the higheſt mountains are to be found in this elevated belt. The Alps of Swiſſerland and Savoy extend through the 45th, the 46th, and the 47th degrees. Among them we find St Gothard, Furca, Bruning, Ruſs, Whiggis, Scheidek, Gunggels, Galanda; and laſtly, that branch of the Swiſs Alps which reaches Tirol by the name of Arlenberg and Arula. In Savoy, we meet with Mont Blanc, the Peak of Argentiere, Cornero, Great and Little St Bernard, Great and Little Cenis, Coupeline, Servin, and that branch of the Savoyard Alps which proceeds towards Italy through the duchy of Aoſt and Montferrat. In this vaſt heap of elevated peaks, Mount Blanc and St Gothard are particularly diſtinguiſhed. The Alps, leaving Swiſſerland and Savoy, and paſſing through Tirol and Carniola, traverſe Saltzbourg, Stiria, and Auſtria, and extend their branches through Moravia and Bohemia, as far as Poland and Pruſſia.—Between the 47th and 48th degrees, we meet with Grimming the higheſt mountain of Stiria, and Priel which is the higheſt in Auſtria. Between the 46th and 47th degrees, the Bacher and the Reinſchnicken, form two remarkable chains. The upper one, which traverſes the counties of Trencſin, Arrava, Scepus, and the Kreyna, ſeparates Upper Hungary from Sileſia, Little Poland, and Red Ruſſia; the inferior one traverſes Upper Croatia, Boſnia, Servia, and Tranſylvania, ſeparates Lower Hungary from Turkey in Europe, and meets the upper chain behind Moldavia, on the confines of Little Tartary. In theſe mountains are ſituated the rich mines of Schemnitz.

To form a general idea of the great height of this Alpine belt, it is neceſſary only to remark, that the greateſt depth of the wells at Schemnitz is 200 toiſes; and yet it appears, from the barometrical calculations of the learned M. Noda, that the greateſt depth of theſe mines is 286 toiſes higher than the city of Vienna. The granito-argillous mountains of Schemnitz, and of the whole of this metallic diſtrict, are inferior, however, to the Carpathian mountains. Mount Krivany in the county of Arrava, and the Carpathian mountains between Red Ruſſia and the Kreyna, appear by their great elevation to rule over the whole of the upper Alpine chain. In the inferior chain we likewiſe meet with mountains of an extraordinary height; among others, Mount Mediednik, which gives its name to a chain extending far into Boſnia; and Mount Hemus, celebrated even among the ancients. In ſhort, this extenſive chain reaches into Aſia, and is there confounded with another chain no leſs famous, which, following exactly the 50th degree of latitude, runs through the whole of Aſia. This chain of mountains is deſcribed by Dr Pallas in the work above mentioned; and we ſhall now trace its courſe in company with this intelligent obſerver.

131 Uralian chain.

This author places the head of the mountains of Oural, between the ſources of the Yaik and the Bielaïa, about the 53d degree of latitude, and the 47th of longitude. Here the European Alps, after having traverſed Europe, and ſent off various branches which we ſhall afterwards examine, loſe their name, which is changed into that of the Ouralic or Uralian mountains, and begin their courſe in Aſia. This lofty chain, which ſeparates Great Bulgaria from the deſerts of Iſchimſka, proceeds through the country of the Eleuths, follows the courſe of the river Irtis, approaches the lake Teleſkaia, and afterwards forms a part of the ſame ſyſtem of mountains with the Altaic chain. There they give riſe to the Oby, the Irtis, and the Jeniſei, which begin their courſe about the 50th degree of north latitude, and fall into the Frozen ocean.

132 Altaic chain.

The Altaic chain, after having embraced and united all the rivers which ſupply the Jeniſei, is continued under the name of *Saianes*, without the ſmalleſt interruption, as far as the Baikal lake. The extenſion of this chain to the ſouth forms that immenſe and elevated plain which is loſt in Chineſe Tartary, which may be compared with the only plain in Quito, and which is called *Gobi* or *Chamo*. The Altai afterwards interpoſing between the ſource of the Tchikoi and of the rivers which ſupply the Amur or Sagaleen, riſes towards the Lena, approaches the city Jakuck beyond the 60th degree of latitude, runs from that to the ſea of Kamtſchatka, turns round the Ochockoi and Penſink gulfs, joins the great marine chain of the Kurile iſles near Japan, and forms the ſteep ſhores of Kamtſchatka, between the 55th and 60th degrees of latitude. After running in the ſame parallel, and giving riſe to the Ohio, the Riviere Longue, the river St Lawrence, and the Miſſiſſippi, they are loſt in Canada. From the eaſtern ſhores of America to the weſtern ſhores of Europe, we find a vaſt interruption.

133 Alpine chain.

The European Alps produce three principal chains, which run towards the equator, and ſome ſmaller ones running towards the pole. The firſt ſouthern chain is ſent out through Dauphine; traverſes Vivarais, Lyonnois, Auvergne, Cevennes, and Languedoc; and, after joining the Pyrenees, enters Spain. There it divides into two or three ramifications, one of which runs through Navarre, Biſcay, Arragon, Caſtile, Marche, and Sierra Morena, and extends into Portugal. The other, after traverſing Andaluſia and the kingdom of Granada, and there forming a number of mountains, again makes its appearance, beyond the ſtraits of Gibraltar, in Africa, and coaſts along its northern ſhores under the name of *Mount Atlas*.—The ſecond principal chain of the Alps paſſes out through Savoy and Piedmont; ſpreads its roughneſſes over the ſtates of Genoa and Parma; forms the belt of the Apennines; and after frequently changing its name, and dividing Italy into two parts, terminates in the kingdom of Naples and in Sicily, producing volcanoes in every part of its courſe. The third chain is ſent off from Hungary, and ſcatters innumerable mountains over all Turkey in Europe, as far as the Morea and the Archipelago at the bottom of the Mediterranean ſea. The northern branches, though ſmaller at firſt, are no leſs clearly defined; and ſome of them even extend their ramifications as far as the Frozen ocean. An Alpine branch, iſſuing from Savoy through the country of Gex, proceeds though Franche Comtè, Suntgaw, Alſace, the Palatinate, and Veterabia.—

 Another

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Another issues from the territory of Saltzbourg, passes along Bohemia, enters Poland, sends off a ramification into Prussia towards the deserts of Waldow, and after having passed through Russia is lost in the government of Archangel.

134 Asiatic Alps.

The Asiatic Alps send forth in like manner several branches both to the south and north. The Ouralic mountains, between the sources of the Bielaia and the Jaik, produce three principal branches; the first of which, including the Caspian sea in one of its divisions, enters Circassia through the government of Astracan, passes through Georgia under the name of *Caucasus*, sends a vast number of ramifications to the west into Asiatic Turkey, and there produces the mountains Tschilder, Ararat, Taurus, Argée, and many others in the three Arabias; while the other division, passing between the Caspian sea and the lake Aral, penetrates through Chorasan into Persia. The second branch, taking a more easterly direction, leaves the country of the Eleuths; reaches Little Bucharia; and forms the ramparts of Gog and Magog, and the celebrated mountains formerly known by the name of *Caf*, which M. Bailly has made the seat of the war between the Dives and the Peris*. It traverses the kingdoms of Casgar and Turkestan, enters through that of Lahor into the Mogul territory, and, after giving rise to the elevated desert of Chamo, forms the western peninsula of India. While these two branches run towards the south, the third branch of the Ouralic chain rises towards the north, following almost the 79th degree of longitude, and forms a natural boundary between Europe and Asia; without, however, bounding the immense empire of Russia. This chain, after coming opposite to Nova Zembla, divides into two considerable branches. The one, running to the north-east, passes along the Arctic shores; the other, proceeding towards the north-west, meets the northern European chain, traverses Scandinavia in the shape of a horse-shoe, covers the low lands of Finland with rocks; and, as is observed by Dr Pallas, appears to be continued from the North Cape of Norway through the marine chain of Spitzbergen, scattering islands and shelves perhaps throughout the northern ocean, that, passing through the pole, it may join the northern and eastern points of Asia and North America.

* *Lettres sur les Atlantides*, let. 16.

135 The Ouralic, which in the country of the Mongols becomes the Altaic chain, proceeds towards the equator. After forming the mountains and caverns wherein, as we are told, the ashes of the Mongol emperors of the race of Gengis-Kan are deposited, together with the vast plain of Chamo, consisting of arid sand, and the frightful rocks and precipices of Thibet, which form the mysterious and desert retreats of the Grand Lama, it crosses the rivers Ava and Menan; contains in its subdivisions the kingdoms of Ava, Pegu, Laos, Tonquin, Cochinchina, and Siam; supports the peninsula of Malacca; and overspreads the Indian ocean with the isles of Sunda, the Moluccas, and the Philippines. From the borders of the Baikal lake and of the province of Selinginskoy, a branch is detached, which spreads over Chinese Tartary and China, is continued into Corea, and gives rise to the islands of Japan.

The great chain having extended to the north, near the city of Jakuck, upon the banks of the Lena, sends off one of its branches to the north-west, which passing between the two Tungusta, is lost in marshy grounds lying in the northern parts of the province of Jennisseiskoy. The same chain, after it has reached the eastern part of Asia, is lost in the icy regions of the north about Nos-Tschalatskoy, or the Icy Promontory, and Cape Czuczenskoy.

136 Southern elevations.

It will be more difficult, perhaps, to trace the elevated belt in the southern hemisphere beyond the tropic of Capricorn, than it has been to distinguish that towards the north. An immense extent of ocean seems to occupy the whole Antarctic part of the globe.—The greatest south latitude of the old continent is not more than 34 degrees, and South America scarcely extends to the 55th degree. In vain has the enterprising Cook attempted to discover regions towards the pole: his progress was constantly interrupted by tremendous mountains and fields of ice. Beyond the 50th degree no land and no habitations are to be found. The islands of New Zealand are the farthest land in these desert seas; and yet the south cape of Taral-Poenamoo extends only to the 48th degree: We do not mention Sandwich-land, which is situated in the 58th degree, because it is too small and too low. It must be recollected, however, that according to the declarations of travellers, the Cordilleras become higher as they advance southward to the straits of Magellan; and that Terra del Fuego, which lies in the latitude of 55, is nothing but a mass of rocks of prodigious elevation. America, however, exhibits to our view elevated points, whence chains of mountains are distributed in different directions over the whole surface of the new continent. There must likewise be great reservoirs, where the most remarkable rivers take their rise, and from which they necessarily descend towards their mouths. In the southern hemisphere, this elevated belt is nearer the equator; and though it does not extend to the 50th degree, it is evidently to be met with, and may be accurately traced, between the 20th and 30th degrees. The high mountains of Tucuman and of Paraguay, which intersect South America about the 25th degree of latitude, may be considered as the American Alps. If we look into the map of the world, we shall be able to distinguish an elevated belt all along this parallel. In Africa, Monomotapa and Caffraria are covered with very high mountains, from which pretty large rivers descend. In the Pacific ocean, we find New Holland, New Caledonia, the New Hebrides, and the Friendly and the Society islands, under the same parallel. We may, therefore, with sufficient propriety, distinguish this parallel by the name of the *Southern Alps*, as we have already distinguished the elevated belt of the 50th degree of north latitude by that of the *Northern Alps*. In America, the Rio de la Plata, which after a course of 500 leagues falls into the ocean at the 35th degree of south latitude; the Pavana, which rises from the mountains of the Arapes, and falls into the Plata at Corriente; the great number of rivers which flow into that of the Amazons, such as the Paraba, which receives in its course the tribute of more than 30 other rivers; the Madera, the Cuchirara, the Ucayal, &c. &c. all descend from these southern Alps. From these Alps likewise three considerable branches of mountains are detached, which go

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go by the common name of *Andes* or *Cordilleras*.—The first branch, which extends towards the south, and passes out from Paraguay through Tucuman, separates Chili from these provinces and from Chimito, and is continued through Terra Magellanica as far as Terra del Fuego. The second branch, directing its course towards the equator, traverses Peru, in vain endeavouring to conceal treasures which the avarice of men has taught them to discover in its bowels; bounds the Spanish Missions; enters Terra Firma through Popayan; and unites South and North America by the isthmus of Panama. The third division, issuing from Paraguay through Guayra and the territory of Saint Vincent, traverses Brazil, distributes ramifications into Portuguese, French, and Dutch Guiana, crosses the Oroonoko, forms the mountains of Venezuela, and near Carthagena meets the second branch coming from Popayan.

137 Mountains of North America.

We have already supposed, that the elevated belt of North America was situated about the 45th degree of north latitude; and there we imagined we recognized the continuation of the northern Alps of the old continent. This chain likewise sends forth considerable branches on both sides. One of them is detached across the sources of the Mississippi, the Belle Riviere, and the Missouri, and at the entrance of New Mexico divides, in order to form California to the west, and the Apalachian mountains to the east.—Thence proceeding through New Biscay, the audience of Guadalaxara, Old Mexico, and Guatimala, it meets at Panama the southern branch, which is part of the Alps of Paraguay. The second branch, following the course of the Mississippi, separates Louisiana from Virginia; serves as a bulwark to the United States of America; forms the Apalachian mountains in Carolina; and at last, traversing East Florida, encloses the gulf of Mexico with the Great and Little Antilles. In the north, we can trace the branches of the elevated belt; on one side observe them proceeding towards Canada, directing their course through Labrador to Hudson's Straits, and at length confounded with the rocks of Greenland, which are covered with eternal snow and ice. On the other side, we see them rising through the country of the Assinipoels and the Kristinos, as far as Michinipis and the northern Archipelago.

138 British mountains.

In tracing the course and direction of the British mountains, we shall begin with the central chain, which runs through the southern part of the island from north to south, commencing at Geltsdale, about 14 miles to the south-east of Carlisle, and ending at Land's End in Cornwall, or rather in the Scilly isles to the west of this. This chain passes from Geltsdale forest through the western districts of Durham and Yorkshire, forming the hills called Kelton Fell, Stanmore, Widehill Fell, Wildbore Fell, Bow Fell, Home Fell, Bun Hill, &c. A little to the west of the chain stand several detached mountains, the principal of which is Skiddaw in Cumberland. Passing through Yorkshire we find Craven, Whurnside, Ingleborough, and Pennygent; and on the east of Lancaster is Pendle. In this course there are several miles of coal and lead. The chain next proceeds through Derbyshire, and in this part of the ridge a great variety of valuable minerals are found, especially lead, copper, gypsum, fluor, barytic earths, martial pyrites, iron ore, manganese, and several ores of zinc. About this point the ridge stretches a little into Cheshire, and seems to terminate; a central chain of somewhat less elevation may, however, still be traced, proceeding in a waving direction towards Salisbury, and having three irregular branches, two to the east, and another running to the south-west into Cornwall. The first eastern branch proceeds towards Norfolk, and to this belong some considerable hills, especially those of Gog Magog in Cambridgeshire. The second branch passes into Kent, and diverges a little into Surry and Hampshire. The continuation of this chain is afforded by the hills of Mendip, Polden, Ledgemoor, and Blackdown in Somersetshire; the Tores and Wilds of Dartmore in Devonshire, and the upland Downs of Cornwall. Malvern hills in Worcestershire deviate a little from the chain, but those of Cotswold in Gloucestershire appear to be a continuation of it. The principal mineral found in this ridge of mountains, after leaving Derbyshire, is the tin ore of Cornwall.

Wales contains many mountains, especially in its northern part, where Snowden is celebrated for its height and classical fame. The top of this mountain is formed almost into a point, and commands an extensive view, not only of the neighbouring counties, but of part of Scotland and Ireland, and the isles of Mann and Anglesey. A line of mountains proceeds from Snowden along the western coast to Plinlimmon; and in this line lie Urrou Seth, Caeridris, and Moyle Vadiau. A few hills of little elevation proved towards Shropshire, among which the Wrekin is the most remarkable. Another small chain proceeds south towards Cardiff, but contains no hills of any eminence. 139

140 Scotch mountains.

Leaving England, and proceeding towards the north, we find the Cheviot Hills, so celebrated in the history of the border skirmishes. These form a regular ridge, running from south-west to north-east, where they join the hills of Galloway. In this part of Scotland there are several mountainous ridges running in various directions, generally north and south according to the course of the rivers; but there is, properly speaking, no uniform chain. Dumfriesshire contains several mountains, some of which are of a considerable height, especially Hartfell in Annandale, from which proceeds the celebrated chalybeate spaw; Lowther near Leadhills; Blacklaw on the borders of Ayrshire; Etrick Pen, in Eskdale moor; Carnkinnow near Drumlanrigg; and Queensberry hill, which gives the title to the dukedom of that name. Proceeding towards the north, we find Pentland hills, a little to the south-west of Edinburgh, and the romantic hills of Arthur's seat and Salisbury Craigs, in the immediate vicinity of that city. On the eastern coast, before crossing the Forth, is North Berwick Law, which must be considered as closing the list of southern hills in Scotland. The principal part of these southern hills consists of calcareous earth, and argillaceous schistus; and except in those of Galloway, granite and other primitive rocks are very sparing. In the Lothian hills the calcareous strata are surmounted by vast blocks of trap, wacke, and basalt.

On the north of the Forth are the hills of Ochil, of little elevation, but celebrated for affording large quantities of agates and chalcedonies. The hills of Kinnoul and Dunsinnan in the eastern part of Perthshire, are generally considered the last of the lowland hills.

The

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The principal northern chain of Britiſh mountains is that of the Grampian hills, extending from Loch Lomond to Stonehaven, and forming the ſouthern boundary of the Highlands; and riſing by a gradual tranſition from the Sidlaw hills on the eaſt, the Campſey hills on the weſt, and the Ochils in the middle. The principal mountains of this chain are Ben Lawers, Ben More, Schehallion, Ben Vorlich, Ben Lomond, and Ben Ledy. Near Ben Lawers is Ben Nevis, the higheſt mountain in Britain, and to the north-weſt of this near Fort Auguſtus, is the long hill of Corri Allok. About 30 miles to the eaſt of this is the high mountain of Cairngorum, famous for the ſpecimens of quartzoſe ſtones found there. Numerous mountains lie in the ſecond diviſions of the Highlands, beyond Loch Linnè, and Loch Neſs, eſpecially on the weſtern ſhore, which is crowded with hills. Few of theſe are conſiderable. To the weſt of Roſsſhire are ſeveral hills, among which Ben Chat, Ben Chaſker, and Ben Golich are the moſt remarkable. More inland ſtands the high mountain of Ben Wevis, nearly equal to Ben Nevis. In moſt of theſe mountains the primitive rocks prevail, and granite is often very abundant. Few minerals, however, except iron ore, are found.

141 Iriſh mountains.

Ireland contains but few mountains, and none of any conſiderable importance. They generally form ſhort lines, or appear in detached groups, one of the higheſt of which is that on the weſt and ſouth of the lake of Killarney, in which is the mountain of Mangerton. A ſmall line of hills called Shecky mountains runs on the north-weſt of Bantry Bay, paſſing towards the eaſt. To the northward of this ſtands Sliblogher and Nagles, and towards the eaſt are the hills of Knockemdown. In the county of Leinſter is a mountain of the ſame name, and to the ſouth of Dublin are the Wicklow hills, from which there were lately ſuch great expectations of golden treaſure. In Ulſter ſtand the mountains of Mourne, the higheſt of which, Donard, is ſaid to be nearly the height of Mangerton. The moſt mountainous part of Ireland is the weſtern peninſula of that iſland, towards which, in the county of Mayo, ſtands Nephin, one of the higheſt in the kingdom. On the ſouth-eaſt of Clewbay is the mountain of Croagh Patrick, alſo in the county of Mayo, which is the laſt Iriſh hill of any importance.

We cannot here with propriety enter on the theory of the formation of mountains. The hypotheſis of the principal geological writers with reſpect to this ſubject, will be ſeen from the general view of the theories to be given in the next chapter. We may in this place only remark, that all the ſyſtems which have been conſtructed, to explain the formation of the primitive mountains, with reſpect to which there is the moſt diſpute, may be reduced to three.

In the firſt of theſe, mountains are ſuppoſed to have been formed ſuch as we now ſee them, except that they have ſuffered ſome degradations and modifications, from certain accidents poſterior to their original formation, and that theſe mountains owed their elevation above the places which ſurround them, to one ſingle accidental accumulation of more materials in one place than in another; an accumulation which might have taken place without that great precipitation which preceded and occaſioned the conſolidation of the cruſt of our globe.

In the ſecond hypotheſis, all the primitive mountains are ſuppoſed to have been raiſed by one cauſe, and in one certain manner; and the materials which compoſe them, to have been thrown out of their natural poſition. It is with reſpect to this raiſing or diſplacement that geologiſts have imagined ſo many different hypotheſes.

In the third general theory, theſe mountains are ſuppoſed to have become pre-eminent from the accidental lowering or removal of the materials which originally ſurrounded them, whether this happened from the materials compoſing theſe mountainous ſituations having ſuffered no diſplacement, or that they had been themſelves removed.

M. Dolomieu is of opinion, that there are mountains whoſe ſituation and ſtructure favour each of theſe three hypotheſes. *

* *Jour. de Min.* No. xiii. p. 421.

Sect. II. *Of Dykes.*

142 Hiſtory of dykes.

We have deſcribed dykes (N° 15.) to be thoſe interruptions of the ſtrata which are formed by perpendicular fiſſures filled with ſtony ſubſtances. As theſe ſtony matters are frequently of that kind called whinſtone, theſe dykes are commonly called *whin dykes*, and the hiſtory of theſe is very important, as they form one of the principal ſubjects in the principal theories of the earth.

143 Names.

Dykes have received different denominations, deſcriptive, in ſome meaſure, of the nature of the ſubſtances of which they are compoſed; or of the ſeeming effects they have produced on the interſected horizontal ſtrata. They are called *baſaltic veins*, *trap dykes*, *whin dykes*; and in the coal countries of Scotland they are called *gaws*, from the idea that they have occaſioned the ſeparation of the coal, and contiguous ſtrata, through which they run.

Theſe dykes have been more attentively obſerved in coal countries, than where they occur elſewhere; becauſe on the accurate knowledge of their courſe, inclination and thickneſs, depend, in a great meaſure, the judicious and ſucceſsful operations of the miner, when his workings approach the dike, or render it neceſſary to cut through it to reach the ſtrata of coal on the other ſide. But, though leſs attended to, they have been obſerved and traced in other places, where a great extent of the horizontal ſtrata have been expoſed in the beds of rivers, as in the bed of the Water of Leith, above St Bernard's Well, near Edinburgh, and on the ſea ſhore, eſpecially on the weſtern coaſts of Scotland, where the rocks are more abrupt and precipitous, and where the violence of the Atlantic ocean has removed part of the horizontal ſtrata, and left the vertical ſtrata remaining, like immenſe walls or dykes. Hence probably the origin of the name; and as they often conſiſt of that ſpecies of ſtone called *whinſtone*, this epithet has been added.

144 Courſe.

The courſe, however, of the greater number which we have had the opportunity of examining, generally lies between the points of the compaſs S. and S. E. and N. and N. W. This is moſt frequently the courſe of the whin dykes of Iſlay and Jura; it is the courſe of a remarkable dyke which traverſes the coal ſtrata at the village of Stevenſon, near Saltcoats, in Ayrſhire; part of which is ſeen on the ſurface, not many hundred yards to the north of the weſt end of that village;

lage; and it is the courſe of two dykes, ſtill more remarkable, in the iſland of Great Cumbray, in the frith of Clyde.

Geologiſts, who have treated this ſubject, do not ſeem to have marked, with much attention, the courſe of the dykes. They have mentioned in general terms, that they follow all directions. More extenſive obſervation may probably ſhew, that the moſt frequent directions of the principal dykes, is from north to ſouth, or a few points deviation from that courſe. And if this be eſtabliſhed, by a fuller and more accurate hiſtory of dykes, the analogy between them and metallic veins will be more complete; for it is obſerved of the latter, that the moſt powerful, that is, the moſt productive, run from north to ſouth.

Dykes do not always run in a ſtraight line. In their courſe they form certain flexuoſities. But, in this winding courſe, the deviations are uſually ſo ſmall, as to have little effect on the general direction of the dyke, which, upon the whole, may be conſidered as nearly the ſame.

The continuity of dykes is ſometimes interrupted, exactly in the ſame manner as frequently happens to the horizontal ſtrata, and which, in technical language is termed a *ſlip*.

In the iſland of Iſlay we have obſerved two dikes of this deſcription, the one on the ſouth ſide of Lochindal, near the point of Laggan; the other on the ſhore of the ſouth-eaſt part of the iſland, a little to the ſouth of the houſe of Ardmore. In both theſe dykes, the extent of the ſeparation of the ſlip was juſt equal to the thickneſs of the dyke. The oppoſite ſides were brought exactly into the ſame line.

After this ſeparation, theſe dykes, in ſo far as they could be traced, preſerve the ſame thickneſs, courſe, and inclination as formerly.

A very remarkable dyke has been diſcovered in the coal field, in the diſtrict of Boulogne in France. It runs in the form of a creſcent from north to weſt.

145 Inclination. The direction of dykes downwards is ſeldom perpendicular. This deviation from a line perpendicular to the horizon is called their inclination. The inclination of a dyke is uſually denominated the *hade* or *hading*. See the article Coalery.

The inclination of different dykes, and even of the ſame dyke, is various, ſometimes approaching to, and ſometimes deviating from the perpendicular. The extent of dykes downwards, we believe, has not been aſcertained with any degree of accuracy, and the termination of very few has yet been detected. The depth to which reſearches of this kind can be carried, is comparatively ſmall. With all the ardour, ingenuity, and power of man, inveſtigations to determine this point, will probably always be limited by the extent of his mining operations. The creſcent-formed dyke juſt mentioned, which occurs in a coal-field in the diſtrict of Boulogne in France, which conſiſts of a ſpecies of marble, found in ſeveral quarries in the vicinity, has been traced to the perpendicular depth of 600 feet, where it is ſucceeded by a ſchiſtus rock, which latter, with the ſame courſe and inclination, continues to interſect the horizontal ſtrata.

146 Extent. The extent of dykes in length has not been accurately determined. Indeed, it muſt be extremely difficult to trace them with any degree of certainty. For thoſe which are obſerved on the ſea coaſt, where they are moſt conſpicuous, ſoon diſappear in the mountains, on the one hand, or on the other loſe themſelves in the ſea. And, as the extent of the ſame coal field rarely exceeds a few miles, they have ſeldom been followed beyond its limits. In many caſes, the change in the nature and arrangement of the ſtrata, renders it almoſt impoſſible. Some, however, have been traced to a very great extent; one in particular, on the banks of the river Meuſe in the Netherlands, has been followed in its direct courſe, to the diſtance of four leagues; and of this dyke it is obſerved, if purſued through all its windings, the extent is not leſs than ſix leagues.

The thickneſs of dykes is various. Sometimes they are obſerved no thicker than a few inches. From that they increaſe to one foot, ſix feet, and very often are found from 10 to 20 feet. There is one in the iſland of Iſlay, of the enormous thickneſs of 69 feet. This immenſe dyke accompanies a lead vein, about a foot thick, which is included between it and the limeſtone ſtrata. In this mining field, two whin dykes, one of them 10 feet thick, have been diſcovered, croſſing the metallic veins. 147 Thickneſs.

In going downwards, dykes are ſaid to decreaſe in thickneſs. This is particularly obſerved of dykes of ſmaller magnitude. Of ſmaller dykes it is alſo ſaid, that they diminiſh in thickneſs towards the extremities.

In one reſpect, ſome whin dykes are exactly analogous to metallic veins, in having branches, or in the miners phraſe, *ſtrings* going off and traverſing the contiguous ſtrata, and forming in the courſe they take, an acute angle with the principal dyke. A whin dyke of this deſcription has been obſerved in the iſland of Jura, on the ſhore of the ſound. The diverging branch terminated in a point among the horizontal ſtrata, at the diſtance of a few feet from the great dyke, aſſuming altogether a wedge-like form.

If we include metallic veins in the account, the vertical ſtrata may be ſaid to be compoſed of every kind of mineral ſubſtance, but almoſt always different from the interſected horizontal ſtrata. By this laſt circumſtance their occurrence is at once recognized. In general, the dykes that are found in Scotland, whether in the coal countries, or in the weſtern coaſts and iſlands, where they are ſo frequent, are of that ſpecies of ſtone which comes under the denomination of trap or whinſtone. Dykes, conſiſting of other ſpecies of ſtone, have alſo been found in Scotland. On the Mull of Kinouth, which forms the ſouthern headland, at the entrance of Lochindaal, in Iſlay, we obſerved a ſmall dyke of granite, croſſing the headland, which is of granular quartz. There are ſome vertical ſtrata of granite in the iſland of Icolmkill, of pitchſtone in the iſland of Arran, and of ſerpentine at Portſoy in Banffſhire. 148 Materials.

Bergman, in his Phyſical Geography, ſuppoſes that granite was never found to be a component part of vertical ſtrata. What has been already mentioned proves the contrary. Granite dykes have alſo been diſcovered in other places. Beſſon has obſerved dikes of this deſcription on the great road between Limoges and Cahors in France, traverſing horizontal ſtrata of argillaceous ſchiſtus, a ſpecies of ſtone which has generally been conſidered of later formation than granite. Theſe dykes, he obſerves, are from an inch to ſix

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six feet in thickness, and the quartz, feldspar, and mica, are of larger size than are usually found in the granite of mountains. Dolomieu has made a similar observation, and considers it as a discriminative character, by which the granite of mountains and that found in vertical strata may be easily distinguished. But this is not always to be admitted as a characteristic mark of distinction. The granite dyke which has been already mentioned, crossing the granular quartz, on the Mull of Kinouth in Islay, is small grained, and others of this latter description have been observed in other places.

There is a very singular dyke on the coast of Ayrshire, between Weems bay and Largs, near the house of Kelly. It is about ten feet thick, traverses the horizontal strata, which consist of plumb-pudding rock, whose cement is sandstone of a red colour, from north-east to south-west, and crosses a larger dike of the whinstone of this country, nearly at right angles. This dike is composed of different materials. Part is of the common whinstone, and part of a plumb-pudding rock, cemented by the matter of the dyke; and these alternate with each other, both in the thickness of the dyke, and lengthwise. On one side, there are four feet thick of whinstone; immediately in contact with this there is plum-pudding stone three feet thick, and so on alternately, across the whole dyke. In tracing the dyke lengthwise across the whole line, there is found a few yards of whinstone, which is succeeded by a few yards of plum-pudding stone, and this is again succeeded by the whinstone.

But, for the general view which is here proposed, it is not requisite to give a full account of all the mineral substances which enter into the composition of vertical strata, or even a minute enumeration of all the varieties that are found in whin dykes.

149 Peculiar structure of whin dykes.

One of the most singular circumstances respecting whin dykes, which seems to have been entirely overlooked by geologists, still remains to be considered. This is the peculiar structure or arrangement of the parts of which they are composed. Of this peculiar arrangement it may be observed in general, that it is in all respects the reverse of what takes place in the horizontal strata.

When the dyke is of small magnitude, it is pretty compact in all its parts; but if an attempt be made to break or separate any part of it, the fracture will be found to run most readily in the perpendicular direction. But when the dyke is of more considerable thickness, it usually forms several divisions, marked by perpendicular fissures, and there is often very great variety in the nature and qualities of the several divisions of the same dyke. The exterior division of one side sometimes, and sometimes the exterior division of both sides, are of a softer texture than the intermediate division; and often contain, in great proportion, specks of radiated zeolite and calcareous spar, while the middle divisions, as well as being harder, are also more homogeneous. In other cases, the reverse of this appears. The middle parts of the dyke are the softest and least compact, exhibiting the greatest variety of heterogeneous substances.

Some whin dykes have a great tendency to assume, when broken, the prismatic form. This is the case with many, even of the most compact texture. In others, where the side of the dyke is exposed to view, and minutely examined, fissures may be traced, discovering the ends of pretty regular prisms. But in some dykes in the island of Jura, the prismatic columns are entirely separated, and lying loose, are four, five, or six-sided, jointed; the perpendicular fissures forming the joints, and in all respects similar to the perpendicular basaltic columns, except being in the horizontal position. In one of the dykes in the island of Jura, the columns are from 12 to 18 inches in diameter. In some others on the sea shore, near the house of Mr Campbell of Jura, and at the harbour of the small isles, in the same island, there are columns of the enormous size of 10 and 12 feet diameter.

A dyke which traverses the basaltic strata of the Giants Causeway in the north of Ireland, exhibits still more remarkably this peculiarity of structure. The smallest masses detached from it assume the columnar form, and most of them are perfectly regular. The fracture invariably runs in the horizontal direction; the columns consequently lie in the same position, are three, four, five, and six-sided, and are generally of small size.

Sect. III. *Of Metallic Veins.*

150 Metallic veins.

The history of metallic veins, although far from being so full and satisfactory as could be wished, is more complete than that of whin dykes. The latter have excited no farther attention than as objects of curiosity to the geologist, or as singular facts in establishing a theory, and when they come in the way of the operations of the miner, to discover their connexion with the contiguous strata; while the wants and luxuries of man have roused ingenuity and exertion in exploring the former, on account of the precious and useful metals with which they are stored. Thus, the splendour and beauty of some metallic substances, and the utility of others, have made them in all ages be esteemed and valued by mankind; and consequently they have been the constant objects of pursuit and investigation. It is obvious that the beauty and utility of metals, on account of which they are so much valued and sought after, excite greater interest in procuring them; on the one hand, the researches and observations of the philosopher in furnishing the history and general principles, and, on the other, the immediate application of this knowledge, and of these principles, in the practice and operations of the miner.

The history of whin dykes is, in general, quite analogous to metallic veins; but, of the latter, from what has been stated, we can speak with more certainty and precision.

151 Distinction of veins.

Three different kinds of metallic veins have been described by geological writers; the *perpendicular* vein, the *pipe* vein, and the *flat* or *dilated* vein. We shall consider each of these in their order.

152 Perpendicular veins.

1. *Of the perpendicular vein.*—This kind of metallic vein occurs most frequently. As may be expected, it is various in its course or direction, thickness, and inclination. Metallic veins are found running in every direction; but, in general, the most powerful veins, that is, the most productive, are observed to run from north to south, or at least a few points deviation from that course; and when any deviation happens, it is usually to the east of north, and to the west of south.

153 Course of veins.

The course or direction of a vein is called in technical

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cal language its *bearing*. The extent of a vein in the line of bearing, we believe, rarely exceeds the range of mountains in which it is discovered. This is the case with the principal vein at Leadhills. It is limited to the chain of mountains in which the operations are now carried on; and although the mines of Wanlockhead are not a mile distant, new veins appear with galena or lead ore, of quite a different quality, and all the accompanying minerals, whether forming part of the vein, or found in cavities, are also quite different from the lead ore and other minerals found in the veins at Leadhills.

154 Inclination.

The inclination of veins is various. Sometimes they are nearly perpendicular; sometimes they deviate considerably from a perpendicular line; sometimes the same vein in its course downward, inclines to one side; sometimes it is perpendicular, and sometimes it inclines to the other side. When the deviation from the perpendicular does not exceed 10°, the vein is still considered as a perpendicular or vertical vein. When a vein is inclined, the two sides which include the metallic substances are in very different positions, and have consequently received from the miners different names. That side which supports the metallic ore, or on which it seems to lean, is called the *ledger side*, or simply the *ledger*. The opposite side which covers the ore, or which overhangs it, is denominated the *hanging side*, or simply the *hanger*. From the inclination of the vein being varied in its course downwards, it must appear that the same sides, according as the inclination varies, must change their position and denomination. This will perhaps be more intelligible by the section at fig. 5. in which AA represents the vein; BB, CC, DD, EE, the strata intersected by it; 1. the hanger; 2. the ledger; 3. the hanger; and, 4. the ledger.

155 Thickness.

The thickness of veins, and indeed of the same vein, is also extremely various. Sometimes they are only a few inches thick. From this they increase to the thickness of several feet. The veins which were wrought at Leadhills, about seven years ago, were from two to six feet within the sides; but some years before that time the principal vein in those mines, by the addition of two strings or small veins, assumed the extraordinary thickness of 14 feet of pure ore. This unusual appearance, both on account of its richness and grandeur, excited so much attention and admiration, that the countess of Hopetoun undertook a journey to these inferior regions, not less than 150 fathoms below the surface of the earth, to witness the splendour and brilliancy of this subterraneous apartment. The uncommon thickness and abundant riches of this vein are still talked of at Leadhills with enthusiasm. But a thicker vein was once wrought at Slangunog in Wales. Fifteen feet of clean ore were for some time dug out of this vein. These are, however, far exceeded by the copper veins in the Parys mountain in Anglesea, which are described by Mr Pennant in his Welsh tour. The thickness of one of these veins is 21 feet, and of another 66 feet.

The broadest metallic vein, of which we have any account, is, we believe, that of the Ecton copper mine, in Derbyshire. In this mine there was worked, at one time, a heap of ore, of the astonishing extent of 70 yards from side to side *.

* *Mawe's Derbyshire*, p. 112.

The extent of veins downwards has in many cases been ascertained. To the regret and disappointment of the miner, they have been frequently intercepted and entirely cut off by the horizontal strata. The rich vein of lead ore at Slangunog in Wales, which we have already mentioned, was intercepted in this manner by a stratum of black schistus or shiver, the nature of which is not described by Williams, who states the fact *. Their researches to recover their lost wealth, which were prosecuted for several years, proved altogether fruitless. The smallest trace of this unusually productive vein was never afterwards discovered.

* *Mineral Kingdom*, vol. 1. p. 274.

156 Two kinds of perpendicular veins.

Two kinds of perpendicular mineral veins have been observed and described. In the one case the relative position of the strata which contain the metallic substances is exactly similar to that of the coal strata when they are intersected by a whin dyke. On one side of the vein the strata are elevated or depressed from their former plane. This is illustrated by fig. 5. where the letters BB, CC, DD, EE, mark the corresponding strata which have been deranged or displaced. In the other kind of vein the mineral substances containing the metallic ores are merely separated without any elevation or depression; for each side of the fissure still remaining in its former plane, the opposite sides of the divided strata exactly correspond to each other. The mines at Strontian in Argyleshire are of this latter description.

Veins of this kind have frequently smaller veins, or, as they are called in the language of the miners, *strings*, which run off at an acute angle, preserve their course for some distance, not, in general, very great, gradually diminish in thickness, and at last are entirely lost among the contiguous strata. At the place of junction the principal vein is always thicker, as has been already noticed with regard to the unusual thickness of the principal vein at Leadhills.

To this account of perpendicular veins we may add, that some veins are found crossing each other, and that whin dykes have also been discovered intersecting metallic veins. Examples of the latter occur in the island of Islay.

157 Pipe vein.

2. *Of the pipe vein.*—The perpendicular vein last described, intersected or cut the strata across. What has been denominated the pipe vein is extremely limited in the line of bearing, but having the same inclination as the strata which include it. It may be considered as in some measure of a circular form, extremely irregular, and always following the course of the strata between which it is included, like the perpendicular veins; sometimes as it dips downwards, it is enlarged; sometimes it is diminished, and sometimes it is so much contracted, that the including strata come into close contact. In a word, this kind of vein is subject to all the irregularities of the veins formerly described, only that its inclination is invariably the same with the accompanying strata.

158 Flat vein.

3. *The flat or dilated vein.*—This kind of metallic vein, after what has been said with regard to other veins, will require but a short description. It is exactly similar to the pipe vein, only that it is more extended in the line of bearing. It is included between the horizontal strata; and therefore its inclination or dip must be the same as the including strata. A vein of this kind might with more propriety and accuracy be regarded as a metallic horizontal stratum, were it not that

that it is always found varying in its dimenſions, and equally irregular as the perpendicular veins which interſect the horizontal ſtrata.

It is almoſt needleſs to add, that the flat or horizontal veins are ſubject to the ſame derangement as the coal ſtrata, when they are interſected by a whin dyke. The vein, along with the including ſtrata, is either elevated or depreſſed, and the ſame thing takes place when they are traverſed by a metallic vein.

159 Metallic ores. To finiſh the ſketch of the hiſtory of metallic veins, we have only to enumerate the different metallic ores that occur in them, and to mention the places where theſe are found in greateſt abundance. In this enumeration we ſhall follow the arrangement of metals given by Brochant, in the ſecond volume of his *Traité Elémentaire de Mineralogie*.

In naming the ſeveral ſpecies, we ſhall adopt the nomenclature of Kirwan, adding the French and German ſynonyms to each. As it would far exceed our limits to give even a *curſory deſcription* of the ſeveral ſpecies, we refer the reader for that to the article MINERALOGY in this work, or to the elementary treatiſes of Kirwan or Brochant, or the more extenſive treatiſe of Haüy.

I. PLATINA

160 Platina ores. Has been found hitherto only in its metallic or native ſtate, and it has as yet only been met with in South America, eſpecially at Choco in New Grenada. It is found in the ſand of rivulets, and probably comes from the primitive mountains.

II. GOLD.

161 Gold ores. *Native gold.*—This is found principally in primitive mountains, ſometimes in veins, and ſometimes diſſeminated through the ſtony matter. The ſubſtances which moſt commonly accompany it are quartz, feldſpar, calcareous ſpar, heavy ſpar, pyrites, red ſilver ore and vitreous ſilver ore, and galena. Gold is ſtill more commonly met with in the ſand waſhed from certain rivers. The countries where gold is chiefly found in rocky ſubſtances, are Hungary, Tranſylvania, Peru, Mexico, Siberia, and Sweden. It has alſo been found in France, near the town of Oiſans, in the department of the Iſere; but not in ſufficient abundance to render the working of the mine profitable. Among the rivers whoſe ſands furniſh gold, we may enumerate the Rhine, the Danube, and the Aranioſch in Tranſylvania.

Gold has been found in ſeveral parts of the Britiſh dominions, eſpecially at Silſoe in Bedfordſhire, in the Wicklow hills in Ireland, and in the neighbourhood of Leadhills in Lanarkſhire. It is ſaid that a jeweller, who died lately in Dublin, often declared that gold, to the value of 30,000l. had paſſed through his hands, which was brought from the Wicklow hills. This mine is now in the hands of government, but we believe does not anſwer the expectation that was firſt formed as to its produce. General Dirom informs us, that in the reign of James V. of Scotland, 300 men were employed for ſeveral ſummers in waſhing the ſand near Leadhills, for gold, of which they are ſaid to have collected to the amount of 100,000l. ſterling. It is ſaid that pieces of gold, an ounce in weight, have been found at Leadhills, and that Lord Hopetoun has a piece ſtill larger in his poſſeſſion *.

* *Mawe's Derbyſhire*, p. 159.

III. MERCURY.

162 Mercury ores. Species 1. *Native Mercury*, or *Quickſilver*. Le Mercure natif. Gediegen Queckſilber.—This is found at Idria in the Auſtrian territories; at Almaden in Spain, at Stahlberg and Moſchellandſberg in the Palatinate, and a few other places.

We are told by Mr Jameſon, that a quantity of quickſilver was diſcovered ſome years ago in a peat moſs, in the iſland of Iſlay, and he thinks it probable that veins of it may be ſtill found there *.

* *Min. of the Iſles*, vol. i. p. 153.

Species 2. *Natural Amalgama.* L'Amalgame natif. Naturaliches Amalgam.—This conſiſts of mercury and ſilver, in very variable proportions. It is found at Saldberg in Sweden; at Roſeneau in Hungary, and eſpecially at Moſchellandſberg in the duchy of Deux Ponts, where it is found mixed with common ferruginous clay, and with other ores of mercury.

Species 3. *Mercury Mineraliſed by the Sulphuric and Muriatic Acids.* Mercure Cornée *ou* Muriaté. Queckſilber Hornerz.—This ſpecies was diſcovered about 30 years ago, in the mines of Moſchellandſberg, and at Morefeld, in the duchy of Deux Ponts, by M. Woulfe, mixed with ferruginous clay, quartz, lithomarga, native quickſilver, and cinnabar. It has alſo been found at Almaden in Spain, and at Herſowitz in Bohemia; but it is very rare.

Species 4. *Native Cinnabar.* Le Cinnabre. Zinnober.—This uſually forms a gangart for the other ores of mercury. It occurs in the ſtratiformed mountains, pretty near the ſurface. This ore is found in a great many parts of Europe, eſpecially at Almaden in Spain, Idria in the Auſtrian territories, at Moſchellandſberg, in Bohemia, in Saxony, in Hungary, in Tranſylvania, in the Palatinate, and in France; but in this laſt it is found but in ſmall quantity.

IV. SILVER.

163 Silver ores. Species 1. *Native Silver.*—A particular variety of this ſpecies, mixed with gold, is very rare. It is principally found in Conigſberg in Norway, and Schlangenberg in Siberia. In the former of theſe places it is found diſſeminated through calcareous ſpar, fluor ſpar, and rock cryſtal, in a vein running through a rock of hornblende ſlate, and accompanied with blende, galena, and pyrites. That of Siberia is found diſtributed through a maſs of heavy ſpar.

Common native ſilver is found in conſiderable quantity in Mexico and Peru. It is alſo met with in Siberia, Saxony, France, Sweden, Norway, in the Hartz, and in Bohemia. It is principally found in the primitive mountains, diſtributed through maſſes of heavy ſpar, quartz, calcareous ſpar, fluor ſpar, pyrites, blende, cobalt, galena, red ſilver ore, and vitreous ſilver ore.

Silver has been found in ſeveral parts of Britain, eſpecially near Alva in Scotland. It is confidently affirmed, that a maſs of capillary ſilver, weighing 16 oz. was found in the lead mines at Garthoneſs in the iſle of Iſlay, mixed with galena †.

† *Min. of Iſles*, vol. i. p. 153.

Species 2. *Antimoniated Native Silver.* L'Argent Antimonial. Spieſglas Silber.—This ſpecies has hitherto been only found in the mine at St Wenceſlas at Altwolfach, and in the duchy of Wurtemberg, in a vein mixed with calcareous ſpar, heavy ſpar, native ſilver, and quartz.

Species

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Species 3. *Arseniated Native Silver.* L'Argent Arsenical. Arsenik Silber.—This is also rare, having been found only at Andreasberg, in the Hartz, and at Kassala in Spain. In the Hartz it is mixed with native arsenic, red silver ore, galena, blende, and calcareous spar. Considerable quantities of silver, probably of this species of ore, are obtained from the lead ore of Leadhills.

Species 4. *Corneous Silver Ore*, or *Muriated Silver.* L'Argent Cornèe *ou* Muriaté. Horn Erz.—This has been found in Peru, Mexico, Saxony, France, Siberia, and, as is affirmed, in Cornwall in England.

Species 5. *Sooty Silver Ore.* L'Argent Noir. Silberschwarze.—This is found in Saxony, France, and Hungary, mixed with other ores of silver, and sometimes with native silver.

Species 6. *Vitreous Silver Ore.* L'Argent Vitreux. Silberglaserz.—This is found in Bohemia, Saxony, Norway, Swabia, Siberia, and in Hungary, mixed with other silver ores, and usually accompanying calcareous spar, heavy spar, and fluor spar.

Species 7. *Red Silver Ore.* L'Argent Rouge. Rothgittegerz.—This is found in the Hartz, Bohemia, Saxony, France, Swabia, and in Hungary, accompanying native arsenic, realgar, vitreous silver ore, galena, calcareous spar, and heavy spar.

V. Copper.

164 Copper ores.

Species 1. *Native Copper.*—This is met with in Siberia, the Uralian and Altaischan mountains, Kamtschatka, Japan, Saxony, France, Sweden, Hungary, Palatinate, and near Redruth in Cornwall, in England. It usually accompanies other ores of copper, especially malachite and copper azure.

Species 2. *Vitreous Copper Ore.* Le Cuivre Vitreux. Kupferglas.—This is found in Siberia, Hungary, Sweden, Norway, Russia, Saxony, Silesia, Hesse, and in Cornwall.

Species 3. *Purple Copper Ore.* La Mine de Cuivre Violette. Buntkupfererz.—This is always found in the neighbourhood of other copper ores, especially with the species last mentioned, and with copper pyrites. It is found in Saxony, Bohemia, the Bannat in Transylvania, the Hartz, Norway, Russia, Sweden, Hungary, Hesse, and in Derbyshire in England, especially in the famous Ecton copper mine.

Species 4. *Yellow Pyrites*, or *Yellow Copper Ore.* La Pyrite cuivreuse. Kupferkies.—This is the most common species of copper ore, and is found both in primitive and secondary mountains, sometimes in beds, and sometimes in veins. It occurs most abundantly in Bohemia, Saxony, Hungary, Sweden, France, Spain, and especially in Britain, where it forms one of the principal varieties of copper ores, found in the famous Parys mine in the isle of Anglesea.

Species 5. *White Copper Ore.* La Mine de Cuivre Blanche. Weisskupfererz.—This species is very rare, but it has been found in Saxony in the mines of Freyberg, in Hesse, in Wirtemberg, and in Siberia, with other copper ores.

Species 6. *Gray Copper Ore.* Le Cuivre Gris. Fahlerz.—This again is a very common species, and is found in all those countries that possess mines of copper.

Species 7. *Black Copper Ore.* Le Cuivre Noir. Kupferschwarze.—This is found mixed with malachite and with green and blue copper ores in Saxony, Hungary, in the Bannat, in Silesia, in Norway, in Russia, in Swabia, in Sweden, and in Siberia. It also occurs in the Parys mine of Anglesea.

Species 8. *Florid Red Copper Ore.* Mine de Cuivre Rouge. Roth-kupfererz.—This usually accompanies native copper, malachite, and brown earthy iron ore. It is met with in Saxony, in the Bannat, in the Hartz, in Norway, in Siberia, near Cologne, and in Cornwall.

Species 9. *Brick-red Copper Ore.* Le Mine de Cuivre couleur de Brique. Ziegelerz.—Found in similar situations with the preceding.

Species 10. *Blue Calciform Copper Ore.* L'Azur de Cuivre. Kupperlazur.—Found in the Bannat, in Hesse, in Saltzburg, in Poland, in Siberia, in Thuringia, and in the Tyrolese. It is usually imbedded in slaty marl, or in sandstone, not far below the surface of the earth.

Species 11. *Malachite.*—This is always found mixed with other copper ores, and occurs in most of the copper mines that have been enumerated.

Species 12. *Mountain Green.* Le Vert de Cuivre. Kupfergoun.—This commonly accompanies species 4, 6, 9, 10, and 11. It is found in Saxony, in the Hartz, in Norway, Silesia, Siberia, Hungary, Wirtemberg, and Britain, as at Leadhills and in Derbyshire.

Species 13. *Olive Copper Ore.* Mine de couleur Olive. Olwenerz.—This species is extremely rare. It has been found chiefly near Karrarach in Cornwall, where it is accompanied by species 11 and 12, and brown iron ore in a gangart of yellow lithomarga mixed with quartz. It is said to have been found also at Jonsbach near Rustelitadt in Silesia.

VI. Iron.

Species 1. *Native Iron.*—This species is very uncommon; but it has been met with in several places, especially at Kamsdorf and Eibenstock in Saxony, at Kransnajarsk near Jenisei in Siberia, at Olumba near St Jago in South America, and Oulle near Grenoble in France. The two most remarkable specimens of native iron are those found in South America and in Siberia. The former of these forms a mass weighing at least 300 quintals, or 15 tons. It is soft and malleable, and in every respect like the purest iron. That of Siberia is a spheroidal mass, weighing about 14 quintals, resting on the surface of the earth, near the summit of a mountain. Its texture is cellular, and its cavities are filled with a transparent, greenish, vitreous matter. No mines or veins of iron are in the neighbourhood of either. 165 Iron ores.

Species 2. *Martial Pyrites.* Pyrite Martiale. Schwefelkies.—This species is one of the most common ores of iron, and is found abundantly in every country where there are any other ores of iron. There are three varieties of it described by Brochant, which are less common, but these are also found in many places.

Species 3. *Magnetic Pyrites.* La Pyrite Magnetique. Magnetkies.—This has been found only in primitive rocks, especially in micaceous schistus, accompanied by quartz, hornblende, &c. and usually lying in beds mixed with other pyrites, galena, and magnetic ironstone.

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ſtone. It is found in Saxony, Bavaria, Norway, and Sileſia.

Species 4. *Magnetic Ironſtone.* Le Fer Magnetique. Magnetiſcher Eiſenſtein.—Of this there are three varieties, the common magnetic ore, which is very common in primitive mountains, eſpecially thoſe that are compoſed of gneiſs and micaceous ſchiſtus. It is often in great abundance, forming large beds, or even whole mountains. It is found in greateſt quantity in Saxony, Bohemia, Italy, Corſica, Sileſia, Siberia, Norway, and eſpecially in Sweden. The ſecond variety, called fibrous magnetic ironſtone, is uncommon, but is found at Bibſburg in Sweden. The third, which Kirwan calls *magnetic ſand*, is found in the banks of ſome rivers, particularly of the Elbe, as alſo in Sweden and Italy.

Species 5. *Specular Iron-ore.* Le Fer Speculaire. Eiſenglanz.—This is found in many places, often in conſiderable quantity, eſpecially in Saxony, Bohemia, France, Normandy, Pruſſia, Sweden, Siberia, Hungary, Corſica, and the iſland of Elba. It is generally found only in primitive mountains, ſometimes in beds, ſometimes in veins, accompanied with quartz, hornſtone, martial pyrites, and magnetic iron ore.

Species 6. *Red ſcaly Iron-ore.* La Mine de Fer Rouge. Roth-Eiſenſtein.—This is rather rare, but is found in ſeveral parts of Saxony, in the Hartz, in Naſſau, in Thuringia and Hungary. Another variety of the ſame ſpecies, the compact red ironſtone of Kirwan, is much more common, being found in Saxony, Bohemia, the Hartz, Heſſe, Siberia, and in France, ſometimes in veins, and ſometimes in beds, commonly mixed with the two following ſpecies, and with argillaceous ironſtone, quartz, hornſtone, and calcareous ſpar.

A third variety, the common hematites or bloodſtone, which is one of the moſt productive iron ores, is always found accompanying the laſt variety, and is of courſe met with in moſt of the ſituations above enumerated. It is procured in abundance in ſeveral parts of England, as in Derbyſhire, but more eſpecially at Ulverſton in Lancaſhire, where there is one perpendicular vein of it 30 yards wide, in a rock of limeſtone. Large quantities of it are carried to Carron, where it is ſmelted with the common Carron ironſtone.

Species 7. *Brown Iron ore.* La Mine de Fer Brune. Braun-eiſenſtein.—Of this there are ſeveral varieties, of which the compact brown ironſtone, and the brown hæmatites, are very common; but the brown ſcaly iron ore is rather rare. The laſt is found at Kamſdorf in Saxony, at Klauſthel, in the Hartz, at Lauterick in the Palatinate, and at Naïla in the principality of Bareith.

Species 8. *Calcareous iron ore.* Le Fer Spathique. Spathiger-eiſenſtein.—This is found both in primary and ſecondary mountains, and there are few veins of iron which do not contain it in greater or leſs quantity.

Species 9. *Black Ironſtone.* La Mine de Fer Noire. Schwarz-eiſenſtein.—This is found in the principality of Bareith, in the Hartz, Saxony, Heſſe, and Palatinate.

The common argillaceous iron ore of Kirwan, is ranked by Brochant as a variety of this. It is very common in moſt iron countries, and much of it is found in Britain, eſpecially in Colebrook-dale, Shropſhire, and in Dean foreſt in Glouceſterſhire. The Carron ore is principally of this kind.

Species 10. *Lowland iron ore.* La Mine de Fer de Gazon. Raſen-eiſenſtein.—There are ſeveral varieties of this, all of which are found in low, humid ſituations, in very extenſive beds, alternating with ſandſtone, clay, &c. This ſpecies is much more abundant in the north than in the ſouth of Europe, eſpecially in the duchy of Brandenburg, in Courland, Lithuania, Livonia, Pruſſia, Pruſſian Poland, and Luſace.

Species 11. *Blue Martial Earth.* Le Fer Terreux bleu. Blaue-eiſenſerde.—This is found imbedded in clay and ſimilar earths, and often accompanies the laſt ſpecies. It occurs in Saxony, Sileſia, Swabia, Bavaria, Poland, Siberia, and the Palatinate.

Species 12. *Green Martial Earth.* Le Fer Terreux vert. Grun-eiſenerde.—This ſpecies is uncommon, having been found only at Braunſdorf, and Schneeburg in Saxony, in veins, accompanying quartz and ſulphur pyrites.

Species 13. *Emery.* L'Emeril. Schmirgel.—This is found in Saxony, diſtributed in a bed of hardened ſteatites, in ſandſtone. It is alſo found in Italy, Spain, Peru, the iſle of Naxos in the Archipelago, where there is a cape called by the Italians, *Capo Smeriglio*, or the *Emery Cape*. It is often mixed with particles of magnetic iron ore, whence ſome have ſuppoſed the emery to be magnetic.

VII. Lead.

166 Lead.

Species 1. La Galène Commune. Gemeiner-Bleiglanz.—This is the moſt common and abundant ore of lead, and is found both in primitive and ſecondary ſtrata, in beds and veins, accompanied with quartz, fluor ſpar, calcareous ſpar, ſparry iron ore, barytic earths, blende, pyrites, and ſeveral ores of ſilver. It is found in great abundance at Leadhills and at Wanlockhead in Dumfriesſhire, in Derbyſhire, Strontian in Scotland, and in the Mendip hills in Somerſetſhire. A variety of this, called compact galena, is found in the ſame ſituations, eſpecially in Derbyſhire. It has often been confounded with *graphite*, or *plumbago*.

Werner enumerates nearly 20 formations, as he calls them, of galena, but Mr Jameſon thinks the galena formation in Dumfriesſhire is different from any of theſe.

Species 2. *Blue Lead Ore.* La Mine de Plomb Bleue. Blau-blei-erz.—This ſpecies has as yet been found only at Zſchopau in Saxony, accompanying fluor ſpar, barytic ſpar, white and black lead, and malachite.

Species 3. *Brown Lead Ore.* La Mine de Plomb Brune. Braun-bleierz.—This ſpecies is alſo very rare, but is found at the ſame place with the laſt, and alſo in Bohemia, Britanny and Hungary.

Species 4. *Black Lead Ore.* La Mine de Plomb Noire. Schwarz-bleierz.—This is found in Saxony, at Freyberg, at Zſchopau, in Cumberland, in ſome parts of Scotland, in Poland, and Siberia.

Species 5. *White Lead Ore.* La Mine de Plomb Blanche. Weiſs-bleierz.—This is not a very abundant ſpecies, but it is found in ſeveral lead mines, eſpecially in Bohemia, Saxony, the Hartz, France, Siberia, Hungary Carinthia, and in ſome of the Britiſh lead mines, eſpecially at Leadhills.

Species 6. *Green Lead Ore.* Phoſphorated lead ore of Kirwan. La Mine de Plomb Vert. Green-bleierz.—This is found in veins, more commonly in the primitive mountains. It is met with in Bohemia, Saxony, Bavaria,

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Bavaria, Siberia, Briſgau, France, Peru, and at Leadhills in Scotland.

Species 7. *Red Lead Spar.* Le Plomb Rouge. Rothes-bleierz.—This is one of the rareſt ores of lead, being as yet only found at Ekatharenburg in Siberia.

Species 8. *Yellow Lead Spar.* Le Plomb jaune. Gelbes-bleierz.—This has been known only for a few years. It has been found at Bleiberg in Carinthia, in a gangart of calcareous ſtone. It has alſo been found near Freyberg in Saxony, at Annaberg in Auſtria, and at Reczbanya in Hungary.

Species 9. *Native Vitriol of Lead.* Le Vitriol de Plomb natif. Naturbiher-blei-vitriol.—This is found in the iſle of Angleſea, in a vein of brown iron ore, mixed with copper pyrites. It is alſo found at Leadhills in Scotland.

Species 10. *Earthy Lead Ore.*—Of this there are two varieties, the friable and the indurated. The former is found in Saxony, in Lorraine, in Poland, and Siberia, Bohemia, and Sileſia. The latter is found in moſt lead mines. Mr Jameſon notices two varieties of lead earth, which he calls white-lead earth, and friable lead earth, as met with at Leadhills.

VIII. Tin.

167 Tin ores.

Species 1. *Tin Pyrites.* La Pyrite d'Etain, Zinnkies. This ſpecies is very rare, and is, we believe, found only in Cornwall, at Wheal rock, among *copper pyrites.*

Species 2. *Common Tinſtone.* La Pierre d'Etain. Zinnſtein.—This is is found chiefly in primitive rocks, as in granite, gneiſs, micaceous ſchiſtus, and porphyry, both in maſſes and veins. It is the common ore of Cornwall, and is found alſo in Saxony, Bohemia, and the Eaſt Indies.

Species 3. *Wood Tin Ore.* L'Etain greret. Zinnerz.—This is found in Cornwall, in the pariſhes of Colomb, St Denis and Roach, accompanying the former.

IX. Bismuth.

168 Biſmuth ores.

Species 1. *Native Biſmuth.*—Biſmuth is a very rare metal, but is moſt commonly found in its native ſtate. It is uſually in a gangart of quartz, calcareous ſpar, and and barytic ſpar. It occurs in Bohemia, in Saxony, in the territory of Hainault, in Suabia, in Sweden, and in France, in the mines of Brittany.

Species 2. *Sulphurated Biſmuth.* La Galéne de Biſmuth. Wiſmuth Glanz.—This is very rare. It commonly accompanies the former, and is found at Joachimſthal, in Bohemia, at Johann-Georgen-ſtadt, Schwarzenberg, and Altenberg in Saxony, and at Ridderhyttan in Sweden.

Species 3. *Biſmuth Ochre.* L'Ochre de Biſmuth. Wiſmuth Okker.—This is ſtill more rare than the laſt, and is chiefly found near Schneeberg in Saxony, and at Joachimſthal in Bohemia.

X. Zinc.

169 Zinc ores.

Species 1. *Blende.* This is ſulphurated zinc, and is one of the moſt common ores of that metal. There are three varieties; the brown, the yellow, and the black. Of theſe the yellow is the moſt rare, and is found in Saxony, in Bohemia, in the Hartz, in Norway, Tranſylvania, and Hungary. The brown and the black are found in moſt of theſe places, and beſides in France and England, eſpecially in Derbyſhire.

Species 2. *Calamine.* La Calamine. Galmel.—Of this there are two varieties, *compact* and *ſtriated.* Both occur only in particular ſtratiform rocks, often forming entire beds with indurated clay, and calcareous ſpar. The latter is uſually found in the cavities of the former. Both occur in Bohemia, in Carinthia, and in moſt of the German lead mines. They are alſo found in Britain, eſpecially at Leadhills, Wanlock-head, and in Derbyſhire.

XI. Antimony.

Species 1. *Native Antimony.*—This is very rare. It was diſcovered at Sahlberg in Sweden, in the year 1748, in a gangart of ſome calcareous ſtone, and it was alſo found ſome years ago at Allemont in France, accompanying other ores of antimony and of cobalt. 170 Antimony ores.

Species 2. *Sulphurated Antimony.* L'Antimoine Gris. Grau-ſpies glas-erz.—There are ſeveral varieties of this, as the compact ſulphurated antimony, found at Braunſdorf in Saxony; at Goldgronach in the principality of Bareith; at Maguria in Hungary, and Auvergne in France: foliated ſulphurated antimony, found at Braunſdorf and Goldgronach, and in the Hartz, and Tranſylvania: ſtriated ſulphurated antimony, found in Saxony, Hungary, France, Swabia, Tuſcany, Sweden, the Hartz, Spain, and in England: plumoſe antimonial ore, found at Freyberg in Saxony, at Braunſdorf and Stahlberg, and at Chemnitz in Hungary. All theſe varieties are uſually found in a quartzoſe rock.

Species 3. *Red Antimonial Ore.* L'Antimoine Rouge. Roth-ſpeis glas-erz.—This is found at Braunſdorf, at Malaſka and Kremnitz, in Hungary, and at Allemont in France. It uſually accompanies the firſt and ſecond ſpecies, eſpecially at Allemont, or the next ſpecies, which is the caſe at Braunſdorf.

Species 4. *Muriated Antimony.* Antimoine blanc. Weies-ſpeis glas-erz.—White antimony is extremely rare; it is principally found at Przibran in Bohemia, in quadrangular, ſhining tables, diſpoſed in bundles upon galena. It is ſaid alſo to have been found at Braunſdorf and Malaſka.

Species 5. *Antimonial Ochre.* L'Ocre d'Antimoine. Spies glas-okker.—This ſpecies is alſo very rare; it is found at Braunſdorf, near Freyberg, and in Hungary, always accompanying the ſecond and third ſpecies.

XII. Cobalt.

Species 1. *White Cobalt Ore.* Le Cobalt blanc. 171 Cobalt ores. Weiſſer ſpeis-kobolt.—This is found in Norway, Sweden, at Anaberg in Saxony, in Swabia and Stiria; but it is very rare. In Saxony and in Norway, it occurs in beds of micaceous ſchiſtus, along with the 7th ſpecies, and with quartz, hornblende, and pyrites.

Species 2. *Dull Gray Cobalt Ore.* Le Cobalt gris. Grauer ſpeis-kobolt.—This is found in Saxony, Bohemia, France, Norway, Swabia, Hungary, Stiria, and in a few mines in England. It is ſometimes mixed with ores of ſilver.

Species 3. *Bright White Cobalt Ore.* Le Cobalt Eclatant. Glanz-kobolt.—This is the moſt common of all the ores of cobalt, and almoſt always accompanies the ores of nickel, and of ſilver. It is found in Bohemia,

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hemia, Saxony, Silesia, the Hartz, Hesse, Sweden, Swabia, Norway, Stiria, Spain, Thuringia, and in England. It is found in beds in the primitive rocks, and in veins in the secondary.

Species 4. *Black Cobalt Ochre.* Le Cobalt Terreux noir. Schwarzer-erd-kobolt.—This is found in Saxony, in Thuringia, Swabia, Hesse, the Palatinate, Saltzburg, and in the Tyrol, accompanying other ores of cobalt, and several ores of silver, copper, and iron.

Species 5. *Brown Cobalt Ochre.* Le Cobalt Terreux brun. Brauner-erd-kobolt.—This is found in considerable quantity at Saalfeld in Thuringia; at Kamsdorf in Saxony, and at Alperspach in Wirtemberg, accompanying other ores of cobalt.

Species 6. *Yellow Cobalt Ochre.* Le Cobalt Terreux jaunne. Geber-erd-kobolt.—This is one of the rarest ores of cobalt. It is found at Saalfield in Thuringia, at Alperspach in Wirtemberg, and at Altemont in Dauphiné in France.

Species 7. *Red Cobalt Ore.* Le Cobalt Terreux rouge. Rother-erd-kobolt. This is found in Saxony, Thuringia, Hesse, Swabia, Bohemia, Allemont in France, and in Norway.

XIII. Nickel.

172 Nickel ores. Species 1. *Sulphurated Nickel.* Le Kupfer Nikel. Kupfer Nikkel.—This is found in veins, both in primitive and secondary mountains, almost always accompanying some of the ores of cobalt, to which it seems to bear some geological relation. It is also found in some silver mines. It is met with in Bohemia, Saxony, Thuringia, the Hartz, in Swabia, Hesse, Allemont in France, Stiria, and in some parts of Britain. Its usual gangart is quartz, barytic and calcareous spar.

Species 2. *Nickel Ochre.* L'Ocre de Nikel. Nikkel-okker.—This is found in the same situations with the last, from a decomposition of which it appears to be produced.

XIV. Manganese.

173 Manganese ores. Species 1. *Gray ore of Manganese.* Le Manganese. Grau-braunstein-erz.—There are several varieties of this, but they are all commonly found near each other, in veins or in masses, commonly in the primitive mountains.

They are found in considerable quantity in many mines in Saxony, Bohemia, Bavaria, and Hungary. They are also met with in France, and in several parts in Britain, as in Derbyshire, Leadhills, and Wanlockhead; in the Mendip hills, and the isle of Jura.

Species 2. *Red Manganese ore.* Le Manganése rouge. Roth-Cronstein-erz. This is very rare, but is found at Katnick, Offenbanya, and especially at Nagyag in Transylvania, at which last place it is found in a gold mine.

XV. Molybdena.

174 Molybdena ores. Le Molybdene sulphure. Wasserbley.—This is found in Bohemia; at several places in Saxony; in Sweden; at Tillot in France, and at Chamouni at the foot of Mont Blanc. It is commonly found in primitive rocks, especially in tin mines.

XVI. Arsenic.

175 Arsenic ores. Species 1. *Native Arsenic.*—This is found in Bohemia, Saxony, the Hartz, Carinthia, Swabia, Transylvania, and in France. It is always met with in veins, in primitive mountains, accompanied by realgar, galena, the ores of cobalt and nickel, and several ores of silver.

Species 2. *Arsenical Pyrites*, or *Marcasite.* La Pyrite Arsenicale. Arsenik-kies. This is found in Bohemia, Saxony, and Silesia, accompanying the common tin stone, and galena, with some other minerals.

Species 3. *Realgar.* Le Realgar. Rauschgelb.—This is found in the Bannat, Bohemia, Saxony, Swabia, the Hartz, the Tyrol, Hungary, and in the neighbourhood of volcanoes, especially Ætna and Vesuvius.

Orpiment, which Brochant makes a variety of realgar, is found in several of the above places, and also in Natolia, in Servia, Transylvania, and Wallachia, usually accompanying quartz and clay.

Species 4. *Native calx of Arsenic.* L'Arsenic oxidé natif. Naturlechur-arsenik-kalk.—This is very rare, but is found in a small quantity in Bohemia and Joachimsthal, in Saxony, at Raschau, at Salatna, in Transylvania, and in Hungary.

XVII. Tungsten.

Species 1. *Tungsten.* Le Tungsténe. Schiverstein. 176 Tungsten ores.
—This is a very rare mineral, but is found at Schlackenwald in Bohemia, at Ehrenfriederdorf in Saxony, and at Riddarkytten, Bisburg in Sweden, usually accompanying quartz, mica, talc, and tin ore.

Species 2. *Wolfram.*—This is also pretty rare, but is found in Bohemia, Saxony, and at Poldice in Cornwall.

XVIII. Uranium.

Species 1. *Sulphurated Uranite.* L'Urane noir. Pecherz.—This is found at Joachimsthal in Bohemia, and 177 Uranium ores.
at Johann-Georgen-Stadt, and Schneiberg in Saxony, accompanying the two following species, and lead and copper ores.

Species 2. *Micaceous Uranitic ore.* L'Urane Micacé. Uran-glimmer.—This is found in the Bannat, Saxony, Wirtemberg; near Autun in France, and near Karrarach in Cornwall.

Species 3. *Uranitic ochre.* L'Ocre d'Urane. Uranokher. This has been found at Joachimsthal in Bohemia, and at Johan-Georgen-Stadt in Saxony, but it is uncommon.

XIX. Titanium.

Species 1. *Menakanite.*—This has been found chiefly 178 Titanium ores.
near Menakan in Cornwall.

Species 2. *Titanite.* Le Ruthile. Ruthil.—This is found at Boinik and Rhonitz in Hungary; in New Castile in Spain; at Aschaffenbourg in Franconia; at St Yrieux in France, and in Mount St Gothard, and some other places in the Alps.

Species 3. *Titanitic Siliceous ore.* Le Nigrine. Nigrin.—This has been found near St Gothard in the Alps, at Ohlapian in Transylvania, &c.

XX. Tellurium.

Species 1. Sylvanite. Le Sylvane natif. Gediegen Sylvan.—This is found chiefly at Fatzeborg in Transylvania, but is now become extremely rare. It occurs 179 Tellurium ores.
in

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in beds of gray wacke and secondary (or transition) limestone.

Species 2. ——— Le Sylvane graphique. Shristerz. —This is found at Offenbanya in Transylvania, in a bed of porphyritic sienete, and granular limestone.

Species 3. ——— Le Sylvane blanc. Weiss-Sylvanerz.—This was brought to Brochant from Freyberg in Saxony.

Chap. III. *Of the most Remarkable Theories of the Earth.*

180 Object of theories of the earth.

A LATE writer considers the proper object of a theory of the earth, to be the tracing the series of those revolutions which have taken place on the surface of the earth; to explain their causes, and thus to connect together all the indications of change that are found in the mineral kingdom. He justly observes, that the formation of such a theory requires an accurate and extensive examination of the phenomena of geology, and that it is inconsistent with any, but a very advanced state of the physical sciences. There is perhaps no research in those sciences more arduous than this; none where the subject is so complex, where the appearances are so diversified, or so widely scattered; and where the causes that have operated are so remote from the sphere of ordinary observation *.

With such requisites, and under such difficulties, it is not surprising that so many who have aimed at constructing theories of the earth, have failed in the attempt. It certainly requires a prodigious accumulation of facts, together with a talent for observation, and for arrangement, which are seldom found united. We shall presently see how far those theories which have hitherto been framed to account for the changes that the earth has undergone, have been successful.

It is not, however, to be supposed, that a correct theory of the earth is impossible, though some may think it an arrogant, if not a presumptuous undertaking, to attempt explaining how the present state of the globe and the revolutions which it has undergone, were brought about. The time is perhaps not far distant when the present prevailing hypothesis will be improved into a rational, and so far as is consistent with the knowledge and acquirements of man, a perfect system.

Dr Kirwan has laid down certain laws of reasoning; which should be adhered to inviolably in investigations of this kind. The first is, that no effect should be attributed to a cause whose known properties are inadequate to its production. The second is, that no cause should be adduced, whose existence is not proved either by actual experience or approved testimony. Many natural phenomena have arisen or do arise, in times or places so distant, that well conditioned testimony concerning them cannot, without manifest absurdity, be rejected. Thus the inhabitants of the northern parts of Europe, who have never felt earthquakes, nor seen volcanoes, must nevertheless admit, from mere testimony, that the first have been, and that the second do actually exist. The third is, that no powers should be ascribed to an alleged cause, but those that it is known by actual observation to possess in appropriated circumstances †.

* *Playfair's Illustrations.*

Sect. I. *Theory of Burnet.*

181 Theory of Burnet.

THE first who formed this amusement of earth-making into a system, was the celebrated Thomas Burnet; a man of polite learning, and rapid imagination. His *sacred theory*, as he calls it, describing the changes which the earth has undergone, or shall hereafter undergo, is well known for the warmth with which it is imagined, and the weakness with which it is reasoned; for the elegance of its style, and the meanness of its philosophy. The earth, says he, before the deluge, was very differently formed from what it is at present; it was at first a fluid mass; a chaos composed of various substances, differing both in density and figure; those which were heaviest sunk to the centre, and formed in the middle of our globe a hard solid body; those of a lighter nature remained next; and the waters, which were lighter still, swam upon its surface, and covered the earth on every side. The air, and all those fluids which were lighter than water, floated upon this also, and in the same manner encompassed the globe; so that between the surrounding body of waters, and the circumambient air, there was formed a coat of oil, and other unctuous substances, lighter than water. However, as the air was still extremely impure, and must have carried up with it many of those earthy particles with which it once was intimately blended, it soon began to defecate, and to depose these particles upon the oily surface already mentioned, which soon uniting, the earth and oil formed that crust which soon became an habitable surface, giving life to vegetation, and dwelling to animals.

This imaginary antediluvian abode was very different from what we see it at present. The earth was light and rich, and formed of a substance entirely adapted to the feeble state of incipient vegetation; it was a uniform plain, everywhere covered with verdure, without mountains, without seas, or the smallest inequalities. It had no difference of seasons, for its equator was in the plane of the ecliptic, or, in other words, it turned directly opposite to the sun, so that it enjoyed one perpetual and luxuriant spring. However, this delightful face of nature did not long continue in the same state, for, after a time, it began to crack and open in fissures; a circumstance which always succeeds when the sun exhales the moisture from rich or marshy situations. The crimes of mankind had been for some time preparing to draw down the wrath of heaven; and they at length induced the deity to defer repairing those breaches in nature. Thus the chasms of the earth every day became wider, and, at length, they penetrated to the great abyss of waters, and the whole earth in a manner fell in. Then ensued a total disorder in the uniform beauty of the first creation, the terrene surface being broken down; as it sunk, the waters gushed out in its place; the deluge became universal; all mankind, except eight persons, were destroyed, and their posterity condemned to toil upon the ruins of desolated nature.

It remains to mention the manner in which he relieves the earth from this universal wreck, which would seem to be as difficult as even its first formation. These great masses of earth falling into the abyss, drew down with them vast quantities of air; and by dashing against each other, and breaking into small parts

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by the violence of the shock, they at length left between them large cavities filled with nothing but air. These cavities naturally offered a bed to receive the influent waters; and in proportion as they filled, the face of the earth became once more visible. The higher parts of its broken surface, now become the tops of mountains, were the first that appeared; the plains soon after came forward, and at length the whole globe was delivered from the waters, except the places in the lowest situations; so that the ocean and the seas are still a part of the ancient abyss that have not had a place to return to. Islands and rocks are fragments of the earth's former crust; kingdoms and continents are larger masses of its broken substance; and all the inequalities that are to be found on the surface of the present earth, are owing to the accidental confusion into which both earth and waters were then thrown.

Sect. II. *Theory of Woodward.*

182 Theory of Woodward.

The next who attempted a theory of the earth was Mr Woodward, who in his essay towards a natural history of the earth, endeavoured to give what he considered as a more rational account of its appearances than had been given by any preceding writer. He was indeed much better qualified for such an undertaking than any of his predecessors, as he was one of the most industrious naturalists of his time. Hence though his system must be considered as weak and untenable, his work contains many important facts relating to natural history.

Woodward sets out by asserting that all terrestrial substances are disposed in beds of various natures, lying horizontally, one over the other, like the coats of an onion, and that they are replete with shells and other marine productions; these shells being found in the deepest cavities, and on the tops of the highest mountains. From these observations, which were warranted by the experience of naturalists at that time, but which we now know not to be universally correct, he proceeds to remark that these shells and extraneous fossils are not productions of the earth, but are all actual remains of those animals which they are known to resemble; that all the beds of the earth lie below each other in the order of their specific gravities, and that they are disposed as if they had been left in this situation by subsiding waters. All this is affirmed with much earnestness, although many of the circumstances are contradicted by daily experience. Thus, we not unfrequently meet with layers of stone above the lightest soils, and find the softest earth below a stratum of hard stone. Woodward, however, having taken for granted, that all the strata of the earth are arranged in the order of their specific gravities, the lightest at the top, and the heaviest near the centre, he deduces as a natural consequence, that all the substances of which the earth is composed were once in an actual state of solution. This universal solution he conceives to have happened at the time of the flood. He supposes that at that time a body of water, which was then in the centre of the earth, uniting with that which was found on the surface, so far separated the terrene parts as to mix all together in one fluid mass; the contents of which afterwards sinking according to their respective gravities, produced the present appearances of the earth. Being aware, however, of an objection that fossil substances are not found dissolved, he exempts them from this universal dissolution, and for that purpose, endeavours to shew that the parts of animals have a stronger cohesion than those of minerals; and that, while even the hardest rocks may be dissolved, bones and shells may still continue entire.

Sect. III. *Theory of Whiston.*

183 Theory of Whiston.

Of all the theories of the earth that have been formed, previous to those of Hutton and Werner, none has been more applauded or more opposed than that of Whiston. Nor is this surprising; for this theory being supported with all the parade of mathematical calculation, confounded the ignorant, and produced the approbation of such as desired to be thought learned, since it implied a considerable knowledge of abstract science, even to be capable of comprehending what the writer aimed at. It is not easy to divest this theory of its mathematical garb, but the result of our philosopher's reasoning appears to be as follows.

He supposes the earth to have been originally a comet, and he considers the history of the creation, as given us in scripture, to have its commencement just when it was, by the hand of the Creator, more regularly placed as a planet in our solar system. Before that time, he supposes it to have been a globe without beauty or proportion; a world in disorder, subject to all the vicissitudes which comets endure; some of which have been found, at different times, a thousand times hotter than melted iron; at others, a thousand times colder than ice. These alternations of heat and cold, continually melting and freezing the surface of the earth, he supposes to have produced, to a certain depth, a chaos entirely resembling that described by the poets, surrounding the solid contents of the earth, which still continued unchanged in the midst, making a great burning globe of more than two thousand leagues in diameter. This surrounding chaos, however, was far from being solid: he compares it to a dense though fluid atmosphere, composed of substances mingled, agitated, and shocked against each other; and in this disorder he describes the earth to have been just at the eve of creation.

But upon its orbit being then changed, when it was more regularly wheeled round the sun, every thing took its proper place, every part of the surrounding fluid then fell into a situation, in proportion as it was light or heavy. The middle or central part, which always remained unchanged, still continued so, retaining a part of that heat which it received, in its primeval approaches towards the sun; which heat he calculates, may continue for about six thousand years. Next to this fell the heavier parts of the chaotic atmosphere, which serve to sustain the lighter; but as in descending they could not entirely be separated from many watery parts with which they were intimately mixed, they drew down a part of these also with them; and these could not mount again after the surface of the earth was consolidated; they therefore surrounded the heavy first descending parts, in the same manner as these surround the central globe. Thus, the entire body of the earth is composed internally of a great burning globe, next which is placed an heavy terrene substance that encom-

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paſſes it, round which alſo is circumfuſed a body of water. Upon this body of water, the cruſt of the earth on which we dwell is placed, ſo that, according to him, the globe is compoſed of a number of coats, or ſhells, one within the other, all of different denſities. The body of the earth being thus formed, the air, which is the lighteſt ſubſtance of all, ſurrounded its ſurface, and the beams of the ſun darting through, produced that light which, we are told, firſt obeyed the Creator's command.

The whole economy of the creation being thus adjuſted, it only remained to account for the riſings and depreſſions on the ſurface of the earth, with the other ſeeming irregularities of its preſent appearance. The hills and valleys are conſidered by him as formed by their preſſing upon the internal fluid, which ſuſtains the outward ſhell of earth with greater or leſs weight; thoſe parts of the earth which are heavieſt, ſink into the ſubjacent fluid more deeply, and become valleys; thoſe that are lighter, riſe higheſt upon the earth's ſurface, and are called mountains.

Such was the face of nature before the deluge; the earth was then more fertile and populous than it is at preſent; the life of man and animals was extended to ten times its preſent duration; and all thoſe advantages aroſe from the ſuperior heat of the central globe, which ever ſince has been cooling. As its heat was then in full power, the genial principle was alſo much greater than at preſent; vegetation and animal increaſe were carried on with more vigour; and all nature ſeemed teeming with the ſeeds of life. But theſe phyſical advantages were only productive of moral evil; the warmth which invigorated the body, increaſed the paſſions and appetites of the mind; and as man became more powerful, he grew leſs innocent. It was found neceſſary to puniſh this depravity; and all living creatures were overwhelmed by the deluge in univerſal deſtruction.

This deluge, which ſimple believers are willing to aſcribe to a miracle, philoſophers have been long deſirous to account for by natural cauſes. They have proved that the earth could never ſupply from any reſervoir towards its centre, nor the atmoſphere by any diſcharge from above, ſuch a quantity of water as would cover the ſurface of the globe to a certain depth over the tops of our higheſt mountains. Where, therefore, was all this water to be found? Whiſton has found enough, and more than a ſufficiency, in the tail of a comet; for he ſeems to allot comets a very active part in the great operations of nature.

He calculates with great ſeeming preciſion, the year, the month, and the day of the week on which this comet (which has paid the earth ſome viſits ſince, though at a kinder diſtance) involved our globe in its tail. The tail he ſuppoſed to be a vaporous fluid ſubſtance, exhaled from the body of the comet, by the extreme heat of the ſun, and increaſing in proportion as it approached that great luminary. It was in this that our globe was involved at the time of the deluge; and as the earth ſtill acted by its natural attraction, it drew to itſelf all the watery vapours which were in the comet's tail; and the internal waters being alſo at the ſame time let looſe, in a very ſhort ſpace the tops of the higheſt mountains were laid under the deep.

The puniſhment of the deluge being thus completed and all the guilty deſtroyed, the earth, which had been broken by the eruption of the internal waters, was alſo enlarged by it; ſo that upon the comet's receſs, there was found room ſufficient in the internal abyſs for the receſs of the ſuperfluous waters, whither they all retired, and left the earth uncovered, but in ſome reſpects changed, particularly in its figure, which, from being round, was now become oblate. In this univerſal wreck of nature Noah ſurvived, by a variety of happy cauſes, to repeople the earth, and to give birth to a race of men ſlow in believing ill-imagined theories of the earth.

SECT. IV. *Theory of Buffon.*

184 Theory of Buffon.

LESS abſtracted and more popular than the theory of Whiſton, but equally fanciful and pompous, was the hypotheſis of Buffon. This ſyſtem, which was received with great admiration, depends principally on two facts which, though generally true, were by Buffon extended much too far.

It had been long obſerved, that ſuch flinty or ſiliceous bodies as form a part of the compoſition of glaſs, are among the moſt abundant materials which compoſe the earth, and that many of them nearly reſemble glaſs in colour, tranſparency, luſtre, hardneſs, and ſpecific gravity. As glaſs is produced by fuſion in a ſtrong heat, it was inferred by Buffon, that the flinty bodies found on the earth derived their origin from a ſimilar fuſion; and as no heat ſufficient to produce ſo great an effect, could be found on our globe, the author has recourſe to the ſun as its ſource. He ſuppoſes the planets, and the earth among the number, to have originally formed a part of the body of the ſun. In this ſituation a comet falling in on that great body, might have given it ſuch a ſhock, and ſo ſhaken its whole frame, that ſome of its particles might have been driven off, like ſtreaming ſparkles from red-hot iron; and each of theſe ſtreams of fire, though very ſmall in compariſon of the ſun, might have been large enough to form a planet much greater than our earth, or any other of the planetary ſyſtem. In this manner the planets, together with the globe which we inhabit, might have been driven off from the body of the ſun by impulſion; and in this way they would have continued to recede from it for ever, had they not been arreſted by the ſuperior power of attraction, exerted on them by the ſun; and thus, by the combination of the centrifugal and centripetal forces, they were whirled round in the orbits which they now deſcribe.

After giving a number of reaſons for the credibility, or at leaſt poſſibility, of the foregoing ſuppoſition, the author concludes that it is evident, that the earth aſſumed its preſent figure when in a melted ſtate. It is natural to think, ſays he, that the earth, when it iſſued from the ſun, had no other form but that of a torrent of melted and inflamed matter; that this torrent, by the mutual attraction of its parts, took on a globular figure, which its diurnal motion changed into a ſpheroid; that, when the earth cooled, the vapours, which were expanded like the tail of a comet, gradually condenſed, and fell down in the form of water upon the ſurface, depoſiting at the ſame time a ſlimy ſubſtance mixed with ſulphur and ſalts, part of which was carried by the motion of the waters into the perpendicular fiſſures of the ſtrata, and produced

produced metals, and the reſt remained on the ſurface, and gave riſe to the vegetable mould which abounds in different places, with more or leſs of animal or vegetable particles, the organization of which is not obvious to the ſenſes.

Thus the interior parts of the globe were originally compoſed of vitrified matter, and probably they are ſo at preſent. Above this were placed thoſe bodies which had been reduced by the heat to the ſmalleſt particles, as ſand, which are only portions of glaſs, and above theſe pumice ſtones, and the ſcoriæ of melted matter, from which were afterwards produced the ſeveral kinds of clay. The whole maſs was covered with water to the depth of five or ſix hundred feet, ariſing from the condenſation of the vapours when the earth began to cool. This water depoſited a ſtratum of mud, mixed with all thoſe ſubſtances which were capable of being ſublimed, or exhaled by fire; and the air was formed of the moſt ſubtile vapours, which, from their ſmall ſpecific gravity, floated above the water.

Such was the condition of the earth, when the tides, the winds, and the heat of the ſun, began to introduce changes on its ſurface. The diurnal motion of the earth, and that of the tides, elevated the waters in the equatorial regions, and neceſſarily tranſported thither great quantities of ſlime, clay, and ſand; and by thus elevating thoſe parts of the earth, they perhaps ſunk thoſe under the poles about two leagues, or a 230th part of the whole; for the waters would eaſily reduce into powder pumice ſtones, and other ſpongy parts of the vitrified matter upon the ſurface; and by this means excavate ſome places and elevate others, which, in time, would produce iſlands and continents, and all thoſe inequalities on the ſurface, which are more conſiderable towards the equator than towards the poles. The higheſt mountains lie between the tropics and the middle of the temperate zones, and the loweſt from the polar circles towards the poles. Indeed, both the land and ſea have moſt inequalities between the tropics, as is evident from the incredible number of iſlands peculiar to theſe regions.

The other circumſtance which forms a principal part of the baſis of this theory, is derived from the compoſition of ſea ſhells. It is well known, that theſe ſhells conſiſt chiefly of an earth like that which conſtitutes the principal part of limeſtone or marble; and it was hence inferred that, after a ſeries of ages, theſe ſhells being broken down into minute particles, produced thoſe immenſe maſſes of calcareous ſubſtances which are now found either in vaſt mountains, or in ſtratified plains, in almoſt every part of the earth.

Buffon conceives very naturally, that the ſurface of the earth muſt, at the beginning, have been much leſs ſolid than it is at preſent, and conſequently the ſame cauſes which at this day produce but ſlight changes, muſt then, on ſo yielding abody, have been attended with very conſiderable effects. There is, he thinks, every reaſon to ſuppoſe, that the earth was at that time covered with the waters of the ſea; and that theſe waters were above the tops of our higheſt mountains, ſince, even in ſuch elevated ſituations, we find ſhells and other marine productions in very great abundance. It appears alſo that the ſea continued for a conſiderable time upon the face of the earth; for as theſe layers of ſhells are found ſo very frequently at ſuch great depths, and in ſuch prodigious quantities, it ſeems impoſſible for ſuch numbers to have been ſupported all alive at one time; ſo that they muſt have been brought there by ſucceſſive depoſitions. Theſe ſhells alſo are found in the bodies of the hardeſt rocks, where they could not have been depoſited all at once, at the time of the deluge, or at any ſuch inſtant revolution; ſince that would be to ſuppoſe, that all the rocks in which they are found were, at that inſtant, in a ſtate of diſſolution, which would be abſurd to aſſert. The ſea, therefore, depoſited them wherever they are now to be found, and that by ſlow and ſucceſſive degrees.

"It will appear alſo, that the ſea covered the whole earth, from the appearance of its layers, which lying regularly one above the other, ſeem all to reſemble the ſediment formed at different times by the ocean. Hence, by the irregular force of its waves and its currents, driving the bottom into ſand-banks, mountains muſt have been gradually formed within this univerſal covering of waters; and theſe ſucceſſively raiſing their heads above its ſurface, muſt, in time, have formed the higheſt ridges of mountains upon land, together with continents, iſlands, and low grounds, all in their turns. This opinion will receive additional weight by conſidering, that in thoſe parts of the earth, where the power of the ocean is greateſt, the inequalities on the ſurface of the earth are higheſt; the ocean's power is greateſt at the equator, where its winds and tides are moſt conſtant; and in fact, the mountains at the equator are found to be higher than in any other parts of the world. (Vid. N° 129.) The ſea, therefore, has produced the principal changes in our earth; rivers, volcanoes, earthquakes, ſtorms, and rain, having made but ſlight alterations, and only ſuch as have affected the globe to very inconſiderable depths."

"In the formation of this theory, ſays Mr Kirwan, 185
genius (I mean genius in its primitive ſenſe, the ſublime talent of faſcinating invention, and not the energetic power of patient, profound, and ſagacious inveſtigation,) unhappily preſided. Yet dazzled by the ſplendid but deluſive ſcenery, preſented by an ardent imagination ſoaring to the ſource of light, and rending from its flaming orb the planetary maſſes that ſurround it; then marking with daring and overweening confidence, fancied ſucceſſive epochs of the conſolidated fabric of the terraqueous globe; the public attention was long arreſted by the magical repreſentation, and the underſtanding nearly betrayed into a partial, if not a total, aſſent to it.

"This proud gigantic theory was, however, like another Goliath, ſoon demoliſhed by a common flint or pebble, the very ſubſtance it ſprung from. Common glaſs eſſentially contains an alkaline ſalt, to which alone it owes its fuſibility; ſiliceous ſubſtances contain none, and are abſolutely infuſible when unaſſociated with any. Macquer found them infuſible not only in furnaces, but in the ſtill incomparably ſuperior heat of inflamed oxygen. Hence the hypotheſis grounded on the aſſumed identity of theſe ſubſtances and common glaſs, vaniſhed like the unembodied viſions of the night. With reſpect to limeſtone, the other pillar on which this theory reſts, Cronſted, Ferber, Born, Arduini, and Bergman, demonſtrated the exiſtence of numerous and immenſe mountains, in which not only no veſtiges of ſhells could be traced, but whoſe internal ſtructure of poſition

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position was incompatible with the supposition of an origination thence derived." *

* Kirwan's Geological Essay's.

Sect. V. *Theory of Whitehurst.*

186 Theory of Whitehurst.

THE first person who founded a theory of the earth on accurate and industrious observation was the late Mr John Whitehurst, who, in an inquiry into the original state and formation of the earth, has advanced opinions which differ considerably from those of preceding naturalists, and in some measures resemble those which are at present in greatest repute.

Mr Whitehurst sets out with stating his opinion, that the terraquous globe, which we now inhabit, was originally in a fluid state, and this, not from any solvent principle or subsequent solution, but owing to the first assemblage of its component parts; whence he presumes that the earth had a beginning, and has not existed from eternity. He rests his proof of this original fluid state of the earth on its spheroidal form, which a fluid globe in its revolution would naturally acquire, but which could not easily be produced in a solid body. The fluidity of the earth and the infinite divisibility of matter, an opinion which generally prevailed at that time, prove, according to him, that the component parts of the elements were uniformly blended together, none being heavier or lighter than another; hence they compose a uniform mass of equal consistence throughout, from the surface to the centre, and consequently the new formed globe was not adapted to the support of animal or vegetable life. It would therefore be absurd to suppose, that organized bodies were created during the chaotic state of the earth; and there is a great presumption that mankind were not created till the earth was become suitable to the nature of their existence.

The component parts of the chaos were heterogeneous, and endowed with peculiar chemical affinities, whereby similar substances were disposed to unite and form select bodies of various denominations, and thus the chaos was progressively formed into a habitable world.

The first operation of nature which presents itself to our consideration is the production of the spheroidal figure of the earth, acquired from its diurnal rotation, and the laws of gravity, fluidity, and centrifugal force. When this form was once completed, the component parts began to act on each other according to their affinities: hence the particles of earth, air, and water, united to those of their own kind, and with their union commenced their specific gravities; and the uniform suspension which had hitherto prevailed throughout the whole of the chaotic mass, was destroyed.

On the component parts separating into homogeneous masses, those of the greatest density began to approach towards the centre of gravity, and those of the greatest levity ascended towards the surface. As the specific gravity of air is so much less than that of water, it is presumed that the former escaped from the general mass sooner than the latter, and formed an impure atmosphere surrounding the newly-formed globe. Water being next in levity, succeeded the air, and formed one vast ocean about the earth. In process of time these elements became perfectly pure, and fit for the preservation of animal and vegetable life.

When the component parts of the chaos had been thus progressively separated, and collected into distinct masses, the following consequences are supposed to have ensued. The solids could not uniformly subside from every part of the surface, and be equally covered by water; for, as the sun and moon were coeval with the chaos, in proportion as the separation of the solids and fluids increased, so, by the action of those bodies on the sea, the tides became greater, and removed the solids from place to place, without any order or regularity. Hence the sea became unequally deep; and those inequalities daily increasing, dry land gradually appeared, and divided the waters which had hitherto been universally diffused over the earth. The primitive islands being thus formed, gradually became firm and dry, and fit for the reception of animals and vegetables.

The atmosphere, the sea, and the land, being thus formed, Mr Whitehurst proceeds to consider the order in which animal and vegetable bodies were severally created. He first supposes that, as the ocean became pure, and fit for animal life, before the formation of the primitive islands, fish were the first animals produced, and he supports this opinion by many ingenious arguments and facts. He observes, that in every instance upon record, the fragments of sea-shells are infinitely more numerous than the bones and teeth of fish. The latter, too, are but rarely deposited in any other matter than in beds of sand and gravel, and not in the solid substance of limestone, as the shells of fish generally are, even to the depth of many hundred yards, and dispersed throughout the whole extent of the secondary strata. Hence it is probable, that shell-fish were produced in prodigious quantities, sooner than any other kind of animal. The ocean being thus stocked with inhabitants, previous to the formation of the primitive islands, many of them became enveloped, and were buried in the mud by the action of the tides; and this would happen more particularly to the shell-fish, as they were less able to extricate themselves. Since the remains of marine animals are thus imbedded at various depths in the earth, there is sufficient proof that these marine bodies were entombed at successive periods of time, and that they were likewise created before the primitive islands, and consequently before any terrestrial islands.

That the earth has, at different times, suffered very violent convulsions, producing extensive ruptures of its solid parts, may reasonably be concluded from the rugged and uncouth appearance of many of the mountainous parts of the world. We see rocks in some places torn asunder, or appearing as if cut with a saw, and we find, in various parts, substances both mineral and organized, which are not generally met with, except in very distant regions. Most of the irregularities of the earth's surface are attributed by Mr Whitehurst to the general deluge. This would, in some instances, have the effect of reducing large masses of matter to a second state of solution; many eminences would be levelled, and some of the valleys would be filled up, while some parts which were before covered with water, might receive such an accession of matter as to fill up their cavities, and on the subsiding of the waters become a vast level plain. On the other hand, those elevated regions which were chiefly composed of the hardest stones, by having the lighter portions of earth washed

away

away from their baſis, would appear conſiderably increaſed in height. Mr Whitehurſt attributes the production of pit-coal alſo to the deluge, as it is difficult to account for the depoſition of ſuch a quantity of vegetable matter (ſuppoſing pit-coal to be of vegetable origin) below the ſurface of the earth, on any other hypotheſis. The animal matters found in a foſſil ſtate, eſpecially thoſe remains of animals which are not now found upon the earth, can only be accounted for, on the ſuppoſition of a deluge.

Mr Whitehurſt, however, is not content with attributing to the deluge moſt of the changes which have taken place on the ſurface of the earth, but he derives from the ſame ſource the curtailed longevity of man, and many of the evils incident to mankind. "At that dreadful era, ſays he, and not before, the year became divided into ſummer and winter, ſpring and autumn, and the ſpontaneous products of the earth no longer ſufficed the calls of human nature without art and labour; wherefore he who ſowed would expect to reap, and he who built an hut for his protection, would naturally expect to enjoy the fruits of his own labour; neceſſity, therefore, was the parent of property, and property created a thouſand imaginary wants, which its poſſeſſors endeavoured to gratify, and their example excited ſimilar ideas in thoſe who had it not, but nevertheleſs ſtudiouſly endeavoured to gratify their artificial wants by unjuſtifiable means. Hence the neceſſity of laws, dominion, and ſubordination, which had no exiſtence in the antediluvian world."

"To that great revolution in the natural world, we may therefore aſcribe many of the evils incident to mankind; for experience ſhews, that men who are born in rude and ſavage climates are naturally of a ferocious diſpoſition; and that a fertile ſoil, which leaves nothing to wiſh for, ſoftens their manners, and inclines them to humanity."

The above is a general outline of Mr Whitehurſt's theory, ſome parts of which are very ingenious, and are corroborated by obſervation, while others are not a little fanciful and improbable. In his ſuppoſition that the earth was originally in a fluid ſtate, he agrees with moſt other theoriſts, as this is a circumſtance which admits of little doubt; though, as Kirwan has ſhewn, it is not neceſſary to ſuppoſe that the whole maſs of the earth was fluid, but only thoſe parts of it which are near the ſurface. In his play of affinities, and conſequent ſeparation of the materials of the earth into homogeneous maſſes, Whitehurſt has been followed by Dr Kirwan, who has framed a beautiful and ingenious ſpeculation on the ſucceſſive changes that took place from the action of the materials on each other ‡.

‡ *Kirwan's Geological Eſſays*, Eſſay 1.

187 Mr Whitehurſt has been betrayed by his fondneſs for a favourite theory, into ſeveral errors reſpecting the ſtratification of the earth, which require to be mentioned. Thus, though the arrangement of the ſtrata, eſpecially where it has not been diſturbed by ſome evident and violent cauſe, is extremely uniform; he has, however, extended this regularity farther than it really obtains. He tells us that the ſtrata invariably follow each other, as if it were in an alphabetical order, or a ſeries of numbers, whatever be their denomination. Not that they are alike in all the different regions of the earth, either in quality or in thickneſs, but that their order in each particular part, however they may differ in quality; yet they follow each other in regular ſucceſſion, both as to thickneſs and quality, inſomuch, that by knowing the incumbent ſtratum, together with with the arrangement thereof in any particular part of the earth, we may come to a perfect knowledge of all the inferior beds, ſo far as they have been previouſly diſcovered in the adjacent country. With reſpect to the ſtrata that accompany coal, ſome inſtances are apparently, but not really, contradictory to this rule.

We now know, however, that Mr Whitehurſt's obſervations do not univerſally apply. In the old mines in the valley of Planen, in Saxony, the ſtrata, though they are near each other, vary conſiderably in thickneſs, from that of a few inches to ſeveral feet, and the ſtratum of coal, in particular, varies from two to thirty-two feet. Again, in Mount Salive, the ſtrata of coal, though in a calcareous mountain, vary conſiderably; and Mr Whitehurſt himſelf informs us, that at Benſal moor, thoſe ſtrata which are in other places the loweſt, are found at the ſurface. Even in Derbyſhire, to which Mr Whitehurſt's obſervations chiefly apply, we are informed that even when the arrangement is the ſame, the thickneſs of the ſtrata varies conſiderably.

SECT. VI. *Theory of Dr Hutton.*

Theory of Hutton.

THE next theory which we have to conſider, is that propoſed by Dr James Hutton, which has become ſo much the object of inquiry and debate, as to give name to one of the two principal ſects into which geologiſts are now divided. 188

The leading principles of the Huttonian theory, as conciſely laid down by one of its greateſt admirers and ſupporters, are the following.

1. The firſt circumſtance which Dr Hutton has conſidered as a general fact is, that by far the greater part of the bodies which compoſe the exterior cruſt of our globe, bear the marks of being formed of the materials of mineral and organized bodies, of more ancient date. The ſpoils or the wreck of an older world are, he thinks, everywhere viſible in the preſent, and though not found in every piece of rock, they are diffuſed ſo generally as to leave no doubt that the ſtrata which now compoſe our continents are all formed out of ſtrata more ancient than themſelves.

2. The preſent rocks, with the exception of ſuch as are not ſtratified, having all exiſted in the form of looſe materials collected at the bottom of the ſea, muſt have been conſolidated and converted into ſtone by virtue of ſome very powerful and general agent. The conſolidating cauſe which he points out is ſubterraneous heat, and the objections to this hypotheſis have been attempted to be removed, by the introduction of a principle new and peculiar to himſelf. This principle is the compreſſion which muſt have prevailed in that region where the conſolidation of mineral ſubſtances was accompliſhed. Under the weight of a ſuperincumbent ocean, heat, however intenſe, might be unable to volatilize any part of thoſe ſubſtances which, at the ſurface, and under the lighter preſſure of our atmoſphere, it can entirely conſume. The ſame preſſure, by forcing thoſe ſubſtances to remain united, which at the ſurface are eaſily ſeparated, might occaſion the fuſion of ſome bodies which in our fires are only calcined.

3. The

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3. The third general circumſtance which this theory is founded on is, that the ſtratified rocks, inſtead of being either horizontal or nearly ſo, as they no doubt were originally, are now found poſſeſſing all degrees of elevation, and ſome of them were perpendicular to the horizon; to which we muſt add, that thoſe ſtrata which were once at the bottom of the ſea are now raiſed up, many of them ſeveral thouſand feet above its ſurface. From this, as well as from the inflexions, the breaking and ſeparation of the ſtrata, it is inferred, that they have been raiſed by the action of ſome expanſive force placed under them. This force, which has burſt in pieces the ſolid pavement on which the ocean reſts, and has raiſed up rocks from the bottom of the ſea into mountains 15,000 feet above its ſurface, exceeds any which we ſee actually exerted, but ſeems to come nearer to the cauſe of the volcano or the earthquake than to any other, of which the effects are directly obſerved. The immenſe diſturbance, therefore, of the ſtrata, is in this theory aſcribed to heat acting with an expanſive power, and elevating theſe rocks which it had before conſolidated.

4. Among the marks of diſturbance in which the mineral kingdom abounds, thoſe great breaches among rocks, which are filled with materials different from the rock on either ſide, are among the moſt conſpicuous. Theſe are the veins, and comprehend not only the metallic veins, but alſo thoſe of whinſtone, of porphyry, and of granite, all of them ſubſtances more or leſs cryſtallized, and none of them containing the remains of organized bodies. Theſe are of poſterior formation to the ſtrata which they interſect, and in general alſo they carry with them the marks of the violence with which they have come into their place, and of the diſturbances which they have produced on the rocks already formed. The materials of all theſe veins, Dr Hutton concludes to have been melted by ſubterraneous heat, and, while in fuſion, injected among the fiſſures and openings of rocks already formed, but thus diſturbed, and moved from their original place.

This concluſion he extends to all the maſſes of whinſtone, porphyry, and granite, which are interſperſed among the ſtrata, or raiſed up in pyramids, as they often appear to be, through the midſt of them. Thus, in the fuſion and injection of the unſtratified rocks, we have the third and laſt great operation which ſubterraneous heat has performed on mineral ſubſtances.

5. From this Dr Hutton proceeds to conſider the changes to which mineral bodies are ſubject when raiſed into the atmoſphere. Here he finds, without any exception, that they are all going to decay; that, from the ſhore of the ſea to the top of the mountain, from the ſofteſt clay to the hardeſt quartz, all are waſting and undergoing a ſeparation of their parts. The bodies thus reſolved into their elements, whether chemical or mechanical, are carried down by the rivers to the ſea, and are there depoſited. Nothing is exempted from this general law; among the higheſt mountains and the hardeſt rocks, its effects are moſt clearly diſcerned; and it is on the objects which appear the moſt durable and fixed, that the characters of revolution are moſt deeply imprinted *.

* *Edinburgh Phil. Tranſ.* vol. v. P. iii. p. 52.

It is not ſurpriſing that this theory ſhould have met with many advocates among the more ſuperficial obſervers of nature. The production of a man in whom genius, obſervation and induſtry were united, and who paſſed a conſiderable part of a long life in chemical and geological reſearches, was calculated to dazzle the imagination by the grandeur of its deſign, and to captivate the judgement by its appearance of regularity and conſiſtence. It has been conſidered as a peculiar excellence of this theory, that it aſcribes to the phenomena of geology an order ſimilar to that which exiſts in the provinces of nature with which we are beſt acquainted; that it produces ſeas and continents, not by accident, but by the operation of regular and uniform cauſes; that it makes the decay of one part ſubſervient to the reſtoration of another, and that it gives ſtability to the whole, not by perpetuating individuals, but by reproducing them in ſucceſſion *.

* *Playfair's Illuſtrations*, p. 129.

189 Objections to the Huttonian theory.

An hypotheſis with ſuch pretenſions could not fail of being minutely examined and ſeverely criticiſed by the more enlightened part of geologiſts, and accordingly very ſerious objections have been made to it by Kirwan and others. We ſhall ſtate a few of what appear to us to be the moſt convincing arguments againſt Dr Hutton's theory, referring thoſe who wiſh to ſee a more detailed refutation of it to the geological writings of Kirwan, and A Comparative View of the Huttonian and Neptunian Theories.

190 From the nature and action of caloric.

Some of the ſtrongeſt arguments againſt this theory are drawn from the nature of caloric, and what we know of its action on other bodies. We know that caloric is of ſo diffuſible a nature, that it is always communicated, from that body or ſet of bodies, in which it is moſt abundant, to that in which it is leſs ſo, till an equilibrium of temperature is produced. But Dr Hutton's theory ſuppoſes a ſubterraneous heat as conſtantly exiſting, capable of fuſing the moſt obdurate rocks, and of raiſing them by its expanſibility from the bottom of the ocean, and yet incapable of extending its influence through the ſuperincumbent ſtrata at all times, ſo as to fuſe or evaporate ſuperior bodies, and gradually expand itſelf, ſo as to acquire that equilibrium which is one of its natural effects. Again, ſuppoſing ſuch a ſubterraneous heat to exiſt, it is ſurely extraordinary, that ſubſtances which we are incapable of fuſing by the ſtrongeſt heat that we can excite, even in the greateſt ſtate of diviſion, ſhould, by this ſubterraneous heat be ſo completely fuſed, and in ſuch vaſt maſſes, as to have aſſumed the appearance under which they now preſent themſelves. If the ſolar rays, in the utmoſt ſtate of concentration, if a united ſtream of inflamed hydrogenous and oxygenous gaſſes from the tube of a blow-pipe or gazometer, cannot melt the ſmalleſt viſible portion of calcareous ſpar or rock cryſtal, how can we conceive that the immenſe mountains of limeſtone and of quartz which are met with in ſo many places could have been fuſed into a ſtate of perfect fluidity? Or even if they could be fuſed, how is it poſſible that the carbonic acid of the limeſtone ſhould not have been diſſipated by ſo ſtrong a heat? If we ſuppoſe with Dr Hutton, that this ſubterraneous heat acts with the aſſiſtance of immenſe preſſure from the ſuperincumbent ſtrata and waters of the ocean, hence preventing the diſſipation of volatile matters, ſtill it ſhould act uniformly, and ſhould fuſe all thoſe bodies which come in its way, that are capable of fuſion. Now, we know that feldſpar, ſchorl, mica, and chlorite, are much more fuſible than quartz, and of courſe, when a maſs compounded of theſe comes under

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under the influence of this heat, all these more fusible substances should be melted as well as the quartz. But in some stones in which most of these ingredients meet, as in the granite of Portsoy, there is every reason to suppose that some of them have been in a fluid state, while the others were solid or less fluid, as crystals of the latter are impressed on a bed of the former, viz. in the instance cited, crystals of feldspar in a mass of quartz. As it is certain, according to the advocates of the Huttonian theory, that at least the quartz was fluid when it was moulded on the feldspar, how happened it that this comparatively fusible stone was not also melted, and blended in one compact mass with the quartz? We also frequently find crystals of quartz penetrated by schorl and chlorite, which is a proof that the latter must have been hard while the former was in a fluid state. Hence it is evident that these appearances could not have been the effect of fusion by heat. Again, we find seams of coal penetrated by thin laminæ and crystals of quartz, an effect which, according to this theory, must have taken place while the quartz was in a state of fusion. But, in this case, the strata of shale above and below the coal should also have been fused (shale being much more fusible than quartz, and thus the whole should have acquired a slaty texture; and besides in this intense heat, the coal should have been entirely charred and lost all its vegetable impressions.

The very existence of such a subterraneous heat, that constantly maintains itself without fuel, ready to act on any emergency, when a quantity of the old world has been abraded and translated, sufficient to furnish the materials of a new one, is avowedly hypothetical, as we have no proof that it exists. Nay, we have direct proof, as far as rational induction can carry us, to the contrary. It was long ago observed, by Irving and Forster, that the heat of the sea diminishes in proportion to the depth to which we proceed in examining it, and the same has been more lately proved by Peron, by various trials in many different latitudes*. Now the contrary of this ought certainly to happen, (unless this subterraneous heat is entirely unlike common heat) if there constantly existed in the bowels of the earth a heat capable of fusing quartz and limestone.

* *Journ. de Phys.* tom. lx. p. 81.

The structure of whin dykes, detailed in Section II. of last Chapter, affords additional arguments in opposition to the Huttonian theory.

191 From the structure of whin dykes.

The evidence which Dr Hutton has adduced to prove the subterraneous eruption of dykes, is drawn from the apparent derangement of the horizontal strata at a place where they are intersected by a dyke, and the peculiar appearance of the coal in their immediate vicinity, which he supposes to be in a state of calcination, from having been in contact with the ejected matter of the dyke in fusion. Let us first attend to the effect of this eruption of a dyke, the apparent derangement of the strata; and let us consider for a moment, what must be the mechanical operation of a mass of this liquid matter bursting upwards through the coal strata. Suppose a coal field of a mile square in extent; suppose that the coal and concomitant strata are perfectly regular, having a moderate *dip* or inclination to the south; and suppose that this coal field is to be intersected by a dyke, ejected in a state of fusion from the bowels of the earth. Considering the nature of the strata which usually accompany coal, such as sandstone, limestone, ironstone, &c. which are very hard and compact, we must allow, that the resistance from such substances would be very great. In this previous state of circumstances, then, what would be the effect of the eruption of a dyke in the middle of the field, in a direction from north to south? Can it even be imagined, that this liquid mass in its progress upwards through the superincumbent strata to the surface of the earth, would merely destroy the continuity of these strata, and not in its irresistible course, carry along with it part of all the substances composing that strata through which it passed? But farther, one of the most obvious consequences of such an eruption, would be the elevation of part of the whole range of the strata on both sides of the dyke, and the extent of this elevation will be in proportion to the power or thickness of the dyke; and, not only is it natural to expect this elevation of the strata to a certain extent, but from the operation of an agent so tremendous and irresistible, that the whole strata should be broken, disjointed and confused. But does this statement correspond with the phenomena? From the history of dykes traversing coal strata, we know that it does not. On the contrary, the whole of the strata, in most cases, preserve the same thickness, the same parallelism, and the same inclination to the horizon on both sides of the dyke. It is true, the half mile of coal field, intersected by a dyke, as we have supposed above, will on one side of it be elevated or depressed. If the dyke, which runs north and south in its course upwards, inclines to the west, the western division will be elevated. But this is not a partial elevation only in the immediate vicinity of the dyke. It extends over the whole field on the west side of the dyke, and the strata continue fair and regular, in all respects corresponding to those from which they have been detached, till they are intersected by another dyke.

From this reasoning, we think the conclusion fair and obvious, that dykes intersecting coal strata have not been formed by subterraneous eruption, and therefore, that the elevation or depression of the strata is not owing to this cause. Dr Hutton's theory, in this respect, is opposed by the facts which it professes to explain, and consequently it is untenable.

Let us now consider the argument drawn from the supposed calcination of the coal which has been in contact with the matter of the dyke in a state of fusion. Here Dr Hutton seems to have overleaped the bounds of his own theory, and lost sight of his own principles, which suppose, that all the strata and stony matters of which the globe is composed, have been consolidated by means of heat; that the exhibition of the common or ordinary phenomena of heat is not to be looked for in the grand processes of nature; because these operations have taken place at great depths in the bowels of the earth, or under immense pressure at the bottom of the sea; and this is the reason that coal, and lime strata, for instance, which have been subjected to this intense degree of heat discover no marks of calcination, the one being deprived of its carbonic acid, and the other of its bitumen. Now, granting this hypothetical argument to be well founded, what is the reason that the coal, which is in contact with a dyke, has undergone the processes of calcination, when this coal is at as great a depth in the bowels of the earth, under as immense pressure, and as much

much excluded from atmofpheric air, as any coal at its original formation. But all the coal in contact with a dyke, is not in this ftate. Clean coal is fometimes found in immediate contact; and, in many places, clean coal is alfo found intercepted between regular ranges of bafaltic columns, and this coal difcovers not the fmalleft mark of calcination. On the other hand, coal in this fuppofed ftate of calcination, has been frequently difcovered, at a great diftance from any dyke or bafaltic fubftance whatever. Maffes of this foul coal often occur, to the regret and difappointment of the miner, in the midft of ftrata otherwife perfectly clean and regular. This laft fact fhews us, that we muft look for the caufe of this fingular phenomenon elfewhere than in the circumftance of the coal having been in contact with a dyke while in fufion; for it appears that the effect does not always follow in the fame circumftances, and that the fame effect is produced in very different circumftances.

Thefe obfervations are probably fufficient to fhew that the above argument in proof of the fubterraneous eruption of dykes, is equally unfatisfactory in explaining the phenomena, and confequently equally untenable with the former. Both, therefore, muft fall to the ground.

192 From the ftructure of metallic veins.

The wedge-like form of dykes might be adduced as another argument againft their formation by fubterraneous eruption; for it is not eafy to conceive that a dyke in a ftate of fufion fhould, in its eruptive progrefs towards the furface of the earth, enlarge and become thicker.

The hiftory of metallic veins furnifhes us with ftronger objections againft Dr Hutton's theory. If, according to this theory, metallic veins have been formed by the fubftances they contain being ignited in a ftate of fufion from the bowels of the earth, it will naturally follow, that the veins thus formed might be traced to the greateft depths, and even to the fubterraneous furnace from which they iffued. But we know that the fact is quite otherwife. The termination of many veins downwards has been difcovered. Even the moft powerful and productive have been unexpectedly cut off by the horizontal ftrata, and no veftige of them could ever be traced. This was the cafe with the rich vein of lead ore at Slangunog in Wales. It is the cafe alfo with many veins in their courfe downwards, to diminifh gradually in form of a wedge, and then they are loft for ever. Now, this certainly could never have happened, had they been formed by fubterraneous eruption. Some trace of their progrefs, fome mark of their courfe through the interfected ftrata, would ftill have remained. But no fuch indications, no fuch traces, are found. We muft therefore conclude, that metallic veins have not been formed in this way, and that this theory, which appears to be fo much at variance with facts, will not account in a fatisfactory manner for their formation.

The maffes of ftone of the fame fpecies with the neighbouring fuperior ftrata, fometimes rounded and worn by the action of water, which are found at great depths in mineral veins, and organized fubftances, petrifactions of vegetables and animals, prefent us with another objection to this theory, equally ftrong and infurmountable. Thefe fubftances are the productions of the furface of the earth; and even fuppofing them to have exifted in the bowels of the earth, it is inconceivable that they fhould have retained their primitive form after they were fubjected to fo high a temperature as is neceffary to hold metals in a ftate of fufion.

Sect. VII. *Theory of Werner.*

193 Theory of Werner.

The lateft, and perhaps moft celebrated, theory that has yet appeared, is that of Profeffor Werner of Freyberg, with an account of which, and fome obfervations on Mr Kirwan's opinions, we fhall clofe this chapter.

We have faid already, (N° 1.) that the fubject of which we are now treating is called by Werner *geognofy*, and his pupils are commonly called *geognofts*.

Werner is of opinion, that our knowledge is already fufficiently advanced to form a rational theory refpecting the formation of the *exterior cruft* of our globe; for he does not deny that we cannot reafon with refpect to what is below this, fince we have no fact which can give us the leaft notion with refpect to it. We are only certain that fome part of our globe has been in a fluid ftate, as is proved by its fpheroidal form. The cryftalline form of granite and other rocky fubftances which conftitute the bafe of that part of the earth with which we are acquainted, are, according to Werner, fufficient proofs that this part at leaft has been in a ftate of minute diffolution. Again, the ftratified appearance of moft mountains and rocks fhew that they are an accumulation of precipitates or fediments which have been depofited one over another. The numerous remains of marine animals which are found imbedded in many rocks, and of which fome fpecies are ftill found in our feas, allow us to believe that this folution was aqueous; that it was a vaft ocean which has covered our globe to a very confiderable height. *The exterior part of the globe*, then, *has been entirely diffolved by the waters which furrounded it, and from this folution certain chemical precipitations took place, which have formed the cruft that we now fee.*

In framing his theory, Werner profeffes to banifh every thing that is hypothetical, and only to draw from general facts fuch immediate confequences as he believes it impoffible not to deduce from them, and on thefe alone he founds his geognofy. The object of this theory, according to one of his difciples (the tranflator of his book on metallic veins), is to acquire a knowledge of the ftructure of the folid cruft of the terraqueous globe, and the relative difpofition of the materials which compofe it; the means of doing this are to be derived from obfervation. Werner fets out with ftating, that the chemical precipitates that took place from the chaotic fluid, did not form a regular furface, but that they collected here and there fo as to produce the primitive mountains. Thefe mountains he calls chaotic, becaufe, fays he, they have been formed during the period when the furface of the earth was a fort of chaos. After the retreat of the waters, thefe elevated parts were firft difcovered. They were expofed to the deftructive action of the elements, and the fhock of tides and torrents. The valleys were hollowed out, and the mountains acquired nearly the form in which we now fee them.

Obfervation has fhewn that the ftrata of which the earth is compofed, may be divided into a certain number of congeries, each of which is compofed of a certain

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tain set of minerals that are nearly the same in whatever part of the world the congeries is found. To these congeries Werner has given the name of formations, of which he distinguishes six kinds or classes, four universal, being found all over the globe, and two partial, found only in particular districts. These formations he has arranged according to the order in which he conceives them to have been produced, beginning with that formation which lies next the solid nucleus of the earth, and which may therefore be conceived to be the oldest, and ending with the most superficial, which is considered as the newest formation.

The first of these classes is called by Werner that of *primitive formations*, which consist of a number of formations lying above each other, being those which are supposed the oldest, as in these no organic remains have been discovered. The substances constituting this class are *granite*, *gneiss*, *micaceous schistus*, *argillaceous schistus*, *primitive limestone*, *primitive trap*, *sienite*, and *porphyry*. Of these the granite is the lowest, and therefore is considered as the oldest; and next this follow the others in the order in which we have enumerated them, except that the primitive limestone, and primitive trap, are found in an uncertain order, alternating with gneiss, argillaceous schistus, or micaceous schistus; and are therefore considered as subordinate to these formations.

When the waters had subsided, and the summits of the primitive mountains had been uncovered, organized bodies were produced; and part of these being intercepted among the chemical precipitations which were still going on, and the mechanical precipitations which now began to take place, were carried with these to the flanks of the primitive mountains, and the valleys between them. Hence were produced a second series of formations, which are called by Werner *transition formations*, or *rocks of transition*, as he considered them to be deposited during the period when the earth was passing from an uninhabited to an inhabited state. Among these formations, however, the organic remains are but few. The substances composing this class, are *transition limestone*, *gray wacke*, *gray wacke slate*, *transition trap*, *siliceous schistus*. Of these the two last are subordinate, alternating with gray wacke and gray wacke slate.

The third formation is what Werner calls *floetz formation*, or that, in which the beds or strata lie nearly horizontal, appearing as if they had been deposited from water. This formation comprehends most of what are usually called secondary strata. It is divided by Werner into three subformations, named from the variety or situation of the sandstone, which forms a principal part of each; as 1. Old red sandstone formation, composed of *floetz limestone*, *old red sandstone*, and *foliated gypsum*. 2. Second sandstone formation, composed of *sandstone*, *floetz limestone*, and *fibrous gypsum*. 3. Third sandstone formation, composed of *sandstone*, *limestone*, and *chalk*, &c. Of these, as before, the first mentioned is the oldest, and in this, somewhere near the gypsum, there is usually found salt or sulphur. In this formation, organic remains are first seen in any great quantities.

The fourth formation is called *independent coal formation*, because in this coal is first found, and because it is not universally spread over the earth as the three preceding, but is collected in insulated masses, independent of each other. This is also divided into three, each successively more recent than the preceding. The first series of strata consist of *slate clay*, *limestone*, *marl*, *soft sandstone*, *greenstone*, *argillaceous ironstone*, *shale*, and *coal*; the second of *indurated clay*, *marl*, *limestone*, *porphyritic stone*, and *coal*; and the third of *loose sandstone*, *conglomerate*, (a variety of sandstone), *slate clay*, and *coal*.

The fifth is called *floetz trap formation*, so called because the *beds* of which it is composed, consist of materials that are mostly of the nature of *trap*, or whinstone. The substances that compose this formation are *gravel*, *sandstone*, *siliceous sandstone*, *clay*, *wacke*, *basalt*, *greenstone*, *schistose porphyry*, *pitchstone*, and *graystone*. *Coal* is also found in this formation, somewhere among the beds of *siliceous sandstone*, *clay*, *wacke*, and *basalt*, to which it is therefore considered as subordinate (F)

The sixth and last formation is the *alluvial formation*, or that which has arisen from the action of lakes and rivers, washing down part of the older strata. This is divided into two series of strata; the first being those that have arisen from the action of lakes newly drained, comprehending *marl*, *sand*, *clay*, and *coal*; and the second, those which have been produced from the action of rivers, comprehending *mud*, *ironstone*, *sand*, *peat*, &c. This formation is the most recent of any, but, like the fourth, it is only partial.

The above is an outline of Werner's geognosy, which is considered as an improvement of what is called the *Neptunian theory*, or that which explains geological appearances by the action of water, in opposition to what is called the *volcanic theory*, or that which attributes these appearances to an igneous origin.

194 Objections to the theory of Werner.

One of the principal objections to the Neptunian theory is drawn from the insolubility in water of many of the substances which compose our globe; but this the Neptunians endeavour to explain, by supposing that at the very commencement of their existence these substances were in that state of minute division which aqueous solutions require, but which no known existing quantity would be able to effect, after the substances had acquired their utmost consolidation, as it is well known, that a solid substance may be kept in solution, at least for a short time, in a less quantity of fluid than was originally requisite to dissolve it.

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(F) We may here notice Werner's opinion with respect to the formation and situation of basalt; as this is the only theory of importance respecting it, that has not been mentioned under the article BASALTES. "I am perfectly convinced (says Werner in a late memoir) that all the varieties of basalt have been produced in the humid way, and that they are of a very recent formation; that they formerly composed a great bed of immense extent, covering both the primitive and secondary strata; that time has anew destroyed a considerable part, and has left only the basaltic eminences, which we now see." Vid. *Jameson's Mineralogy of Dumfries*, p. 184.

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A second objection is derived from the difficulty of supposing that these substances could have been consolidated below water, or that the water could completely shut up the pores of a body, to the entire exclusion of itself; so that had the mineral substances been consolidated as here supposed, the solvent ought either to remain within them in a liquid state, or, if evaporated, should have left the pores empty, and the body pervious to water.

Mr Playfair argues strenuously against the notion of these substances being precipitated from the chaotic fluid, which has been so ingeniously supported by Kirwan, who ascribes the solution of all substances in the chaotic fluid to their being finely pulverised, or created in a state of the most minute division; and the solvent being then insufficient in quantity, he supposes that, on that account, the precipitation took place the more rapidly.

"If, says Mr Playfair, he means by this to say, that a precipitation without solution would take place the sooner, the more inadequate the menstruum was to dissolve the whole, the proposition may be true, but will be of no use to explain the crystallization of minerals, the very object he has in view; because to crystallization it is not a bare subsidence of particles suspended in a fluid, but it is a passage from chemical solution to non-solution, or insolubility, that is required.

"If on the other hand he means to say, that the solution actually took place more quickly, and was more immediately followed by precipitation, because the quantity of the menstruum was insufficient, this is to assert that the weaker the cause, the more instantaneous will be its effect." *

* *Playfair's Illustrations*, sect. 161.

195 Werner's theory of dykes and veins.

Werner's theory of dykes and veins requires a more particular consideration.

This theory supposes, that the spaces which are now occupied by vertical strata, or dykes, including also metallic veins, were originally fissures, formed by the operation of different causes.

1. The unequal height and density of mountains, are considered as the most general causes of fissures. When the mountains were in a soft and humid state, that side which was least supported not only separated by its own weight, but the whole strata of the side gave way, and sunk below their former plain. This also seems to be the opinion of Saussure, with regard to the formation of fissures. It is not to be expected, that events of this kind should be of frequent occurrence, now that mountains have acquired sufficient firmness and stability to resist the force of gravity, operating in consequence of the inequality of weight and diversity of the materials of which they are composed. Instances, however, of the operation of such causes are not altogether wanting, even in modern times. After a season of excessive rains, in the year 1767, similar fissures were formed in mountains in Bohemia and Lusatia.

2. When the waters covered the surface of the earth, the unequal weight of the mountains was supported by their pressure; but when the waters retreated, this pressure was removed, the equilibrium was destroyed, the unsupported side of the mountain separated and sunk; and in this manner a fissure was formed.

3. The evaporation of the moisture, after the retreat of the waters, and the consequent diminution of bulk by contraction of the substances which enter into the composition of mountains, are also considered as the causes of fissures.

4. Fissures, too, derive their origin from other local and accidental causes, and especially from earthquakes. In the year 1783, when Calabria was afflicted with this most dreadful of all calamities which visit the earth, mountains were separated, exhibiting fissures similar to those which are now occupied by vertical strata.

The second part of the theory is employed in proving that the empty spaces, occasioned by the operation of one or other of the causes which have been enumerated, were filled from above; that the different substances, of which the vertical strata are composed, were held in solution by the waters which covered the earth; and that they were precipitated, by different chemical agents, according to the order of chemical affinity, and deposited in the places which they now occupy. In support of the opinion, that these fissures were filled from above, Werner adduces facts of angular and rounded fragments of stones of various species, and organized bodies, as marine shells and vegetables, having been found in vertical strata, at the immense depth of 150 and 200 fathoms. It may be doubted, on good grounds, whether this theory, supported by all the ingenuity and experience of its author, will account, in a satisfactory manner, for that regularity of position and arrangement which are discovered in the vertical strata; for, notwithstanding the seeming disorder which a superficial vein may exhibit, they are not less regular and uniform than the horizontal strata. And when our researches are extended beyond the narrow bounds within which they are at present limited, when we are better acquainted with their relative positions and connexions, this uniformity and regularity will become more conspicuous. It may be doubted whether the fortuitous operation of such causes as have been stated, be equal to the effect of the formation of the vertical strata, as they now appear.

But, supposing that fissures were produced by some of the causes which have been mentioned, few of these causes could operate till the retreat of the waters left the mountains uncovered. It was only then, that the mountains, by the inequality of height and density, being left unsupported, separated, and sunk from their former situation; it was then only that the process of evaporation could take place, succeeded by diminution of bulk and consequent contraction. In short, none of the causes which have been stated, could have any effect before the waters had retreated, excepting earthquakes; of the operation of which there is no proof previous to that period. The materials which compose the vertical strata, it is said, were formed by deposition from the waters which covered the mountains, holding them in solution. But before the fissures could be formed to receive these materials by precipitation and deposition, the waters had retired. A second deluge must therefore have happened, from the waters of which the various substances which enter into the composition of vertical strata have been deposited. This the theory does not suppose to have taken place; and, without such a supposition, it seems to be attended with considerable difficulty. But another difficulty still remains. It does not appear how the peculiarity of structure, Theories of the Earth

ſtructure, which was mentioned in our account of whin dykes, Sect. II. of the laſt chapter, can be accounted for by the principles of this theory. If it be granted, that the horizontal ſtrata were formed in the humid way, the materials of which they are compoſed muſt have been precipitated from the waters which held them in ſolution, by the laws of chemical affinity. But the vertical ſtrata are ſuppoſed to have been formed in the ſame manner, and according to the ſame proceſs. Now, this being the caſe, What is the reaſon that the vertical ſtrata ſhould exhibit a peculiarity of ſtructure and arrangement, different from the horizontal ſtrata? Some of the whin dykes which have been already deſcribed, are very remarkable for this ſingular ſtructure, eſpecially thoſe which aſſume the form of priſmatic columns. Theſe columns are in the horizontal poſition, and, excepting the latter circumſtance, theſe dykes, in every reſpect, reſemble a baſaltic ſtratum, in which the columns are perpendicular.

More arguments might be adduced in oppoſition to the theory of Werner; but we muſt haſten to conclude this chapter, with mentioning a few of Dr Kirwan's peculiar opinions.

196 Kirwan's theory of the declivities of mountains.

Among theſe, the manner in which he accounts for the unequal declivities of the ſides of mountains, forms one of the moſt conſpicuous objects; and to this we ſhall principally confine ourſelves, and ſhall give it in his own words, as extracted from his eſſay on the declivities of mountains, to which we were obliged in the firſt ſection of Chap. II.

"To aſſign the cauſes of this almoſt univerſal allotment of unequal declivities to oppoſite points, and why the greateſt are directed to the weſt and ſouth, and the gentleſt, on the contrary, to the eaſt and north, it is neceſſary to conſider,

"1. That all mountains were formed while covered with water.

"2. That the earth was univerſally covered with water at two different eras, that of the creation, and that of the Noachian deluge.

"3. That in the firſt era we muſt diſtinguiſh two different periods, that which preceded the appearance of dry land, and that which ſucceeded the creation of fiſh, but before the ſea had been reduced nearly to its preſent level. During the former, the primeval mountains were formed; and during the latter, moſt of the ſecondary mountains and ſtrata were formed.

"4. That all mountains extend either from eaſt to weſt, or from north to ſouth, or in ſome intermediate direction between theſe cardinal points, which need not be particularly mentioned here, as the ſame ſpecies of reaſoning muſt be applied to them, as to thoſe to whoſe aſpect they approach moſt.

"Theſe preliminary circumſtances being noticed, we are next to obſerve that, during the firſt era, this vaſt maſs of water moved in two general directions, at right angles with each other, the one from eaſt to weſt, which needs not be proved, being the courſe of tides which ſtill continue, but were in that ocean neceſſarily ſtronger and higher than at preſent; the other from north to ſouth, the water tending to theſe vaſt abyſſes then formed in the vicinity of the ſouth pole, as ſhewn in my former eſſays. Before either motion could be propagated, a conſiderable time muſt have elapſed.

"Now the primeval mountains formed at the commencement of the firſt era, and before this double direction of the waters took place, muſt have oppoſed a conſiderable obſtacle to the motion of that fluid in the ſenſe that croſſed that of the direction of theſe mountains. Thus the mountains that ſtretch from north to ſouth muſt have oppoſed the motion of the waters from eaſt to weſt; this oppoſition diminiſhing the motion of that fluid, diſpoſed it to ſuffer the earthy particles with which in thoſe early periods it muſt have been impregnated, to cryſtallize or be depoſited on theſe eaſtern flanks, and particularly on thoſe of the higheſt mountains, for over the lower it could eaſily paſs; theſe depoſitions being inceſſantly repeated at heights gradually diminiſhing as the level of the waters gradually lowered, muſt have rendered the eaſtern declivities or deſcent, gentle, gradual, and moderate, while the weſtern ſides receiving no ſuch acceſſions from depoſitions, muſt have remained ſteep and craggy.

"Again, the primeval mountains that run from eaſt to weſt, by oppoſing a ſimilar reſiſtance to the courſe of the waters from north to ſouth, muſt have occaſioned ſimilar depoſitions on the northern ſides of theſe mountains, againſt which theſe waters impinged, and thus ſmoothed them.

"Where mountains interſect each other in an oblique direction, the north-eaſt ſide of one range being contiguous to the ſouth-weſt flanks of another range, there the influx of adventitious particles on the north-eaſt ſide of the one, muſt have frequently extended to the ſouth-weſt ſide of the other, particularly if that afflux were ſtrong and copious; thus the *Erzgebirge* of Saxony, which run from weſt to eaſt, have their north-eaſt ſides contiguous to the ſouth-weſt ſide of the Rieſengebirge that ſeparate Sileſia from Bohemia, and hence theſe latter are covered with the ſame beds of gneiſs, &c. as the northern ſides of the Saxon, and thereby are rendered ſmooth and gentle, comparatively to the oppoſite ſide, which, being ſheltered, remains ſteep and abrupt, which explains the ſeventh obſervation.

"The cauſes here aſſigned explain why the covering of adventitious ſtrata on the higheſt mountains is generally thinneſt at the greateſt height, and thickeſt towards the foot of the mountain; for the bulk of the water that contained the adventitious particles being proportioned to its depth, and the maſs of earthy particles with which it was charged being proportioned to the bulk of the water that contained them, it is plain, that as the height of water gradually decreaſed, the depoſitions from it on the higher parts of the mountains muſt have been leſs copious than on the lower, where they muſt have been often repeated.

"Hence, 2. granite mountains, generally the moſt ancient, frequently have their northern or eaſtern ſides covered with ſtrata of gneiſs or micaceous ſchiſtus, and this often with argillite or primeval ſandſtone, or limeſtone, theſe being either of ſomewhat later formation, or longer ſuſpendible in water.

"Hence, 3. different ſpecies of ſtone are often found at different heights of the ſame flank of a mountain, according as the water which conveyed theſe ſpecies, happened to be differently impregnated at different heights. During the firſt era its depoſitions formed the primitive ſtony maſſes; after which the creation of fiſh, limeſtone, ſandſtone, (*puddingstone*) and ſecondary argillites, in which piſcine remains are found, were depoſited,

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ted. But during the second era, that of the Noachian deluge, by reason of the violence and irregularity of its aggression, the depositions were more miscellaneous, and are found at the greatest heights; yet in general they may well be distinguished by the remains of land animals, or of vegetables, or of both, which they present in their strata (or at least by the impressions of vegetables which they bear) as these must have been conveyed after the earth had been inhabited. But mountains regularly stratified bearing such remains, for instance the carboniferous, cannot be deemed to have been formed in a period so tumultuous. During this deluge the waters also held a different course, proceeding at first from south to north, and afterwards in both opposite directions, as shewn in treating of that catastrophe in my second essay.

"Hence, and from various contingent local causes, as partial inundations, earthquakes, volcanoes, the erosion of rivers, the elapsion of strata, disintegration, the disruption of the lofty mounds by which many lakes were anciently hemmed in, several changes were produced in particular countries, that may at first sight appear, though in reality they are not, exceptions to the operations of the general causes already stated.

"Thus the mountains of Kamtschatka had their eastern flanks torn and rendered abrupt by the irruption of the general deluge, probably accompanied by earthquakes. And thus the Meissener had its east and north flanks undermined by the river Warre, as Werner has shewn; thus the eighth and sixteenth observations are accounted for, as is the thirteenth, by the vast inundations so frequent in this country, (1. *Pallas*, p. 172), which undermined or corroded its east side, while the western were smoothed by the calcareous depositions from the numerous rivers in its vicinity.

"Hence, 4. we see why on different sides of lofty mountains different species of stones are found, as Pallas and Saussure have observed, (2. *Sauss.* § 981.), a circumstance which Saussure imagined almost inexplicable, but which Dolomieu has since happily explained, by shewing that the current which conveyed the calcareous substances to the northern, eastern, and north-eastern sides of the Alps, for instance, was stopped by the height of these mountains, and thus prevented from conveying them to the southern sides, and thus the north-eastern sides were rendered more gentle than the opposite, (3. *New Roz.* p. 423.), conformably to the theory here given.

"Hence, 5. where several lofty ridges run parallel to each other, it must frequently happen that the external should intercept the depositions that do not surround them, and thus leave the internal ridges steep on both sides.

"Hence, 6. low granitic or other primitive hills are frequently uncovered by adventitious strata on all sides, as at Phanet in the county of Donegal, or are covered on all sides; the impregnated waters either easily passing over them, or stagnating upon them, according to the greater or less rapidity of its course, and the obstacles it met with."

197 Kirwan's theory of dykes.

Dr Kirwan's theory of the formation of whin dykes, is as follows.

He supposes that the dyke existed in the spot where it is found previous to the formation of the horizontal strata; that, during the formation of the latter by deposition, their equal extension on each side of the dyke was obstructed by its height preventing the passage of the current of waters; that the strata on that side of the dyke which were first formed, occasioned a much more considerable pressure than on the side on which the strata of latter formation repose, and must have pulled the upper and more moveable extremity of the slip gradually towards the side on which there was least pressure; on that side it must therefore overhang: this pressure being of earlier date than on the opposite side, must have had a more considerable effect in depressing each particular stratum, and forcing their integrant particles into closer contact, than could have been produced in those of later formation; and consequently the strata must be lower. The ingenious author has added, with good reason, that he is not satisfied with this explanation. It is undoubtedly quite incompatible with the phenomena which it attempts to explain. For it has been already observed, that the coal and contiguous strata are, in every respect, the same on both sides of a dyke, to whatever distance they may have been elevated or depressed, which demonstrates clearly, that their formation must have been coeval. But, besides, the same derangement takes place in a slip where there is merely a solution of contiguity of the horizontal strata, one side being only elevated or depressed above or below the corresponding side from which it has been detached without having a vertical stratum or dyke interposed.

Earthquakes and Volcanoes.

Chap. IV. *Of Earthquakes and Volcanoes.*

In the preceding chapters we have given a short account of the materials which constitute the globe of 198
the earth; we have taken a view of the relative position and connexion which subsist among these materials, so far as they are known, and we have considered some of the changes which are supposed to have taken place in their arrangement and distribution, and some of the theories which have been proposed to account for these changes. We have hitherto contemplated nature in a state of seeming repose, conducting her operations by a gradual and silent process, and accomplishing the most beneficial and wonderful effects, unheeded and unobserved. We are now to take a view of those more terrible and sudden changes which are exhibited in the devastation and ruin which accompany the earthquake and the volcano;—changes awful in the contemplation, but dreadful and terrible in their tremendous effects.

Many of the phenomena which accompany earthquakes and volcanoes, are common to both. Earthquakes are frequently the forerunners, and sometimes the attendants, of volcanic eruptions; but earthquakes have often existed, and their terrible effects have been severely felt, where no volcano was ever known.

In the present chapter, we propose to consider the phenomena, history, and causes of earthquakes and volcanoes, which will form the subjects of the two following sections. In the first we shall treat of earthquakes, and in the second of volcanoes.

Sect. I. *Of the Phenomena and History of Earthquakes.* 199

Places where earthquakes prevail.

Earthquakes have been felt in most countries of the world. There are, however, particular places, which

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which ſeem to be more ſubject to this dreadful calamity than others; and this does not ſeem to depend on any local circumſtances, with regard to particular regions of the earth. It may be obſerved in general, that earthquakes are more frequent within the tropics; but there are places within the torrid zone, which are more rarely viſited by earthquakes than ſome of the more temperate, or even the colder regions of the earth. In the iſlands of the Weſt Indies, and in ſome parts of the American continent which lie between the tropics, the earthquake is more frequently felt than in moſt other regions of the earth. But the northern ſhores of the Mediterranean, the kingdom of Portugal, and ſome other places without the tropics, have been oftener the ſcene of deſolation, by the effects of the earthquake, than many of the iſlands and extenſive continents within the torrid zone. From this circumſtance in the hiſtory of earthquakes, it would appear that they are not limited to particular regions, on account of proximity to the equator or diſtance from it, on account of inſular ſituation or extent of continent. Particular iſlands, however, and particular parts of continents, have undoubtedly been oftener viſited by earthquakes than others. Of all the iſlands of the Weſt Indies, Jamaica has moſt frequently experienced their dreadful effects. Indeed, ſcarcely a year paſſes, without ſeveral ſhocks of an earthquake being felt in that iſland. Mexico and Peru in South America, are more ſubject to earthquakes than the other regions of the American continent. Portugal has been often ſhaken to the very foundations, by terrible earthquakes, while Spain, immediately adjoining, or it may be ſaid, including it, is, comparatively, almoſt exempted from their effects. It has been obſerved, that earthquakes have been leſs deſtructive in Italy than in Sicily, which are in the immediate vicinity of each other, and are both volcanic countries.

Obſervations on phenomena ſo awful and terrible, can ſcarcely be expected to be very numerous. The operation of the cauſes which produce them is too rapid, the effects are too ſudden and unexpected, to be rendered the ſubject of accurate or attentive philoſophical inveſtigation; or, perhaps, we might acknowledge at once, that they are too extenſive and too obſcure for the powers of man. They are beyond the graſp of the human mind.

It has been already obſerved, that earthquakes are more frequent in volcanic countries than in any others. In theſe regions they are oftener dreaded and expected than in other places. Where a volcano exiſts, and when it has ceaſed to throw out flame and ſmoke for any long period, ſhocks of earthquakes begin to be dreaded. This has been very generally the caſe with the principal volcanoes of the world, the events of whoſe hiſtory have been recorded. An earthquake is often the forerunner of an eruption, and the very firſt warning of its approach.

200 Phenomena which precede and accompany them.

Earthquakes are often preceded by long droughts. The earthquake, however, does not immediately ſucceed the ceſſation of the drought, or the fall of rain. Some electrical appearances are obſerved to take place in the air, before the earthquake comes on. The aurora borealis is frequent and brilliant, and bright meteors are often ſeen darting from one region of the heavens to another, or from the atmoſphere to the earth.

Before the ſhock comes on, the waters of the ocean appear to be unuſually troubled; without the effect of wind, or any perceptible cauſe, it ſwells up with great noiſe. Fountains and ſprings are alſo greatly diſturbed, and their waters are agitated, and become muddy. The air at the time of the ſhock has been obſerved to be remarkably calm and ſerene, but afterwards it becomes dark and cloudy.

The noiſe which accompanies the ſhock of an earthquake is ſometimes like that of a number of carriages, driving along the pavement of a ſtreet with great rapidity. Sometimes it is like a ruſhing noiſe, ſimilar to that of wind, and ſometimes it reſembles the exploſions occaſioned by the firing of artillery. The noiſe which accompanied the earthquake, which was pretty generally felt over Scotland about three years ago, we recollect, reſembled that of a heavy perſon walking rapidly, and barefooted, through an adjoining room.

The effect of earthquakes on the ſurface of the earth is various. Sometimes it is inſtantaneouſly heaved up in a perpendicular direction, and ſometimes aſſumes a kind of rolling motion, from ſide to ſide. Sometimes the ſhock commences with the perpendicular motion, and terminates with the other.

Great openings or fiſſures are made in the earth by the ſhock, and theſe in general throw out vaſt quantities of water, but ſometimes ſmoke and flame are alſo emitted. Flame and ſmoke are often ſeen iſſuing through the ſurface of the earth, even where no chaſm or fiſſure has been produced.

The effects of an earthquake on the ocean are not leſs terrible than thoſe on land. The ſea ſwells up to a great height; its waters ſometimes ſeem to be entirely ſeparated, and from the place of ſeparation, currents of air, ſmoke, and flame are diſcharged. Similar effects have been obſerved to take place in lakes, ponds, and rivers. Their waters are thrown into great agitation, and are ſometimes ſwelled up. Places in which there was a conſiderable body of water, have become dry land, and dry land has been converted into an extenſive lake by the ſhock of an earthquake.

The moſt terrible earthquake that has yet viſited the earth, has never been felt over its whole ſurface. Their effects, however, extend to very diſtant regions, from the centre or principal ſcene of deſolation. The exiſtence of an earthquake is indicated much more extenſively by water than by land. Where its effects have not been at all perceived on dry land, the agitation produced on the waters in the ocean, or in lakes and rivers, has been often communicated to a very great diſtance.

The duration of the ſhock of an earthquake rarely exceeds a minute, and perhaps very few continue for near that length of time. But the ſhocks are ſometimes repeated in rapid ſucceſſion; and perhaps from the effect on the ſenſes, and the dread and alarm which are thus occaſioned, it is ſuppoſed that their duration is much longer than it really is.

But as no general account of the phenomena which accompany an earthquake, from the difficulty or ſcantineſs of obſervation, can be complete, it will be rendered much more intelligible and intereſting, if we enter a little

little more into the detail of the hiſtory of particular earthquakes; and in the account of ſome of them which we propoſe to lay before our readers, it will be found that moſt of the appearances and effects which have been enumerated, were obſerved.

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Earthquake in Calabria in 1638.

The firſt earthquake, the hiſtory of which we ſhall now detail, happened in Calabria, in the year 1638. This earthquake is rather to be conſidered as an exception to what was ſaid with regard to their not taking place in the neighbourhood of a volcano, ſoon after an eruption. The volcanoes in that vicinity had experienced violent eruptions a very ſhort time before. Five years before, there had been an eruption of Mount Veſuvius, and two years only had elapſed from the time that a ſimilar event had befallen Ætna. This mountain, indeed, at the very time, threw out a great body of ſmoke, which ſeemed to cover the whole iſland, and entirely concealed the ſhores from view. The air over the ſea at a little diſtance was calm and ſerene, and the ſurface of the water was perfectly ſmooth. Seemingly without any cauſe, it began to be ſlightly agitated, as happens to the ſurface of water in a heavy ſhower of rain. A dreadful noiſe ſucceeded, and the ſmell of ſulphureous vapours was perceived. The noiſe, like the rattling of chariots, grew more frequent and loud, and the ſhock at laſt was terribly felt, when the earth was heaved up, or rolled in the form of waves.

This earthquake is particularly deſcribed by Kircher, the celebrated geographer. "On the 24th of March, (ſays he), we departed in a ſmall boat from the harbour of Meſſina in Sicily, and the ſame day arrived at the promontory of Pelorus. Our deſtination was for the city of Euphemia in Calabria, but unfavourable weather obliged us to remain at Pelorus three days. Wearied at length with delay, we determined to proceed on our voyage, and although the ſea ſeemed unuſually agitated, yet it did not deter us from embarking. As we approached the gulf of Charybdis, the waters ſeemed whirled round with ſuch violence, as to form a large hollow in the centre of the vortex. Turning my eyes to Mount Ætna, I ſaw it throw out huge volumes of ſmoke, which entirely covered the iſland. This awful appearance, with the dreadful noiſe, and the ſulphureous ſmell which accompanied it, filled me with ſtrong apprehenſions that ſome terrible calamity was approaching. The ſea itſelf exhibited a very unuſual appearance, its agitation reſembling that of the waters of a lake which is covered with bubbles in a violent ſhower of rain. My ſurpriſe was ſtill increaſed by the calmneſs and ſerenity of the weather; not a breeze ſtirred, not a cloud obſcured the face of the ſky, which might be ſuppoſed to produce theſe dreadful commotions. I therefore warned my companion, that the unuſual phenomena which we obſerved, were the forerunners of an earthquake. Soon after we ſtood in for the ſhore, and landed at Tropæa; but we had ſcarcely arrived at the Jeſuits college in that city, when a horrid ſound, which reſembled the rattling wheels of an infinite number of chariots, driven furiouſly along, ſtunned our ears. Soon after a terrible ſhaking of the earth began; the ground on which we ſtood ſeemed to vibrate, as if we were in the ſcale of a balance, which continued waving. The motion ſoon grew more violent; I could no longer keep my legs, but was thrown proſtrate upon the ground. After ſome time had elapſed, when I had recovered from the conſternation; and finding that I was unhurt amidſt the general craſh, I reſolved to make the beſt of my way to a place of ſafety, and running as faſt as I could, I reached the ſhore. I ſoon found the boat in which I had landed, as well as my companions; and leaving this ſcene of deſolation, we proſecuted our voyage along the coaſt. Next day we arrived at Rochetta, where we landed, although the earth ſtill continued in violent commotion. But we had ſcarcely reached the inn when we were again obliged to return to the boat. In about half an hour we ſaw the greateſt part of the town, as well as the inn where we had ſtopped, levelled with the ground, and moſt of the inhabitants buried in its ruins. As we proceeded onward, we landed at Lopezium, which is a caſtle about half way between Tropæa and Euphemia, to which we were bound: and, here, wherever I looked, nothing but ſcenes of ruin and horror preſented themſelves. Towns and caſtles were levelled with the ground, and Stromboli at the diſtance of 60 miles threw out an immenſe body of flames, accompanied with a noiſe which could be diſtinctly heard. But our attention was quickly drawn from more remote to preſent danger. The rattling ſound which immediately precedes an earthquake, again alarmed us; every moment it ſeemed to grow louder and louder, and to approach nearer the place on which we ſtood. A dreadful ſhaking of the earth now began, ſo that being unable to ſtand, my companions and I caught hold of whatever ſhrub was next us, to ſupport ourſelves. After ſome time the violent commotion ceaſed, and we ſtood up, and propoſed to proſecute our voyage to Euphemia, which lay within ſight, but in the meantime, while we were preparing ourſelves, I turned my eyes towards the city, but could ſee nothing but a thick, black cloud, which ſeemed to reſt on the place. This appeared an extraordinary circumſtance, as the ſky all round was calm and ſerene. We waited till the cloud paſſed away, and then turning to look for the city, it was totally ſunk, and where it formerly ſtood, nothing remained but a diſmal and putrid lake."

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In Sicily in 1693.

In the year 1693, an earthquake happened in Sicily, which not only ſhook the whole iſland, but alſo reached to Naples and Malta. Previous to the ſhock, a black cloud was ſeen hovering over the city of Catania, which was deſtroyed at this time. The ſea began to be violently agitated; the ſhocks ſucceeded like the diſcharge of a great number of artillery; the motion of the earth was ſo violent, that no perſons could keep their legs. Even thoſe who lay on the ground were toſſed from ſide to ſide, as on a rolling billow; high walls were razed from their foundations, and were thrown to the diſtance of ſeveral paces. Almoſt every building in the countries which it viſited was thrown down; 54 cities and towns, beſides a great number of villages, were either greatly damaged, or totally deſtroyed. Among thoſe which we have already mentioned, was the city of Catania, one of the moſt ancient and flouriſhing in the kingdom. After the thick cloud which remained after the earthquake had diſſipated, no remains of this magnificent city could be ſeen. Of 18,900 inhabitants, not fewer than 18,000 periſhed by this dreadful calamity.

203
In Jamaica in 1692.

The terrible earthquake which viſited the iſland of Jamaica in 1692, affords us another example of almoſt the whole of the phenomena which were enumerated

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as the forerunners or attendants of earthquakes. It was on the 7th of June, in that year, that this dreadful calamity, which in two minutes totally deſtroyed the town of Port Royal, on the ſouth ſide of Jamaica, and at that time the capital of the iſland, took place. The effect of the ſhock on the ſurface was immediately preceded by a hollow rattling noiſe, like that of thunder. The ſtreets were heaved up like waves of the ſea, and then inſtantly thrown down into deep pits. All the wells diſcharged their waters with prodigious agitation; the ſea burſt its bounds, and deluged a ſmall part of the town which was not entirely overwhelmed. The fiſſures produced in the earth were ſo great, that one of the ſtreets ſeemed twice as broad as formerly, and in ſome places the earth opened and cloſed again for ſome time. A great many of theſe openings were ſeen at once. In ſome of them, the houſes and inhabitants, and every thing that was near, were ſwallowed up. Some perſons were ſwallowed up in one of theſe chaſms, and what will appear moſt extraordinary, and indeed almoſt incredible, were thrown out alive from another. Whole ſtreets ſunk in ſome, and from others an immenſe body of water was projected high into the air. Smells which were extremely offenſive now ſucceeded; nothing but the diſtant noiſe of falling mountains was heard, and the ſky, which before the ſhock was ſtill and ſerene, aſſumed a dull red colour.

The effects of this earthquake were not limited to this ſpot. It was ſeverely felt through the whole iſland, which in many places ſuſtained very material damage. Indeed there were few houſes which were not either injured or thrown down. In ſome places the inhabitants, houſes, trees, and whole ſurface, were ſwallowed up in the ſame chaſm; and what was formerly dry land was left a pool of water. The wells in almoſt every corner of the iſland, whatever was their depth, threw out their water with great violence. The rivers were either entirely ſtopped, or ceaſed to flow for 24 hours; and many of them formed to themſelves new channels. At the diſtance of 12 miles from the ſea, an immenſe body of water ſpouted out from a gap which was formed in the earth, and was projected to a great height in the air. Such was the violence of the ſhock, that many perſons were thrown down on their faces, even in places where the ſurface of the ground remained unbroken. It was obſerved that the ſhock was moſt ſeverely felt in the immediate vicinity of the mountains. Could this ariſe from the greater preſſure, and conſequently the greater reſiſtance, or was it becauſe the force which produced theſe terrible effects exiſted near them?

After the great ſhock which deſtroyed the town of Port Royal, the inhabitants who eſcaped went on board ſhips in the harbour, where many of them remained for two months, during which time the ſhocks were repeated, and were ſo frequent, that there were ſometimes two or three in the courſe of an hour. Theſe were ſtill accompanied with the ſame rattling noiſe, like that of thunder, or like the ruſhing noiſe occaſioned by a current of air in rapid motion. They were alſo attended with what are called *brimſtone blaſts*. Theſe, it is probable, were ſulphureous vapours which iſſued from the openings made by the earthquake. The atmoſphere, however, ſeemed to be loaded with noiſome vapours, for a very general ſickneſs ſoon ſucceeded, which in a ſhort time ſwept off not fewer than 3000 perſons.

But of all the earthquakes, the hiſtory of which is on record, that which happened at Liſbon, in the year 1755, was by far the moſt extenſive in its effects, and, from its recent occurrence, will probably be deemed the moſt intereſting. In the year 1750, ſeveral ſhocks of earthquakes had been ſenſibly felt. The four following years were remarkable for exceſſive drought. The ſprings which formerly yielded abundance of water, were totally dried up and loſt; the winds which chiefly prevailed were from the north and north-eaſt. During this period alſo there were ſlight tremors of the earth; the ſeaſons in 1755, were unuſually wet, and the ſummer, as the conſequence of this, proved unuſually cold. But for the ſpace of 40 days before the earthquake happened, the ſky was more clear and ſerene. On the laſt day of October the face of the ſun was conſiderably obſcured, and a general gloom prevailed over the atmoſphere. The day following (the 1ſt of November) a thick fog aroſe, but it was ſoon diſſipated by the heat of the ſun. Not a breath of wind was ſtirring; the ſea was perfectly calm, and the heat of the weather was equal to that of June or July in this country. At 35 minutes after nine in the morning, without any previous warning, excepting the rattling noiſe reſembling that of diſtant thunder, the earthquake came on with ſhort, quick vibrations, and ſhook the very foundation of the city, ſo that many of the houſes inſtantly fell. A pauſe, which was indeed juſt perceptible, ſucceeded, and the motion changed. The houſes were then toſſed from ſide to ſide, like the motion of a waggon driven violently over rugged ſtones. It was this ſecond ſhock which laid great part of the city in ruin, and, as might be expected, great numbers of the inhabitants were deſtroyed at the ſame time. The whole duration of the earthquake did not exceed ſix minutes. When it began, ſome perſons in a boat, at the diſtance of a mile from the city, and in deep water, thought the boat had ſtruck on a rock, in conſequence of the motion which was communicated to it. At the ſame time they perceived the houſes falling on both ſides of the river. The bed of the Tagus was in many places raiſed to the very ſurface of the water; ſhips were driven from their anchors or moorings, and were toſſed about with great violence; and the perſons on board did not for ſome time know whether they were afloat or aground. A large new pier with ſeveral hundreds of people upon it, ſunk to an unfathomable depth, and not one of the dead bodies was ever found. The bar of the river was at one time ſeen dry from ſide to ſide; but ſuddenly the ſea came rolling in like a mountain, and in one part of the river the water roſe in an inſtant to the extraordinary height of 50 feet. At noon another ſhock happened; the walls of ſome houſes that remained were ſeen to open from top to bottom, near a foot wide, and were afterwards ſo exactly cloſed, that ſcarcely any mark of the injury remained.

204 At Liſbon in 1755.

205 The ſhock of this earthquake felt at Colares;

But what was the moſt ſingular circumſtance attending this earthquake was, the prodigious extent to which its effects reached. At Colares, 20 miles from Liſbon, and two miles from the ſea, the weather was uncommonly warm for the ſeaſon, on the laſt day of October. About four o'clock in the afternoon, a fog aroſe which, proceeding

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proceeding from the ſea, covered the valleys. This was an unuſual occurrence at that ſeaſon of the year; but ſoon after the wind ſhifting, the fog returned to the ſea, collected over its ſurface, and became very thick and dark; and as the fog diſperſed, the ſea was violently agitated, and with great noiſe. On the firſt of November, at the dawn of day, the ſky was fair and ſerene; about nine o'clock the ſun was overclouded, and became dim. Half an hour after, the rattling noiſe like that of chariots was heard; and this ſoon increaſed to ſuch a degree, that it reſembled the exploſions of the largeſt artillery. The ſhock of an earthquake was immediately felt, and was quickly ſucceeded by a ſecond and a third. In theſe ſhocks it was obſerved, that the walls of buildings moved from eaſt to weſt. From ſome of the mountains flames were ſeen iſſuing, ſomewhat reſembling the kindling of charcoal accompanied with a great deal of thick black ſmoke. The ſmoke which aroſe from one mountain was at the ſame time accompanied with noiſe, which increaſed with the quantity of ſmoke. When the place from which the ſmoke iſſued was afterwards examined, no ſigns of fire could be perceived.

206 At Oporto. At Oporto, near the mouth of the river Douro, the earthquake began at 40 minutes paſt nine. The ſky was quite ſerene when the hollow rattling noiſe was heard, and it was immediately attended with a commotion of the earth. In the ſpace of a minute or two, the river roſe and fell five or ſix feet, and continued this motion for four hours. In ſome places it ſeemed to open, and diſcharge great quantities of air. The ſea was alſo violently agitated, and indeed the agitation was ſo great, to the diſtance of a league beyond the bar, that it was ſuppoſed the diſcharge of air from that place muſt alſo have been very conſiderable.

207 Deſtroys St Ubes. St Ubes, a ſea-port town twenty miles ſouth of Liſbon, was entirely ſwallowed up by the repeated ſhocks of this earthquake, and the immenſe ſurf of the ſea which was produced. Large maſſes of rock were detached from the promontory at the extremity of the town. This promontory conſiſts of a chain of mountains compoſed of a very hard ſtone.

208 Felt in Spain. The ſame earthquake was felt in almoſt every part of Spain. The only places which eſcaped from its effects were the provinces of Arragon, Catalonia, and Valencia. At Ayamonte, which is near the place where the Guadiana falls into the bay of Cadiz, the earthquake was not felt till a little before ten o'clock. It was here alſo preceded by the hollow rattling noiſe. The ſhocks continued with intervals, for 14 or 15 minutes, and did very conſiderable damage. Scarcely half an hour had elapſed from the time that the commotion firſt began, when the ſea, the river, and canals, roſe violently over their banks, and laid every place near them under water. The ſea rolled in in huge mountains, n d carried every thing before it.

The earthquake began at Cadiz ſome minutes after nine in the morning, and laſted about five minutes. The water in the ciſterns under ground was ſo much agitated, that it roſe in the form of froth. About ten minutes after eleven, a hugh wave was ſeen coming from the ſea, at the diſtance of eight miles, which was ſuppoſed not to be leſs than 60 feet high, and burſt in upon the city. The water returned with the ſame violence with which it approached, and places which were deep at low water were left quite dry. Similar waves continued, but gradually leſſening till the evening.

The earthquake was not felt at Gibraltar till after ten o'clock. There it began with a tremulous motion of the earth, which continued for about half a minute. A violent ſhock then followed; the tremulous motion again commenced, and continued for five or ſix ſeconds, and then ſucceeded a ſecond ſhock, but leſs violent than the firſt. The whole time did not exceed two minutes; the earth had an undulating motion; ſome of the guns on the batteries were ſeen to riſe, and others to ſink. Many people, ſeized with ſickneſs and giddineſs, fell down. Some who were walking or riding, felt no ſhock, but were attacked with ſickneſs. The ſea had an extraordinary flux and reflux; it ebbed and flowed every 15 minutes; it roſe ſix feet, and then fell ſuddenly ſo low, that a great many fiſh and ſmall boats were left on the ſhore.

The ſhock was felt at Madrid nearly at the ſame time as at Gibraltar. It continued for ſix minutes, and the ſame ſickneſs and giddineſs prevailed. It was not felt by thoſe who walked ſmartly, or who were in carriages, and no accident happened excepting two perſons who were killed by the fall of a ſtone croſs from the porch of a church.

Malaga, a ſea-port town on the Mediterranean, experienced a violent ſhock; the bells were ſet a ringing in the ſteeples, and the water of the wells overflowed, and as ſuddenly retired. St Lucar, at the mouth of the Guadalquiver, ſuffered much from a ſimilar ſhock, as well as from an inundation of the ſea, which broke in, and did great damage. At Seville, 16 leagues above this, a number of houſes was thrown down; the celebrated tower of the cathedral, called *La Giralda*, opened in the four ſides; the waters were thrown into violent agitation, and the veſſels in the river were driven on ſhore.

In Africa this earthquake was felt nearly as ſeverely as in Europe. Great part of the city of Algiers was deſtroyed. This happened about ten in the morning. About the ſame time at Arzilla, a town in the kingdom of Fez, the ſea ſuddenly roſe with ſuch impetuoſity, that it lifted up a veſſel in the bay, and forced it on ſhore with ſuch violence that it was broken to pieces. A boat was alſo found within land, at the diſtance of two muſket ſhots from the ſea. At Fez and Mequinez, many houſes were thrown down, and numbers of perſons were buried in the ruins. 209 In Africa.

Many people were deſtroyed at Morocco by the falling of houſes. Eight leagues from the city the earth opened, and ſwallowed up a village with all its inhabitants, to the number of 8,000 or 10,000, as well as all their cattle. Soon after the earth cloſed, and they were ſeen no more. The town of Sallee alſo ſuffered greatly; a third part of the houſes were thrown down; the waters ruſhed into the ſtreets with great violence, and when they retired, they left behind them a large quantity of fiſh. The earthquake began at Tangier at ten in the morning; its whole duration was about ten or twelve minutes. The ſea came up to the walls with great violence, and retired immediately with the ſame rapidity, leaving behind a great quantity of fiſh. This agitation of the water was repeated no leſs than 18 times, and continued till about ſix o'clock in the evening. It began at the ſame time at Tetuan, but its duration

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ration was only about seven or eight minutes. Three of the shocks were so violent as to excite great apprehensions that the city would be destroyed. Similar effects were produced by the same earthquake at different places along the African shore of the Mediterranean.

210 In Madeira and the West Indies.

At the town of Funchal in Madeira, the first shock of this earthquake was felt at 38 minutes past nine. It was preceded by the rattling noise, which seemed to be produced in the air; the shock, it was supposed, continued for more than a minute; the earth moved with a vibratory, undulating motion; and some of the vibrations increased greatly in force. The noise in the air which accompanied the shocks, lasted some seconds after the motion of the earth had ceased. At three quarters past eleven, the day being calm and serene, the sea retired suddenly, then, without the least noise, rose with a great swell, overflowed the shore, and entered the city. It rose 15 feet perpendicular above high-water-mark. Having thus fluctuated four or five times, it at last subsided, and resumed its former stillness. In the northern part of the island, the inundation was still more violent. It first retired to the distance of 100 paces, and suddenly returning, overflowed the shore, broke down walls of magazines and storehouses, and left behind it great quantities of fish in the streets of a village. At this place the sea rose only once beyond the high-water mark, although it continued to fluctuate much longer before it entirely subsided than at Funchal.

Such were the effects of this earthquake, in those places where it was accompanied with considerable damage. It was, however, perceptibly felt to a great distance in every direction, either, by a slight motion of the earth, or by the agitation of the waters. At the island of Antigua the sea rose to such a height as had never been before known, and afterwards the water at the wharfs, which used to be six feet deep, was not more than two inches. About two in the afternoon, the sea ebbed and flowed at Barbadoes in a very unusual manner. It overflowed the wharfs, and rushed into the streets. This flux and reflux continued till 10 at night.

211 In France.

Shocks were distinctly felt in different parts of France, as at Bayonne, Bourdeaux, and Lyons. The waters were also observed to be agitated in different places, as at Angouleme, and Havre de Grace, but with a less degree of violence than some which have been mentioned. At Angouleme, a subterraneous noise like thunder was heard, and soon after a torrent of water, mixed with red sand, was discharged from an opening in the earth. Most of the springs in the neighbourhood sunk, and continued dry for some time.

212 In Germany.

The effects of this earthquake were also very perceptible in many places of Germany. Throughout the duchy of Holstein, the waters were greatly agitated, particularly the Elbe and Trave. The water of a lake, called *Libsec*, in Brandenburg, ebbed and flowed six times in half an hour, and although the weather was then perfectly calm, this motion was accompanied with a great noise. A similar agitation took place in the waters of the lakes called *Mupelgast* and *Netzo*, but here there was also emitted a most offensive smell.

The sea was greatly agitated round the island of Corsica, and many of the rivers of the island overflowed their banks. The same earthquake was felt in the city of Milan in Italy, and its neighbourhood. Turin in Savoy experienced a very smart shock.

213 In Switzerland.

Many of the rivers of Switzerland became all at once muddy, although there had been no rain. The lake of Neufchatel rose to the height of two feet above its usual level, and continued at this height for a few hours. The waters of the lake of Zurich were also greatly agitated.

214 In Holland.

The commotion of the waters in Holland was still more remarkable. In the afternoon of the 1st of November, the waters of the Rhine at Alphen, between Leyden and Woerden, were so violently agitated, that the buoys were broken from their chains, large vessels parted from their cables, and smaller ones were thrown upon the dry land. At 11 in the forenoon at Amsterdam, when the air was perfectly calm, the waters in the canals were thrown into great commotion, so that boats broke loose from their moorings, chandeliers were observed to vibrate in the churches, although it is said no motion of the earth was perceptible. In the forenoon at Haarlem, not only the water in the rivers, canals, &c. but, it is asserted, smaller quantities of fluids contained in vessels, were greatly agitated, and sometimes dashed over the sides of the vessels. This continued for about four minutes. Between 10 and 11 in the forenoon, in some of the canals at Leyden, the waters rose suddenly, and produced very perceptible undulations.

215 In Norway, &c.

The effects of this earthquake were traced as far north as Norway and Sweden: many of the rivers and lakes in Norway were greatly agitated; shocks were felt in several of the provinces of Sweden, and commotions of the waters, with the rivers and lakes, especially in Dalecarlia, were observed. The river Dala suddenly overflowed its banks, and as suddenly retired; and at the same time, a lake which is a league distant from it, bubbled up with great violence. Several smart shocks were felt at Fahlun, a town in Dalecarlia.

216 In Britain.

In many places of Great Britain and Ireland, the agitation of the waters was very perceptible. At Eaton bridge in Kent, near a pond of an acre in extent, some persons heard a sudden noise, which they supposed was occasioned by something falling into the pond, for it was then a dead calm, and ran to the spot; where they saw the pond open in the middle, while the water dashed over a perpendicular bank two feet high. This motion was repeated several times, and still accompanied with a great noise.

At Cobham in Surry, between 10 and 11 o'clock A. M. a person was watering a horse at a pond, the waters of which were derived from springs. At the moment the animal was drinking, the waters retired from his mouth, and left the bottom of the pond dry. It then returned with great violence, and when it retired, its progress was towards to the south. About the same time at Busbridge, in the same county, while the weather was remarkably calm, the waters of a canal 700 feet long and 58 broad, were greatly agitated, and this was accompanied with an unusual noise. The waters rose between two and three feet above the usual level, in the form of a heap or ridge, extending 30 yards in length. This ridge then heeled towards the north side, and flowed with great impetuosity over the grass walk; it then returned to the canal, again heaped up in the middle, and then heeled to the south side with

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with ſtill greater violence, flowing over the graſs walk, and leaving ſeveral feet at the bottom of the canal on the north ſide perfectly dry. Theſe motions continued for 15 minutes, after which the waters reſumed their former tranquillity. During the agitation of the waters, the ſand and mud at the bottom were thrown up, and mixed with them.

In Suffolk, the water of a pond at Dunſtal roſe gradually for ſeveral minutes in the form of a pyramid, and then fell down like a water-ſpout. In other ponds in the ſame neighbourhood, the waters of which were leſs agitated, there was a ſmooth flux and reflux from the one extremity to the other.

At Earſycourt in Berkſhire, about 11 o'clock, a perſon ſtanding near a fiſh pond, felt a violent trembling of the earth, which continued for about a minute. He obſerved immediately after, the water move from the ſouth to the north end of the pond, leaving the bottom of the ſouth end quite dry, to the extent of ſix feet. It then returned, flowed at the ſouth end, roſe three feet up the bank, and immediately after returned to the north bank, where it roſe to the ſame height. Between the flux and reflux the waters formed a ridge in the middle of the pond, 20 inches higher than the level on each ſide, and boiled up with great violence.

Similar p[illegible] were obſerved about half after ten, near Durham. A perſon was alarmed with a ſudden ruſhing noiſe, which ſeemed to proceed from a pond. The water roſe gradually up without any fluctuating motion, ſtood ſome inches higher than the uſual level; it then ſubſided and ſwelled again, and continued in this manner riſing and falling for the ſpace of ſix or ſeven minutes, riſing four or five times in a minute.

The effects of this earthquake in Derbyſhire excited conſiderable alarm. At Barlborough, between 11 and 12 o'clock, in a boathouſe on the weſt ſide of a large body of water, called *Pibley dam*, which is ſuppoſed to cover not leſs than 30 acres of land, there was heard a ſudden and terrible noiſe; a ſwell of water proceeding from the ſouth, roſe two feet on the ſlope dam head at the north end. It then ſubſided, but immediately returned. The water continued thus agitated for 45 minutes, but became gradually leſs violent. At Eyam bridge in the Peak, an overſeer of the lead mines, ſitting in his room about 11 o'clock, felt a ſudden ſhock, by which the chair on which he ſat was ſuddenly raiſed, and ſome pieces of plaſter were broken off from the ſides of the room. The commotion was ſo great that he thought the engine ſhaft had fallen together, and he ran out to ſee what was the matter, and found every thing in ſafety. Some miners employed at the time in a drift 120 yards deep, were greatly alarmed firſt with one ſhock, and then with a ſecond, which ſeemed to be ſo violent as to make the rocks grind upon one another, Three other ſhocks ſucceeded the two firſt at intervals of a few minutes, and became gradually weaker.

A little after 10 o'clock in the morning, the water in a moat which ſurrounds Shireburn caſtle in Oxfordſhire, exhibited a very unuſual appearance. A thick fog prevailed, the air was perfectly ſtill, and the ſurface of the water quite ſmooth. At one corner it was obſerved to flow towards the ſhore, and then again to retire; and this flux and reflux continued for ſome time quite regular. Every flux began ſlowly; but increaſed in its velocity till near its full height, when it ruſhed with great impetuoſity; and having remained for a ſhort time ſtationary, it then retired, at firſt ſlowly, but at laſt it ſunk with great rapidity. What will appear moſt ſingular in this commotion of the water is, that it was limited to one part of the moat. At a different corner about 25 yards diſtant no motion could be perceived. But in that part of the moat directly oppoſite to the place where the motion of the water was firſt obſerved, the water roſe towards the ſhore at the ſame time as at the other ſide. In a pond at a little diſtance the waters were agitated in a ſimilar manner, but the riſings and ſinkings took place at different times from theſe in the moat.

On the evening of the ſame day, about three quarters after ſix, and about the time of two hours ebb of the tide, at White rock in Glamorganſhire, a great body of water ruſhed up accompanied with great noiſe. It was in ſuch quantity that it floated two veſſels not leſs than 200 tons burden each, drove them from their moorings, and carried them acroſs the river. The whole length of time of the riſe and fall of this body of water did not exceed 10 minutes, ſo that it ſeemed to have burſt from the earth at the ſpot where it appeared. It ſeems ſingular, if the account of it be correct, that on this ſpot the effects of the earthquake ſhould be felt at the diſtance of ſeven or eight hours from the time it was felt in other parts of the iſland.

The waters of the lakes in Scotland were alſo greatly agitated from the ſame cauſe. Half an hour after nine in the morning, without the leaſt breath of wind, the water in Loch Lomond roſe ſuddenly and violently againſt its banks. It immediately fell very low, again returned to the ſhore, and in five minutes roſe as high as at firſt. This commotion continued till 15 minutes after 10, with an alternate flux and reflux every five minutes. From this time, till 11 o'clock, the height to which the water roſe gradually diminiſhed, till it reſumed its former tranquillity. But each flux and reflux continued for a period of five minutes as at firſt. Here the violence of the ſhock was ſuch, that a large ſtone lying at ſome diſtance from the ſhore in ſhallow water, was moved from its place and carried to dry land, leaving a deep furrow in the ground along which it had moved. 217 In Scotland.

About the ſame time the waters of Loch Neſs in the north of Scotland exhibited alſo a very unuſual agitation. About ten o'clock the river Oich, which falls into the head of the loch, ſwelled very much, and ran upwards from the loch with a high wave two or three feet above its uſual level. The motion of the wave was in a direction contrary to that of the wind, and it proceeded with great rapidity up the river for the ſpace of 200 yards, broke on a ſhallow, and overflowed the banks. It then returned gently to the loch. This ebbing and flowing continued for about an hour, the height of the waves gradually diminiſhing, till, about 11 o'clock, a wave higher than any of the former broke with ſuch violence on the bank on the ſide of the river, that it ran upwards of 30 feet from the bank.

Between two and three o'clock in the afternoon, at Kinſale in Ireland, when the weather was perfectly calm and the tide nearly full, a great body of water ſuddenly burſt into the harbour, and with ſuch violence, 218 In Ireland.

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lence, that it broke the cables of two veſſels, each moored with two anchors, and of ſeveral boats which lay near the town. The veſſels were whirled round ſeveral times by an eddy formed in the water, and then hurried back again with the ſame rapidity as before. Theſe motions were repeated different times; and while the current ruſhed up along one ſide of the harbour, it ran down with the ſame violence along the other. The muddy bottom of the harbour was greatly altered; the mud was removed from ſome places and depoſited in others. At one place the height of the water, where it was meaſured, was found to be five feet and a half; in other places it is ſaid to have been much higher, particularly where it flowed into the market-place with ſuch rapidity, that many perſons had not time to eſcape, but were immerſed, knee deep, in the water. Theſe commotions extended ſeveral miles up the river, and were moſt perceptible in ſhallow places. The alternate elevation and depreſſion of the water continued about ten minutes, when the tide returned to its uſual level. In the evening, between ſix and ſeven, the water roſe again, but with leſs violence than before, and continued to ebb and flow till three next morning. The riſe of the waters was not at firſt gradual, but, accompanied with a hollow noiſe, roſe ſix or ſeven feet in a minute, and ruſhed in like a deluge, after which it as ſuddenly ſubſided. The waters, too, became thick and muddy, emitting at the ſame time a moſt offenſive ſmell. Similar agitations of the waters were obſerved all along the coaſt to the weſtward of Kinſale.

219 Effects at ſea.

Such were the phenomena of this earthquake, as they were obſerved on land in the different places which have been mentioned. Its effects were alſo ſeverely felt at ſea. A frigate off St Lucar received ſo violent a ſhock, that it was ſuppoſed ſhe had ſtruck the ground. Another, veſſel in N. Lat. 36. 24. between nine and ten in the morning, was ſo much ſhaken and ſtrained as if ſhe had ſtruck upon a rock. The ſeam of the deck opened, and the compaſs was overturned. The ſenſation experienced by ſome perſons on board of another veſſel, which was then in N. Lat. 25°. W. Long. 40°. were ſuch as if ſhe had been ſuddenly raiſed up and ſuſpended by a rope. One perſon looking out at the cabin window, thought he ſaw land about a mile diſtant; but when he reached the deck, no land was to be ſeen. A ſtrong current was obſerved croſſing the ſhip's way to leeward. The current returned in about a minute with great violence; and, at the diſtance of about a league, three craggy pointed rocks were ſeen throwing up water of various colours, and ſeemingly reſembling fire. This appearance terminated in a thick black cloud, which aroſe heavily in the atmoſphere. Between nine and ten in the morning another ſhip, 40 leagues off St Vincent, received ſo violent a ſhock, that the men on deck were thrown a foot and a half above its ſurface, and the anchors, although they were laſhed down, bounced up. Immediately after the ſhip ſunk in the water ſo low as the main chains. On heaving the lead a great depth of water was found, and the line was of a yellow colour, and gave out the ſmell of ſulphur. The firſt ſhock was the moſt violent; but ſmaller ones were repeated for 24 hours.

220 On ſprings.

The effects of this earthquake on ſprings were very remarkable. On the afternoon of the 31ſt of October, the water of a fountain at Colares was obſerved to be greatly diminiſhed. On the morning of the 1ſt of November, the day on which the earthquake happened, it became thick and muddy, but afterwards recovered its uſual quantity and limpidity. In ſome places ſprings appeared where there had been formerly no water, and continued afterwards to flow. At Varge, on the river Macaas, many ſprings of water burſt forth at the time of the earthquake, and ſome threw up their waters mixed with ſand of various colours, to the height of 18 or 20 feet. In Barbary, a ſtream of water, which was as red as blood, burſt forth from a mountain, which was ſplit in two. At Tangier all the fountains were dried up during the whole of the day on which the earthquake happened. The mineral waters of Toplitz, a village in Bohemia, which have been celebrated ſince the year 1762, experienced a very remarkable change. The principal hot ſpring had continued to flow from the time it was diſcovered, of the ſame temperature and the ſame in quantity. On the morning of the earthquake, between 11 and 12 o'clock, the waters of this ſpring increaſed ſo much in quantity, that all the baths ran over in the ſpace of half an hour. A ſhort time before the water increaſed, it flowed from the ſpring thick and muddy; and then having entirely ſtopped for about a minute, it burſt out with great violence, carrying before it a great quantity of reddiſh ochre. It afterwards became limpid, and flowed as formerly; but in larger quantity, and of a higher temperature. At Angouleme in France the earth opened in one place, and diſcharged a great body of water, which was mixed with reddiſh ſand. Moſt of the ſprings in the neighbourhood ſunk ſo low, that for ſome time it was ſuppoſed they had become quite dry.

Such were the extraordinary effects of this terrible earthquake, which extended over a ſpace not leſs than four millions of ſquare miles. Other earthquakes, although of more limited extent, have produced effects not leſs deſtructive, and particularly ſome of the earthquakes which have viſited Italy and Sicily in modern times; accounts of which have been drawn up with accuracy and attention. Some of theſe we ſhall now detail.

221 Earthquake in Calabria in 1783.

One of the moſt calamitous earthquakes was that which befel Calabria in the year 1783. Of this earthquake Sir William Hamilton, who, ſoon after the earthquake happened, viſited the ſcenes of deſolation which it left behind, has drawn up a particular account. He obſerves, that "if on a map of Italy, and with your compaſs on the ſcale of Italian miles, you were to meaſure off 22, and then fixing the central point on the city of Oppido, which ſeemed to be the ſpot where the earthquake had exerted its greateſt force, form a circle, the radius of which will be 22 miles, you will then include all the towns, villages, &c. that have been utterly ruined, and the ſpots where the greateſt mortality happened, and where there have been the moſt viſible alterations on the face of the earth. Then extend your compaſs in the ſame ſcale to 72 miles, preſerving the ſame centre, and form another circle, you will include the whole country that has any mark of having been affected by the earthquake. A gradation was plainly obſerved in the damage done to the

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the buildings, as alſo in the degree of mortality, in proportion as the countries were more or leſs diſtant from this ſuppoſed centre of the evil."

This earthquake, it has been remarked, differed very conſiderably from others in one circumſtance, which was this. Where it happened that two towns were ſituated at the ſame diſtance from the centre, one of which was placed on a hill, and the other on a plain, it was found that the town on the loweſt ſituation always ſuſtained the greateſt damage from the ſhocks of the earthquakes which are alluded to above.

That part of Calabria which moſt ſeverely felt this dreadful calamity, lies between the 38th and 39th degrees of latitude, and the force of the earthquake extended from the foot of the Appenines called Monte Dijo, Monte Sacro, and Monte Caulene, as far to the weſtward as the Tyrrhene ſea. By the ſhock of the 5th of February, every town, village, and farm-houſe neareſt to the mountains, whether ſituated on ſome part of the elevated ground or on the plain, was left a heap of ruins. In proportion to the diſtance from the centre, as has been already hinted, the damage ſuſtained was more or leſs conſiderable. But even the more diſtant towns and villages ſuffered greatly from the ſhocks which happened on the 7th, 26th, and 28th of February, and on the 1ſt of March. From the time the firſt ſhock came on, the earth continued in a conſtant tremor; the ſhocks were felt with different degrees of force in different parts of the provinces which were the ſcene of this terrible calamity; and the motion was either in a whirling direction, as in a vortex, or horizontal, or pulſatory, the beatings proceeding from the bottom upwards. The apprehenſions and alarms of the miſerable inhabitants were terribly increaſed by this variety of changing motions, dreading that every moment the earth would open under their feet and ſwallow them up. That part of Calabria which ſuffered from this earthquake, was alſo drenched with long continued and heavy rains, accompanied with frequent and furious ſqualls of wind. Theſe rains prevailed particularly on the weſtern ſide, where many fiſſures had appeared in the mountains. Some mountains had been lowered greatly, and others had been entirely ſwallowed up. The roads were rendered impaſſable by the deep chaſms which were left by the ſhock; valleys were filled up by the parts of mountains which were ſplit aſunder; the courſe of rivers was changed; ſprings were dried up, and new ſprings burſt out where none exiſted before.

At Laureana in Farther Calabria, two houſes, ſurrounded with extenſive plantations of olive and mulberry trees, ſituated in a valley, were removed by the force of the earthquake, with all their trees, and carried to the diſtance of a mile; and on the ſpot where they formerly ſtood, hot water burſt from the earth, and was projected to a conſiderable height into the air. The water was mixed with ſand of a reddiſh colour. Some countrymen and ſhepherds, who were employed in rural affairs near this ſpot, were ſwallowed up, with their teams of oxen, and their whole flocks of goats and ſheep. The number of inhabitants who loſt their lives in this calamity, exceeded, according to ſome calculations, 32,000; but it is ſuppoſed by others, that, including ſtrangers, the number was not leſs than 40,000.

The inhabitants of the town of Scilla, on the firſt ſhock of the earthquake on the 5th of February, had fled along with their prince to the ſea ſhore for ſafety, and remained either on the ſtrand or in boats near the ſhore. In the night time a tremendous wave overflowed the land to the diſtance of three miles from the ſhore, and, in its return, ſwept off near 3000 of the inhabitants, among whom was the prince. This water was ſaid by ſome to have been boiling hot, ſo that many of the people were ſuppoſed to have been ſcalded with it. A mountain, it is aſſerted, of 500 palms in height, and 1300 palms in circumference at its baſe, was detached from the place where it ſtood, and carried to the diſtance of four miles. It was about the ſame time that the hill on which the town of Oppido ſtood, and which extended three miles in length, was ſplit in two, and filled up on each ſide the bed of a river. Two great lakes were formed by the current of the rivers being ſtopped; and, as they increaſed in extent, infected the air with their putrid and noiſome exhalations.

Sir William Hamilton, who was then reſident at Naples as ambaſſador from Britain, was indefatigable in obtaining every kind of information with regard to the effects of this earthquake. With this view he made an extenſive tour over thoſe parts of the country which had been viſited by this calamity. Some of the accounts which were firſt publiſhed ſeemed to have been ſomewhat exaggerated, either from the love of the marvellous in thoſe who framed them, or from the exceſſive alarms of the ſurviving ſufferers. On the 2d of May following Sir William landed on the coaſt of Nether Calabria. The effects of the earthquake were firſt perceived at Cedraro. The inhabitants had quitted their houſes, but it did not appear that the town had ſuſtained any material damage. Moſt of the inhabitants of St Lucido were then living in barracks, and the baron's palace, as well as the church ſteeple, had ſuffered greatly. He afterwards landed at the town of Pizzo in Farther Calabria. This town ſtood on volcanic tufa. It ſuſtained great injury from the ſhock of the 5th February, but was completely deſtroyed by that of the 28th. Here he was informed, that Stromboli, a volcanic mountain which is nearly oppoſite, and in full view, but 50 miles diſtant, had ejected much leſs matter, and had thrown up leſs ſmoke, during the time of the earthquakes, than it had done for many years before. Even at this time ſlight ſhocks of earthquakes were occaſionally felt. One indeed happened the ſame night. The boat in which he ſlept received a ſmart ſhock, and ſeemed to be lifted out of the water; but this ſhock was unaccompanied with noiſe.

The town of Monteleone is ſituated on a hill which overlooks ſome fine rich plains and the ſea below. Theſe plains, formerly covered with numerous towns and villages, now exhibited a gloomy ſcene of utter deſolation. The town of Monteleone itſelf had not ſuffered materially from the firſt ſhock on the 5th of February; bnt it was conſiderably damaged by ſome of thoſe which took place afterwards. It was generally obſerved, that the ſhocks of the earthquake came on with a rattling noiſe, which ſeemed to proceed from the weſtward. They uſually began with a horizontal motion, and terminated with a whirling motion, during which moſt of the buildings in the province were thrown down. It was generally obſerved too, that previous to a ſhock the

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clouds seemed to be unusually still and motionless, and that a shock quickly succeeded a heavy shower of rain.

Approaching the plain, it was observed, according to the general remark made above, that the towns and villages were more or less desolated in proportion to their vicinity to the plain. Of the town of Mileto, which stood in a bottom, not a house remained. Soriano and the noble Dominican convent presented a heap of ruins. According to the same general remark, all the buildings which stood upon the high grounds, the soil of which is a gritty sandstone, sustained less damage than those situated in the plain, for the latter were universally thrown down. The soil of the plain is a sandy clay of various colours, and full of sea shells. It is frequently intersected by rivers and torrents which have formed wide and deep ravines. Passing through St Pietro, a town in ruins, Sicily was seen and the summit of Mount Ætna, which at this time threw out a considerable quantity of smoke. In a swampy plain through which he passed, Sir William examined a number of small holes in the earth, of the shape of an inverted cone. These holes were covered with sand as well as the surrounding soil. During the earthquake of the 5th of February, water mixed with sand spouted up to a considerable height from each of these openings. The river, it was observed, before these fountains burst out, was dried up; but soon after the waters returned, and overflowed their banks. It appeared from more extensive observation, that the same thing had uniformly happened to all the other rivers in the plain during the shock of the 5th of February. This has been ascribed to the first impulse of the earthquake proceeding from the bottom upwards, and this seemed to be the general opinion. The surface of the plain then rising suddenly, the rivers which are shallow naturally disappeared; and the plain returning with violence to its former level, the rivers returned and overflowed from the sudden depression of the boggy grounds, which would naturally force out the water under their surface.

The town of Rosarno, with the duke of Monteleone's palace, was a heap of ruins; six feet high of the walls only remained. It was somewhat singular, that the only building which escaped uninjured was the public jail. At Laureana Sir William ascertained the truth of the circumstance of the two tenements which were said to have been removed from their situations. These stood in a valley surrounded with high grounds. In the same valley were observed hollows in the form of inverted cones similar to those which he had formerly examined. Between this place and the town of Polistene he did not see a single house, after travelling four days through a rich and beautiful country. Every thing presented the most indescribable misery: the violence of the earthquake was so great that all the inhabitants were buried in an instant alive or dead in the ruins of their houses. This town was situated between two rivers that were occasionally subject to overflow their banks. Of six thousand inhabitants, more than two thousand lost their lives by the shock on the 5th of February.

The princess Gerace Grimaldi, with four thousand of her subjects, perished at Casal Nuova on the same day; some persons who were dug alive out of the ruins observed, that they felt their houses fairly lifted up without any previous warning. An inhabitant of this town, being at that moment on a hill which overlooked the plain, when he felt the shock turned round towards the town, but he could see nothing excepting a thick white cloud of dust. So completely was this town destroyed, that no vestige of house or street remained; all lay in the same confused heap of ruins. Other towns had suffered in the same manner, and now exhibited the same scene of desolation.

Terra Nuova suffered severely from the same earthquake. It is situated between two rivers which had formed deep and wide ravines in their course; one of these was not less than 500 feet deep, and three quarters of a mile broad. In consequence of the great depth of this ravine, and the violent motion of the earth, two large masses of the soil on which a great part of the town, consisting of some hundred houses, had been thrown into the ravine at the distance of half a mile from the place where they formerly stood. Many of the inhabitants who had been carried along with their houses, were dug out of the ruins alive, and even some of them escaped unhurt. Of 1600 inhabitants, 400 only remained alive. In other places in the same neighbourhood, great tracts of land had been removed and carried to a considerable distance, with all their plantations and crops, which continued to grow and thrive in their new situation as well as formerly. The river here disappeared at the moment of the earthquake; but soon after returned, and covered the bottom of the ravine to the depth of three feet. This water was observed to be salt like that of the sea.

The whole town of Molochi di Sotto had been thrown into the ravine, and a vineyard of many acres lay near it in an inclined situation, but had not suffered any other injury. In several parts of the plain, the soil, with all its trees and crops of corn, to the extent of many acres, had sunk eight and ten feet below the level of the plain; and in other places it had risen the same height. The soil of this plain, it is to be observed, is composed of clay mixed with sand, which readily assumes any form.

222 Destruction of Oppido.

Sir William next proceeded to Oppido, which, it will be recollected, was considered as the central point on which the greatest force of the earthquake was exerted. This city stands on a mountain of gritstone of a reddish colour. It is surrounded by two rivers, which run in a deep ravine. It had been reported, that the mountain on which the city stands, had been split in two, and stopped up the course of the rivers; but it appeared on examination, that huge masses of the plain on the edge of the ravine, had been detached into it, and had so far filled it up, as to stop the course of the rivers, the waters of which were collecting, and forming lakes to a great extent. Part of the rock, it was found, on which the city stood, was separated, and with several houses upon it, was thrown into the ravine. Great tracts of land, with plantations of vines and olives, were transported from one side of the ravine to the other, to a distance exceeding half a mile.

"Having walked, (says Sir William,) over the ruins of Oppido, I descended into the ravine, and examined carefully the whole of it. Here I saw, indeed, the wonderful force of the earthquake, which has produced exactly the same effects as those described in the ravine at Terra Nuova, but on a scale infinitely greater. The enormous masses of the plain detached from each side of

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of the ravine, lie sometimes in confused heaps, forming real mountains, and having stopped the course of two rivers (one of which is very considerable), great lakes are already formed; and if not assisted by nature or art so as to give the rivers their due course, must infallibly be the cause of a general infection in the neighbourhood. Sometimes I met with a detached piece of the surface of the plain (of many acres in extent) with the large oaks and olive trees, with corn or lupins under them, growing as well and in as good order at the bottom of the ravine, as their companions from whence they were separated do on their native soil, at least 500 feet higher, and at the distance of about three quarters of a mile. I met with whole vineyards in the same order in the bottom, that had likewise taken the same journey. As the banks of the ravine from whence these pieces came are now bare and perpendicular, I perceived that the upper soil was a reddish earth, and the under one a sandy white clay, very compact, and like a soft stone. The impulse these huge masses received, either from the violent motion of the earth alone, or that assisted with the additional one of the volcanic exhalations set at liberty,* seems to have acted with greater force on the lower and more compact stratum than on the upper cultivated crust: for I constantly observed, where these cultivated lands lay, the under stratum of compact clay had been driven some hundred yards farther, and lay in confused blocks; and, as I observed, many of these blocks were in a cubical form. The under soil, having had a greater impulse, and leaving the upper in its flight, naturally accounts for the order in which the trees, vineyards, and vegetation fell, and remain at present in the bottom of the ravine.

"In another part of the bottom of the ravine there is a mountain composed of the same clay soil, and which was probably a piece of the plain detached by an earthquake at some former period: it is about 250 feet high, and 400 feet diameter at its basis. This mountain, as is well attested, has travelled down the ravine near four miles; having been put in motion by the earthquake of the 5th of February. The abundance of rain which fell at that time, the great weight of the fresh detached pieces of the plain which I saw heaped up at the back of it, the nature of the soil of which it is composed, and particularly its situation on a declivity, account well for this phenomenon; whereas the reports which came to Naples of a mountain having leaped four miles, had rather the appearance of a miracle. I found some single timber trees also with a lump of their native soil at their roots, standing upright in the bottom of the ravine, and which had been detached from the bottom of the plain above mentioned. I observed also, that many confused heaps of the loose soil, detached by the earthquake from the plains on each side of the ravine, had actually run like a volcanic lava (having probably been assisted by the heavy rain), and produced many effects much resembling those of lava during their course down a great part of the ravine. At Santa Christina, near Oppido, the like phenomena have been exhibited, and the great force of the earthquake of the 5th of February seems to have been exerted on these parts, and at Casal Nuova, and Terra Nuova."

The next places which were visited were the towns of Seminara and Palmi. Palmi is nearer the sea, and had suffered most; not fewer than 1400 of the inhabitants having been destroyed. In the course of his tour in this part of the country, he was informed that the sea was observed to be hot, and fire was seen issuing from the earth.

At Reggio, although the shock had been much less violent than in other places, no house was yet habitable. During the earthquakes which visited this place in 1770 and 1780, near 17,000 inhabitants lived for several months encamped in the fields, or in barracks.

Having examined the different places on the Calabrian coast, which had suffered from this terrible earthquake, Sir William Hamilton sailed for Messina in Sicily, to be informed of its effects there. He found that the shock had been very violent, but far less so than on the opposite shores. Many of the houses, even in the lower part of the town, were standing, and some of them had sustained little damage; but in the more elevated situations the shocks seemed to have had scarcely any effect. This still corresponds with the general remark, which was already made. A striking instance of this appeared in two convents, which are situated on elevated places, and had suffered nothing from the earthquakes which had afflicted the country for four months. It was said that fire had been seen issuing from fissures of the earth near the shore. The shock of the earthquake on the 5th of February, seemed to proceed from the bottom upwards; but the succeeding shocks came on with a horizontal or whirling motion.

A remarkable circumstance with regard to fish, was taken notice of at Messina, and indeed the same thing was observed along the coast of Calabria, where the effects of the earthquake had been most severe. A small fish, somewhat larger than the English white bait, but resembling it, and which usually lies at the bottom of the sea, buried in sand, had remained for several months after the commencement of the earthquakes, near the surface, and was taken in great abundance to be the common food of poor people. Before the earthquake, this fish was extremely rare, and was considered as a great delicacy. After the earthquake, indeed, it was observed, that fish of all kinds were found in greater abundance.

These earthquakes, of which we have now given so detailed an account, continued for many months afterwards; tremulous motions of the earth continued to be felt, and they were not perfectly settled even in the year 1784.

223 Earthquakes in Peru.

The southern continent of America is often visited by earthquakes. In the year 1797, Peru was afflicted with this dreadful calamity, which perhaps in the extent of surface which experienced the dreadful shock, exceeds that of any earthquake, the history of which is on record. The following is a short account of this earthquake, by M. Cavanilles. "In the midst, (says he), of the most profound calm, there is frequently heard a dreadful bellowing noise, the forerunner of earthquakes, to which this part of the world is often exposed. After the year 1791, this noise was frequently heard in the neighbourhood of the mountain of Tunguragua. Antonio Pineda and Née, the two naturalists employed in the expedition round the world, when examining the declivity of this volcano, the lava of which had been hardened more by the internal fire than

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than by the ardour of the ſun, were ſtruck with terror by the horrible ſound which they heard, and the heat which they experienced. Pineda, that valuable member of ſociety, whoſe premature death is ſtill deplored by the friends of ſcience, foretold that a terrible eruption was preparing in the mountain of Tunguragua; and his conjectures were confirmed by the event. On the 4th of February 1797, at three quarters paſt ſeven in the morning, the ſummit of the volcano was more free from vapours than uſual; the interior part of the mountain was agitated by frequent ſhocks, and the adjacent chains burſt in ſuch a manner, that in the ſpace of four minutes an immenſe tract of country was convulſed by an undulating movement. Never did hiſtory relate the effects of an earthquake ſo extraordinary, and never did any phenomenon of nature produce more misfortunes, or deſtroy a greater number of human beings. A number of towns and villages were deſtroyed in a moment: ſome of them, ſuch as Riobamba, Quero, Pelileo, Patate, Pillaro, were buried under the ruins of the neighbouring mountains; and others in the juriſdictions of Hambata, Latacunga, Guaranda, Riobamba, and Alauſi, were entirely overthrown. Some ſuſtained prodigious loſs by the gulfs which were formed, and by the reflux of rivers intercepted in their courſe by mounds of earth; and others, though in part ſaved, were in ſuch a ſhattered ſtate as to threaten their total ruin. The number of perſons who periſhed during the firſt and ſucceeding ſhocks is eſtimated at 16,000. At ten o'clock in the morning, and four in the afternoon, the ſame day, (February 4.) after a dreadful noiſe, the earth was again agitated with great violence, and it did not ceaſe to ſhake, though faintly, for the whole months of February and March; but, at three quarters paſt two in the morning of the 5th of April, the villages already ruined were again expoſed to ſuch violent ſhocks as would have been ſufficient to deſtroy them. This extraordinary phenomenon was felt throughout the extent of 140 leagues from eaſt to weſt, from the ſea as far as the river Napo; and without doubt farther, for we are little acquainted with theſe diſtricts which are inhabited by the ſavages. The diſtance north-eaſt and ſouth-weſt between Popayan and Piura, is reckoned to be 170 leagues; but in the centre of that diſtrict, 1 degree 16·6 from theſe places, is ſituated the part totally deſtroyed, and which comprehends 40 leagues from north to ſouth between Guarandam and Machache, and twenty leagues from eaſt to weſt. But, as if an earthquake alone had not been ſufficient to ruin this fertile and populous country, another misfortune, hitherto unknown, was added. The earth opened, and formed immenſe gulfs; the ſummits of the mountains tumbled down into the valleys, and from the fiſſures in their ſides there iſſued an immenſe quantity of fetid water, which in a little time filled up valleys a thouſand feet in depth and ſix hundred in breadth. It covered the villages, buildings, and inhabitants; choaked up the ſources of the pureſt ſprings, and being condenſed by deſiccation, in the courſe of a few days into an earthy and hard paſte, it intercepted the courſe of rivers, made them flow backwards for the ſpace of 87 days, and converted whole diſtricts of dry land into lakes. Very extraordinary phenomena, which will doubtleſs be one day mentioned in hiſtory, occurred during theſe earthquakes; I ſhall, however, content myſelf with mentioning only two of them. At the ſame moment that the earth ſhook, the lake of Quirotoa, near the village of Inſiloc, in the juriſdiction of Latacunga, took fire, and the vapour which roſe from it ſuffocated the cattle and flocks that were feeding in the neighbourhood. Near the village of Pelileo, a large mountain named Moya, which was overturned in an inſtant, threw out a prodigious ſtream of the before-mentioned thick fetid matter, which deſtroyed and covered the miſerable remains of that city. Naturaliſts will one day find, in theſe ravaged countries, objects worthy of their reſearches. Fragments of the minerals and earths of Tunguragua are about to be tranſported to Spain: but it is not in ſuch fragments that we ought to ſearch for the cauſe of theſe ſurpriſing phenomena; we muſt viſit the country itſelf, where this conflict of the elements took place, and where the ruins it occaſioned are ſtill to be ſeen (G.)" 224

In Scotland.

To the hiſtory of earthquakes now given, we ſhall only add the following account of the earthquakes which have taken place at Comrie in Perthſhire, in Scotland, which was communicated to the Royal Society of Edinburgh, by Dr Finlayſon, in a letter from Mr Taylor.

"The earthquakes which have lately (January 1790) taken place at Comrie (H) and its neighbourhood, are certainly very deſerving of attention. I ſhall therefore cheerfully comply with your requeſt, and give you as particular a deſcription as I can of ſuch of them as have been moſt remarkable. To give a particular account of all the noiſes or concuſſions which, during the laſt half year, have been heard or felt at Comrie, and within a ſhort diſtance to the north, eaſt, and weſt of that village, is beyond my power, and would indeed be of little uſe. With regard to theſe ſmall concuſſions, it will be ſufficient to ſay, that many of them have ſometimes been obſerved to ſucceed one another in the ſpace of a few hours; that they take place in all kinds of weather; that they are thought by ſome people to proceed from north-weſt to ſouth-eaſt, and by others from north-eaſt to ſouth-weſt; that they have not been obſerved to affect the barometer; that they do not extend in any direction above three or four miles from Comrie; and that towards the ſouth they are bounded by the Earn, which is in the immediate vicinity of the village. The ſame perſon, though beſtowing the minuteſt attention, is often uncertain whether they proceed from the earth

(G) The volcano of Tunguragua occaſioned an earthquake in 1557.

(H) Comrie is a village about 22 miles weſt of Perth, ſituated in the valley of Strathearn, and on the north ſide of the river Earn, about four miles below the place where it iſſues from the lake. The remains of a Roman camp on the oppoſite ſide of the river, have made the name of this village very well known to Scottiſh antiquaries.

earth or from the air, ſometimes believing them to come from the one, and ſometimes from the other; neither do all agree with reſpect to the ſeat of any one of them.

"After the ſtricteſt inquiry, I find it impoſſible to determine with accuracy the date of any of the concuſſions which took place before the 2d of September laſt. Some people in the neighbourhood of Killin aſſert poſitively, that they heard unuſual rumbling noiſes in the month of May; but the impreſſion which theſe noiſes made was ſo faint, that they would probably have been ſoon forgotten altogether, had they not been ſucceeded by concuſſions of a leſs equivocal nature. Towards the end of Auguſt, two or three ſhocks are ſaid to have been felt at Dundurn, Dunira Lodge and Comrie; but I have not been able to learn the preciſe day or hour on which any of them happened. The truth is, the concuſſions hitherto obſerved were feeble, and the minds of the people ſeem not to have been rouſed to particular attention till the 2d of September. About eleven o'clock that evening, a ſmart ſhock was felt at Comrie. I myſelf heard here, for the firſt time, a rumbling noiſe, which I took for that of a large table, dragged along the floor above ſtairs, and which I probably would never have thought of again, unleſs my attention had been turned to it by the alarm which it had excited in the neighbourhood. Many other feeble noiſes or concuſſions are ſaid to have been obſerved in Glen Leadnach and about Comrie during the months of September and October. At that time, however, I confeſs I was diſpoſed to doubt the numerous reports of earthquakes with which the country was filled, and to aſcribe them to the workings of an imagination, on which the alarm of the 2d of September ſtill continued to be impreſſed.

"On the 5th of November, a concuſſion took place two or three minutes before ſix o'clock P. M. which was too violent to be miſtaken. Some compared the noiſe which accompanied it to that of heavy loaded waggons, dragged with great velocity along a hard road or pavement, and thought, that it paſſed under their feet. To me it ſeemed as if an enormous weight had fallen from the roof of the houſe, and rolled with impetuoſity along the floor of the rooms above; and it muſt have made a ſimilar impreſſion on the ſervants, for ſome of them inſtantly ran up ſtairs to diſcover what had happened. Others were ſenſible of a tremulous motion in the earth, perceived the flames of the candles to vibrate, and obſerved the mirrors and kitchen-utenſils placed along the walls to ſhake and clatter. There is alſo reaſon to believe, that the waters in the loch of Monivaird, in the near neighbourhood of Ochtertyre, ſuffered unuſual agitation, as the wild fowl then upon the loch were heard to ſcream and flutter. The noiſe on this occaſion, as far as I can judge, did not laſt above ten or twelve ſeconds. During the courſe of the day, the mercury in the barometer roſe and fell ſeveral times, and at ſix o'clock it ſtood at 28½ inches. The ſky was then perfectly ſerene, and hardly a breath of wind was to be felt; but next morning, about ſix o'clock, a violent tempeſt roſe, which raged without intermiſſion for 24 hours.

"At Glen Leadnach, Comrie and Lawers, this concuſſion was much more violent, and the noiſe that accompanied it much more alarming. The inhabitants of theſe places, and of Aberuchill and Dunira, declare, that they perceived diſtinctly the earth heaving under them, and the motion communicated to their chairs, and other furniture. They imagined that the ſlates and ſtones were tumbling from their houſes, and many of them ran out in the greateſt trepidation, from the notion, that the roofs were falling in. Even the domeſtic animals were alarmed, and contributed, by their howls and ſcreams, to increaſe the terrors of the people. Though I have not been able to diſcover whether Loch Earn was ever agitated by theſe concuſſions, there is little doubt, that the river near Comrie was affected on this occaſion, as two men then on its banks heard the daſhing of its waters. This great ſhock was ſucceeded by a number of thoſe ſlighter rumbling noiſes which have been already mentioned. Not leſs than 30 of them were counted in the ſpace of two hours after it happened; but they did not extend above two miles to the eaſt, north and weſt of Comrie.

"On the 10th of November, at three o'clock P. M. we had here another ſhock of much the ſame length, violence and extent, as that on the 5th. The mercury in the barometer on this day was more ſtationary than on the former, and at the time of the earthquake was 29 inches high. The weather was calm and hazy. It was a market-day at Comrie; and the people, who were aſſembled from all parts of the country, felt as if the mountains were to tumble inſtantly upon their heads. The hard-ware expoſed for ſale in the ſhops and booths ſhook and clattered, and the horſes crowded together with ſigns of unuſual terror.

"About one o'clock P. M. of the 29th December, we had another pretty ſmart ſhock, during a violent ſtorm of wind and rain, which continued the whole day, and which was at its height during the time of the earthquake. Indeed, as has been remarked already, theſe concuſſions ſeem to have no dependence on the weather. According to the accounts of thoſe who live neareſt to the centre of the phenomena, rumbling noiſes, like thoſe above deſcribed, may be heard in all ſtates of the atmoſphere.

"Though I mention no more of theſe earthquakes, you are not to conclude, that many more have not taken place, and ſome of them perhaps equally violent with thoſe of the 5th and 10th of November. Several ſhocks have happened during the ſtillneſs of the night, which, even at this diſtance from Comrie, where their centre ſeems to be, have been abundantly terrifying. But the great reſemblance, or rather the perfect ſimilarity of their effects, and of the impreſſion they make on our minds, renders it unneceſſary for me trouble you with a particular deſcription of each of them.

"The direction of all the noiſes or concuſſions I have obſerved, great as well as ſmall, appeared to be in the ſame line from N. W. to S. E. Others deſcribe them as ſometimes proceeding in that direction, and ſometimes as coming from N. E. to S. W. I have not heard any other line of direction aſcribed to them.

"Upon the fulleſt enquiry, I find, that theſe earthquakes have been very limited in point of extent. The greater ſhocks have been feebly felt at Loch Earn head, about Killin, and at Ardonich, on the ſouthern bank of Loch Tay. They do not appear to have extended farther eaſtward on that lake; and, what is more remarkable, they have not been felt in Glen Almond,

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mond, or the ſmall glen through which the military road from Crieff to Tay-bridge paſſes. The farmer at Auchnafree, (which lies at the head of Glen Almond, and is ſeparated from Glen Leadnach only by the mountain Benechoni, over the northern ſide of which his ſhepherds daily travel), has aſſured me, that neither he, nor any of his people, have been at any time ſenſible of the leaſt extraordinary noiſe or concuſſion. Towards the eaſt, the two firſt great ſhocks extended to Monzie, Cultoquhey and Dollary, about ſeven miles diſtant from Comrie. The ſhock of the 5th of November reached ſtill farther, and was felt, though but faintly, at Ardoch and Drummond Caſtle towards the S. E. In the direction of the ſouth, however, the banks of the Earn ſeem to be its general boundary, as the noiſe of the moſt violent concuſſions was heard but faintly at the manſe of Comrie, and along the ſtrath on the ſouth ſide of the river. The limits of the leſſer concuſſions, I am confident, do not extend above three miles in any direction from their centre. They are commonly obſerved at Lawers on the eaſt; throughout the whole of Glen Leadnach, at Dunira, Dalchonzie and Aberuchill, on the north and weſt; and do not reach ſo far as the manſe, which is about three quarters of a mile on the ſouth of Comrie (1)."

In another communication, dated in 1793, from the ſame gentleman, he obſerves, that "there is no reaſon to believe that theſe phenomena are yet come to an end. After temporary intermiſſions, ſometimes of ſeveral months, they have returned, ever ſince their firſt appearance in 1789, without any apparent difference in their extent or force. The rumbling noiſes or ſlighter concuſſions, as uſual, are obſerved at Comrie, in Glen Leadnach, and the places in their near neighbourhood; the more violent extend to much the ſame diſtance as formerly deſcribed. Having been only occaſionally in that country ſince February 1791, I have not been able to aſcertain dates. On the 2d of September 1791, at five minutes paſt five in the afternoon, a ſlight ſhock was felt at Ochtertyre. The barometer was not in order, on which account the weight of the atmoſphere could not be aſcertained. Its electrical ſtate was tried by Sauſſure's electrometer, but no indication of any thing uncommon was perceived. Since that period, ſhocks have been obſerved at different times till within theſe few weeks paſt.

"From this account, it will be obſerved, that all the greater ſhocks have taken place in the ſeaſon of autumn or the beginning of winter; that this has been now repeated for more than four years; and that thoſe greater ſhocks have been ſucceeded at ſhort intervals by rumbling noiſes or more feeble concuſſions. It has alſo been remarked, that they have in general been preceded or followed by great rains or boiſterous weather; but variations in the weather take place ſo frequently in our climate at that ſeaſon of the year, that the connection between them and the phenomena above deſcribed, is probably altogether accidental."

After the view which we have given of the phenomena and hiſtory of earthquakes, we now proceed to the conſideration of the cauſes, by the operation of which, according to the ſpeculations of philoſophers, theſe terrible convulſions of nature, which ſpread ruin and deſolation in ſome of the faireſt portions of the earth, are to be accounted for. Various opinions have been formed, and various hypotheſes have been propoſed, for the explanation of theſe dreaded phenomena. 225 Cauſes of earthquakes,

According to ſome of the ancient philoſophers, ſubterraneous clouds exiſted in the internal cavities of the earth, and theſe burſting into lightning, ſhook and demoliſhed the vaults which contained them. This was the opinion of Anaxagoras. It was ſuppoſed by others, that earthquakes were owing to the falling in of immenſe arched roofs, which confined ſubterraneous fires; the vaults or arches being weakened by the conſtant burning of theſe fires. Some aſcribed earthquakes to the vapour of water which was produced, and greatly rarefied, by means of internal fires, while others, among whom was Epicurus and ſome of the peripatetic philoſophers, ſought for the explanation of the phenomena of earthquakes, in the exploſion of certain inflammable ſubſtances, which were exhaled from the internal cavities of the earth. 226 according to the ancients;

Some of the modern philoſophers, as Gaſſendi, Kircher, Varenius, Des Cartes, and others, have adopted the laſt hypotheſis, according to which it is ſuppoſed, that there are immenſe cavities in the earth, communicating with each other. Some of theſe cavities contain water, and others contain vapours and exhalations, ariſing from bituminous, ſulphureous, and other inflammable ſubſtances. Theſe combuſtible materials being kindled by ſome ſubterraneous ſpark, or by ſome actual flame, proceeding through narrow fiſſures from without, or by the heat evolved during the mixture of different ſubſtances, and the formation of new ones, produce commotions on the ſurface of the earth, according to the extent of the cavities, and the quantity and active nature of the inflamed matter. Thoſe who ſupport 227 the moderns.

(1) "The tract within which the concuſſions deſcribed in this letter appear to have been confined, is a ſpace of a rectangular form, which extends from eaſt to weſt along the north ſide of the Earn about 22 miles in length, by a little more than five in breadth; reckoning the utmoſt length from about Monzie to the head of Loch Tay, and the breadth from a little ſouth of the Earn northward to the ridge which ſeparates the branches of that river from thoſe of the Almond. The whole of this tract is mountainous, except toward the eaſtern extremity, where it joins the low country, and on the banks of the river Earn on the ſouth. It is interſected by narrow glens or valleys, the moſt conſiderable of which is Glen Leadnach, where the centre of the concuſſions ſeems to be placed. The mineralogy of this part of the country has not hitherto been accurately examined; but it is known in general, that the ſtone is the primary ſchiſtus, and in ſome places granite; that no mineral veins, nor any hot ſprings, have been found in it, and that no volcanic appearances have been obſerved. In the valleys, among the mountains, iron ore, of the kind that is called bog ore, is ſaid to abound. Dr Hutton has remarked, that the line which terminates this tract on the ſouth eaſt, ſeems to be nearly the ſame with that where the primary ſtrata ſink under the ſurface, and are covered by the ſecondary or horizontal ſtrata. *Note by Mr Playfair.*"

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support this hypothesis think, that it receives illustration from a common experiment of mixing together iron filings and sulphur, and burying them in the earth; and in consequence of the chemical action of these substances on each other, and the elastic vapours thus produced, the shaking of the earth is effected.

228 Hypothesis of Woodward.

A different hypothesis has been proposed by Dr Woodward. According to this hypothesis, water is continually raised by means of subterraneous heat, from the abyss which he supposes to occupy the centre of the earth, to furnish rain and dew. Obstructions may take place in this process of nature, and whenever this happens, a swelling and commotion are occasioned by the heat in the waters of the abyss. This force is at the same time exerted against the incumbent strata, and thus the agitation and concussion, with the other phenomena which accompany earthquakes, are produced.

229 Of Amontons.

Another hypothesis, different from any of these, has been proposed by M. Amontons, of which the following explanation is given. The atmosphere being taken at 45 miles high, and the density of the air increasing in proportion to the absolute height of the superincumbent column of fluid, it is shewn that at the depth of 43,528 fathoms below the surface of the earth, the air is but one-fourth lighter than mercury. But this depth is only about one seventy-fourth of the semidiameter of the earth. The immense sphere beyond this depth, the diameter of which is 6,451,538 fathoms, may perhaps be only filled with air: this air must be here greatly condensed, and heavier than the heaviest bodies with which we are at present acquainted. It is found by experiment, that the more air is compressed, the more do equal degrees of heat increase its elastic force, and the more capable it becomes of producing violent effects. As, for instance, the temperature of boiling water increases the elasticity of the air beyond its natural force in temperate climates, by a quantity equal to one-third of the weight with which it is pressed. Hence it is concluded, that a degree of heat which on the surface of the earth produces only a moderate effect, may occasion violent convulsions by the rarefaction of the denser air at great depths; but if it be considered that this condensed air may be exposed to much higher degrees of heat than that of boiling water, the elastic force of the air thus produced, and assisted by the great weight of a high column, may be more than sufficient to convulse and break up the solid orb of 43,528 fathoms, the weight of which, comparing it with that of the included air, would be trifling.

These hypotheses, however insufficient they may appear for explaining in a satisfactory manner the phenomena of earthquakes, were generally adopted till about the middle of the 18th century, when the knowledge of electricity began to be cultivated and extended. This principle was applied successively in the explanation of many natural phenomena, and, among others, the phenomena of earthquakes were ascribed to the same principle. An earthquake which was felt at London in the month of March, 1749, directed the attention of philosophers to this explanation.

230 Of Stukeley.

The first who made this attempt, we believe, was Dr Stukeley, who had been much occupied about that time with electrical experiments. The consideration of the phenomena which accompanied this earthquake, led him to suppose that it could not be occasioned by vapours generated in the cavities of the earth, or by any process like fermentation, in which elastic fluids are formed and disengaged, to which such effects could be ascribed. He is of opinion, that no evidence has yet been brought to establish the probability of the existence of extensive cavities within the earth. On the contrary, he thinks there is good reason to presume, that it is in a great measure solid, so that there is little space for those changes which are supposed to be effected within the cavities, to take place. Coal pits, he adds, which have been frequently known to be on fire, and for a great length of time, never exhibited any of the phenomena which accompany an earthquake on the surface of the ground above.

The earthquake which visited London and other places of Britain, in March 1749, was felt in a circuit of 30 miles diameter; but there was no eruption of fire or vapour, and it was unattended with smoke or smell. From this consideration alone, of the extent of surface which felt the effects of the earthquake, he supposes that it could not be ascribed to the expansive force of subterraneous vapours; for, he observes, small fire-balls which are exploded in the air, emit a sulphureous smell to the distance of several miles. Now, it cannot be imagined, that so prodigious a force, acting instantaneously, on so great an extent of ground, should neither break the surface, nor indicate its presence either by the sight or smell. But if this effect is to be ascribed to fermentation, this process is not instantaneous; it continues many days, and the evaporation of such a quantity of inflammable matter would require a long space of time. Such an effect, therefore, can only be accounted for on electrical principles, the operation of which is always instantaneous.

If earthquakes were occasioned by vapours and subterraneous fermentations, explosions and eruptions, such processes would entirely destroy springs and fountains, wherever they had once existed. This, however, is contrary to what happens, for although springs are stopped, or otherwise changed, previous to an earthquake, or about the time it happens, they very often recover their former state. In the great earthquake which happened A. D. 17, in Asia Minor, and which shook a mass of earth 300 miles in diameter, and destroyed 13 great cities, neither the springs nor the face of the country received any injury.

If it be considered, that a subterraneous power capable of moving 30 miles in diameter, as in the earthquake mentioned above, which happened at London, must exist and operate at least 15 or 20 miles under the surface, the hypothesis of earthquakes being occasioned by the force of vapours will be found totally inapplicable, because this force must move an inverted cone of solid earth, the base of which is 30 miles in diameter, and the axis 15 or 20. This is an effect which is impossible to any known natural power, excepting that of electricity.

But besides, no subterraneous explosion can account for the singular effects of an earthquake on ships that are far out in the ocean. It has been already observed, that they seem as if they struck on a rock, or as if some solid body struck against their bottom. Even fishes, it is found, are particularly affected by the shock of an earthquake; but a subterraneous explosion could only produce on the water a gradual swell. It could not communicate

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communicate to it that impulse by which it produces effects, as if it were a stone projected with great force against solid bodies.

From the consideration of all these circumstances, Dr Stukeley is of opinion, that the phenomena of earthquakes can only be satisfactorily explained on electrical principles. He was particularly led to this opinion by directing his attention to the phenomena which accompanied the earthquakes which took place in England in 1749 and 1750. For five or six months previous to this time, the weather had been unusually warm; the wind was from the south and south-west, and there had been no rain, so that the earth was particularly prepared to receive an electrical shock. The flat country of Lincolnshire had suffered greatly from extreme drought, and hence, as dry weather is favourable to electricity, earthquakes and other similar phenomena are more frequent in southern regions of the world. Before the earthquake at London, all vegetables had been unusually premature, and it is well known how much electricity quickens vegetation. About the same time the aurora borealis had been very frequent. A very short time before the earthquake, it had exhibited unusual colours, and its motions were to the south, contrary to the ordinary direction. From these circumstances an earthquake was predicted by Italians and others who had been accustomed to the appearances which precede them. During this year, too, meteors of different kinds, as fire-balls, lightnings, and coruscations, had been common; and particularly it was observed in the night preceding the earthquake, and early in the morning on the day on which it happened, that coruscations were very frequent. In these circumstances nothing was wanting to produce an earthquake, according to this hypothesis, but the touch of a non-electric body. This body must be derived from the air or atmosphere; hence it is inferred, that if a non-electric could discharge its contents upon any part of the earth, in this prepared and highly electrical state, a violent commotion or earthquake must be produced; and as the discharge from an excited tube produces a shock on the human body, so the discharge of electric matter from an extent of many miles of solid earth, must produce an earthquake. The rattling, uncouth noise which attends it, is to be ascribed to the snap which is occasioned by the contact.

Before the earthquake alluded to came on, a black cloud suddenly covered the atmosphere to a great extent; the discharge of a shower, according to this hypothesis, probably occasioned the shock; and as the electrical snap precedes the shock, a sound was observed to roll from the Thames towards Temple-bar, before the motion of the houses ceased. This noise, which is generally the forerunner of earthquakes, it is supposed can only be accounted for on the principles of electricity. The contrary to this would take place, were these phenomena owing to subterraneous eruptions. The flames and sulphureous smells which accompany earthquakes, might, it is thought, be more easily accounted for on the same principles, than by eruptions from the bowels of the earth. The sudden concussion, too, seems to be produced by a motion which could only be excited by electricity, not proceeding from any convulsion in the interior parts of the earth, but from a uniform vibration along its surface, like that of a musical string, or like the vibratory motion of a glass, when the edge is rubbed with the finger. From the circumstance that earthquakes are chiefly fatal to places near the sea coasts, along the course of rivers, and elevated situations, a farther proof is derived, that they depend on the operation of electricity. The course or direction which the earthquake above alluded to took, affords an illustration of this point. Another argument in favour of the electrical hypothesis, is drawn from the effects of the earthquake, or the state of the weather at the time, on persons of weak or nervous constitutions. To some these disorders proved at that time fatal; and its effects, in general, were similar to those of artificial electricity.

231 Of Beccaria.

A similar hypothesis was proposed by Beccaria, to account for the phenomena of earthquakes. He supposes that the electric matter to which these phenomena are owing, is lodged deep in the earth, and that it is this matter discharged from the earth, to restore the equilibrium or deficiency which the clouds in the atmosphere have sustained during thunder storms, by giving out their electrical matter to another part of the earth. This, he supposes, is confirmed by the noise resembling thunder, and the flashes of lightning which are perceived during earthquakes.

232 Of Priestley.

Dr Priestley proposes to construct, on the principles of Stukeley and Beccaria, an hypothesis which he thinks will explain the phenomena in a more satisfactory manner. For this purpose he supposes the electric matter to be some way or other accumulated on one part of the surface of the earth, and on account of the dryness of the season, not easily to diffuse itself. It may, as Beccaria supposes, force its way into the higher regions of the air, forming clouds in its passage out of the vapours which float in the atmosphere, and occasion a sudden shower, which may farther promote the passage of the fluid. The whole surface thus unloaded will receive a concussion like any other conducting substance, on parting with or receiving a quantity of the electric fluid. The rushing noise will likewise sweep over the whole extent of the country; and upon this supposition also, the fluid, in its discharge from the country, will naturally follow the course of the rivers, and also take the advantage of any eminences, to facilitate its ascent into the higher regions of the air. In making some experiments on the passage of the electrical fluid over water, he observed that it produced a tremulous motion, and therefore he concludes that it must receive a concussion resembling that which is given to the waves of the sea by an earthquake. To try this still farther, he immersed his hands in water, while an electrical flash passed over its surface, and he felt a sudden concussion, like that which is supposed to affect ships at sea during an earthquake. The impulse, which was felt in different parts of the water, was strongest near the place where the explosion was made.

"Pleased with this resemblance of the earthquake, he observes, I endeavoured to imitate that great natural phenomenon in other respects; and it being frosty weather, I took a plate of ice, and placed two sticks about three inches high on their ends, so that they would just stand with ease; and upon another part of the ice I placed a bottle, from the cork of which was suspended a brass ball with a fine thread. Then making the electrical flash pass over the surface of the ice, which it did

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did with a very loud report, the nearer pillar fell down, while the more remote stood, and the ball which had hung nearly still, immediately began to make vibrations, about an inch in length, and nearly in a right line from the place of the flash.

"I afterwards diversified this apparatus, erecting more pillars, and suspending more pendulums, sometimes upon bladders stretched on the mouth of open vessels, and at other times on wet boards swimming in a vessel of water. This last method seemed to answer the best of any; for the board representing the earth, and the water the sea, the phenomena of them both during an earthquake may be imitated at the same time; pillars, &c. being erected on the board, and the electric flash being made to pass, either over the board, over the water, or over them both *."

* *Hist. of Elect.*

433 Of Dolomieu.

The ingenious Dolomieu proposes to account for these phenomena on different principles. On this subject he makes the following observations with regard to the earthquakes which desolated Calabria in 1783, and the causes by which they were produced. "The sea, says he, during the earthquakes of 1783, had little share in the shocks on the main land. The mass of water experienced no general movement, or fluctuation, or oscillation; the waves did not rise above their ordinary limits. Those which on the night of the 5th February beat against the coast of Sicily, and which afterwards covered the point of the Faro of Messina, were only the effects of a particular cause. The fall of a mountain into the sea raised the waters, which received an undulating motion, as happens always in similar cases. The undulation reached from the point of Sicily beyond the cape of Rosacolmo, extending in length along the coast which runs to the south; but always with a decrease in elevation as it was more remote from Sicily. Whatever inquiries the author has made, he has not been able to discover, in all the details which have been given him, any proofs of the existence of electrical phenomena; no spark, no disengagement of the electrical fluid, which the Neapolitan naturalists wish to assign as the cause of earthquakes.

"The state of the atmosphere was not the same in the whole range of earthquakes. While the tempests and the rain seemed to have conspired with them for the destruction of Messina, the interior part of Calabria enjoyed very fine weather. A little rain fell in the plain in the morning of the 5th of February; but the sky was clear during the rest of the day. This month and that of March were not only pretty serene, but likewise warm. There were some storms and rain; but they were the natural attendants of the season.

"The moving force seems to have resided under Calabria itself, since the sea which surrounds it had no share in the oscillations or vibrations of the continent. This force seems also to have advanced along the ridge of the Apennines in ascending from the south to the north. But what power in nature is capable of producing such effects? I exclude electricity, which cannot accumulate continually during the course of a year, in a country surrounded with water, where every thing conspires to place this fluid in equilibrio. Fire remains to be considered. This element, by acting directly upon the solids, can only dilate them; then their expansion is progressive, and cannot produce violent and instantaneous movements. When fire acts upon fluids, such as air and water, it gives them an astonishing expansion; and we know that then their elastic force is capable of overcoming the greatest resistances. These appear the only means which nature could employ to operate the effects we speak of: but in all Calabria there is no vestige of a volcano; nothing to point out any interior combustion; no fire concealed in the centre of mountains, or under their base; a fire which could not exist without some external signs. The vapours dilated, the air rarefied by a heat constantly active, must have escaped through some of the crevices or clefts formed in the soil; they must there have formed currents. Both flame and smoke must have issued by some one or other of these passages. These once opened, the pressure would have ceased; the force not meeting with any more resistance, would have lost its effect; and the earthquakes could have no longer continued. None of these phenomena took place: we must then renounce the supposition of a combustion acting directly under Calabria. Let us see whether, having recourse to a fire at some distance from this province, and acting upon it only as an occasional cause, we shall be able to explain all the phenomena which have accompanied the shocks. Let us take for example Ætna in Sicily, and suppose large cavities under the mountains of Calabria; a supposition which *cannot be refused*. It is certain that immense subterraneous cavities do exist, since Ætna, in elevating itself by the accumulation of its explosions, must leave in the heart of the earth cavities proportioned to the greatness of the mass.

"The autumn of 1782 and the winter of 1783 were very rainy. The interior waters, augmented by those of the surface, may have run into those caverns which form the focus of Ætna: there they must have been converted into vapour capable of the highest degree of expansion, and must have pressed forcibly against every thing which opposed their dilatation. If they found canals to conduct them into the cavities of Calabria, they could not fail to occasion there all the calamities of which I have given the description.

"If the first cavity is separated from the second by a wall (so to speak) or some slight division, and this separation is broken down by the force of the elastic vapour, the whole force will act against the bottom and sides of the second. The focus of the shocks will appear to have changed place, and become weaker in the space which was agitated most violently by the first earthquake.

"The plain, which was undoubtedly the most slender part of the vault, yielded most easily. The city of Messina, placed upon low ground, experienced a shock which the buildings on higher grounds did not. The moving force ceased at once as suddenly as it acted violently. When, at the periods of the 7th of February and the 28th of March, the focus appeared changed, the plain scarce suffered any thing. The subterraneous noise, which preceded and accompanied the shocks, appeared always to come from the south-west, in the direction of Messina. It seemed like thunder under ground, which resounded beneath vaults.

"If Ætna, then has been the occasional cause of the earthquakes, it has also prepared, for some time, the misfortunes of Calabria, by gradually opening a passage along the coast of Sicily to the foot of the Neptunian

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nian mountains: for during the earthquakes of 1780, which disturbed Messina the whole summer, they felt, for the whole length of that coast, from Taormina even to the Faro, considerable shocks; but near the villages of Alli and Fiume de Nisi, which are situated about the middle of that line, shocks so violent were experienced, that they dreaded lest the mouth of a volcano should open. Each shock resembled the effort of a mine that had not strength to make an explosion. It appears, that then the volcano opened a free passage for the expansion of its vapours, and that they have since circulated without restraint; since in the year 1783 the earthquake was almost nothing upon that part of Sicily, at the time that Messina buried under its ruins the half of its inhabitants."

234 Ascribed to the force of steam.

By others the phenomena of earthquakes have been ascribed to the force of vapour or steam, which, no doubt, is an agent sufficiently powerful, if it is confined so, that its prodigious elastic force may be exerted; but it is denied by those who oppose this hypothesis, that earthquakes, though very frequent in regions where subterranean fires are really known to exist, as in volcanic countries, always happen in such places, and therefore water cannot be converted into vapour. But, besides, it is well known, that this vapour, even admitting the possibility of its production in subterranean cavities, would be re-converted into water, the moment it came in contact with a cold body, which would deprive it of the principle of heat, in combination with which water assumes the form of vapour.

Many objections might have been made to the hypotheses which have been proposed to account for earthquakes. Many of these will probably occur to the attentive reader, who is a little acquainted with the nature and properties of the agents by which they are supposed to be produced; but whatever may be the cause of these extraordinary phenomena, it appears that it is very far from being clearly ascertained. Perhaps all the agents which have been stated as the cause of earthquakes, may have some influence in contributing to the effect, and may operate at different times, and in different circumstances.

Sect. II. *Of Volcanoes.*

235 Volcanoes in every part of the world.

Volcanoes exist in almost every part of the world, from the north to the south pole. Hecla in Iceland, and a volcano which has been observed in Terra del Fuego, at the termination of the southern continent of America, nearly comprehends the extremities of the globe; and having mentioned these boundaries, it is unnecessary to observe, that they exist in all climates.

236 Number of them.

The number of volcanoes at present known, is not less than 100. The volcanoes of Europe are well known: these are Vesuvius in Italy, Ætna in Sicily, and Hecla in Iceland. To these may be added the volcanoes in the Æolian or Lipari islands on the coast of Italy, of which Stromboli is remarkable for having thrown out flames, without the eruption of other volcanic matter, for more than 2000 years. In Asia there is a volcano in Mount Taurus; five in Kamtschatka, 10 in the islands of Japan; one in the peak of Adam in the island of Ceylon; four which have been observed in Sumatra; and some others in different parts of the Asiatic continent or islands. There are also some volcanoes on the African continent, as well as in some of the islands. Volcanoes exist also in the American continent, and in many of the islands which have been discovered in the South seas.

237 Are all near the sea,

Almost all volcanoes are in the immediate vicinity of the sea. Mount Taurus, in the interior of Asia, and some of the volcanoes in the Andes, are the only exceptions to this.

238 and in the tops of mountains.

Another general remark which may be made with regard to volcanoes is, that they always occupy the tops of mountains. No volcano was ever found bursting out in plains. The existence of volcanoes at the bottom of the ocean seems to be an exception; but it is to be observed, that these are also in the peaks of mountains, which have been raised up from great depths at the bottom of the ocean.

239 Symptoms of an eruption.

The first symptom of an approaching eruption is an increase of the smoke, if smoke has been emitted, in fair weather. This smoke is of a whitish colour; but, after some time, black smoke is observed to shoot up in the midst of the column of white smoke. These appearances are usually accompanied with explosions. The black smoke is then followed, at a shorter or longer distance of time, by a reddish-coloured flame. Showers of stones are afterwards thrown out, and some of them are projected to great heights in the air, which shews that the force by which they are impelled is very great. Along with these, ashes are likewise ejected. These phenomena, which daily increase in frequency and violence, are also usually preceded and accompanied by earthquakes, and hollow noises from the bowels of the earth, something like those that precede earthquakes unaccompanied with volcanic eruptions. The smoke, flame, and the quantity of stones and ashes, increase, and the stones are at last thrown out red hot.

The smoke which issues from the crater has been observed to be sometimes in a highly electrified state. The ashes are strongly attracted, and carried up along with the smoke to great heights in the atmosphere, forming a dense black column of vast height and size. Flashes of lightning are seen darting in a zigzag direction, through the column of smoke and ashes; and this lightning is sometimes attended with thunder. But from some observations which have been made, this thunder and lightning are seemingly less intense than atmospheric electricity. When these terrible appearances have continued for four or five months, or for a longer or shorter time, according to the nature of the eruption, the lava begins to flow. This is a current of melted matter, which sometimes boils over the top, and sometimes, when the mountain is high, as is the case with Ætna, bursts out at the side, and makes a passage for itself. The period of the duration of the eruption is very different. Sometimes it continues to flow, at intervals, for the space of several weeks.

240 Matters thrown out of volcanoes.

The matters ejected from volcanoes are lavas, which are either more or less consolidated; ashes, slags of different kinds, and stones which have undergone little or no fusion. For an account of the nature and properties of volcanic productions, see Mineralogy. Stones have been projected into the air from Mount Ætna, to the height of 7000 feet. A stone which was ejected from Vesuvius, measured 12 feet long, and 45 feet in circumference; and even larger masses have been thrown out from Ætna.

Water has been frequently ejected from volcanoes. This

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This water is fometimes cold, and fometimes hot. Eruptions of water have taken place, both from Vefuvius and Ætna. At one time falt water was ejected from Mount Vefuvius. Different opinions have been held concerning the origin of this water, or its connexion with the volcano. This is founded on the circumftance already taken notice of in the general remark which was made, that almoft all volcanoes are in the vicinity of the fea.

It feems to be a fingular circumftance in the hiftory of volcanoes, that when once eruptions have commenced, they follow each other in rapid fucceffion; and at other times that they ceafe for a long period. From the year 1447, Ætna ceafed to throw out any fire till the year 1536, when a terrible eruption took place, accompanied with fmoke, flame, afhes, and burning ftones. This conflagration continued to rage with great violence for many weeks. The following year a river fwelled and overflowed its banks to a great diftance; furious fqualls of wind fucceeded, after which there was a terrible eruption from Ætna. The torrents of flaming and fufed matter which flowed out, deftroyed towns, villages, and vineyards, to a great extent. After the conflagration, the fummit of the mountain fell in with a dreadful crafh. For 100 years after this period, the eruptions feemed to obferve fome kind of regularity, returning periodically every 25 and 30 years. From the year 1686 to 1755, the fame year on which the earthquake at Lifbon happened, for more than half a century, Ætna enjoyed profound repofe.

The firft confiderable eruption of Vefuvius, the account of which is recorded in hiftory, happened in the year 79 of the Chriftian era. It was this eruption which deftroyed Herculaneum and Pompeii; but this was not the firft eruption of this mountain, for the ftreets of thefe cities have been fince difcovered to be paved with lava. Since that time, 30 different eruptions have taken place. There was a very remarkable one in 1538.

241
Volcanoes become extinct, and are rekindled.

It would appear that volcanoes feem to become quite extinct, and are rekindled. Some of the Roman writers, as Diodorus Siculus, Vitruvius, and others, fpeak of Vefuvius only as having been a volcano. After this period it burnt for 1000 years, and again became extinct, from 1136 to 1506. Pools of water had collected in the crater, and woods were growing on its fides, and even in the crater itfelf. Vefuvius has now burnt for three centuries paft, as furioufly as ever; but particularly, during the 18th century. Of 29 eruptions which have taken place from Vefuvius, fince the reign of Titus, half of the number have happened in the 18th century.

Befide the volcanoes, the hiftory of which we have now briefly detailed, volcanoes are known to exift at the bottom of the ocean. Thefe are diftinguifhed by the name of *fubmarine volcanoes*. Excepting in fituation, fo far as the hiftory of fubmarine volcanoes is known, they refemble the volcanoes on land. It would appear that they exift in the tops of mountains at the bottom of the ocean, and eject immenfe burning maffes of matter in whirlwinds of afhes and pumice, with prodigious torrents of lava. Submarine volcanoes are either very few in number, or the places where they exift have not been afcertained. Thofe that are certainly known are at Santorin, the Azores, and Iceland.

242
Submarine volcanoes.

The ifland of Santorin, formerly called Thera and St Irene, was denominated by the Greeks, in allufion to its origin, Καμινοι, or "burnt." According to Pliny, there is a tradition that it rofe out of the fea, at a very remote but unknown period.

Without going far back into hiftory, to inquire concerning the early eruptions of this volcano, we fhall mention fome of a later date, the exiftence of which is better afcertained. In 1457, an eruption took place, at which time afhes and red-hot rocks were ejected, with a great quantity of lava. This event, with the date of it, is recorded on a marble ftone, erected near the gate of Fort Scarus, in Santorin. An eruption alfo took place in 1570. This produced a new ifland, called the *Little Kaminoi*. In 1650, the agitations of the volcanoes continued for the greater part of a year. Smyrna and Conftantinople were incommoded with the afhes, which rufhed from the ocean in whirlwinds of flame. The fame volcano opened again in 1707. The Little Kaminoi, mentioned, was increafed, and it is now more than three leagues in circumference. A violent eruption took place in 1767, which fhook the earth greatly for fome days, and raifed the fea in fuch a manner, as to excite apprehenfions of the deftruction of the iflands in the neighbourhood. A thick black fmoke darkened the air, which was fo infected with a ftrong fmell of fulphur, that many perfons and animals were fuffocated by it. Black afhes refembling gunpowder were difperfed around, and torrents of flame iffuing from the fea, and waving above it, to the height of feveral feet, lighted, at intervals, the horrid fcene. At the end of 10 or 12 days the eruption began to be more moderate; and a new ifland which had been thrown up was difcovered. When it was examined, many parts of it were ftill burning; but the next day, thofe whom curiofity had drawn to the fpot, were compelled to betake themfelves to flight. They felt the new foil moving; in fome parts it rofe, and funk in others. The earth, fea, and fky, foon refumed their formidable appearance; the boiling fea changed colour; flames in rapid fucceffion iffued as from a furnace, but accompanied with afhes and pumice. The frightful noife of fubterranean thunders was heard; it feemed as if enormous rocks, darting from the bottom of the abyfs, beat againft the vaults above it, and were alternately repelled and thrown up again. The repetition of their blows feemed to be diftinctly heard. Some of them finding a paffage, were feen flying up red hot into the air, and again falling into the fea from which they had been ejected. Maffes were produced, held together for fome days, and then difappeared. In this general diforder, large portions of the Little Kaminoi were fwallowed up. Meanwhile the labour of the volcano took a larger furface. Its ejections became prodigioufly abundant, and a new ifland was feen forming. By fucceffive additions continued for near four months, it made a junction with that produced in June. From the colour of its foil it was named the *Black Ifland*. It is larger than the Little Kaminoi, and is feparated from it by a narrow ftrait. After frequent alarms for feveral months, the volcano opened again on the 15th of April in the following year; but the eruption was only for a moment, when it threw out a multitude of burning rocks, which fell at the diftance of two miles.

Similar

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Similar submarine volcanoes have been observed near the island of St Michael, one of the Azores or Western islands in the Atlantic ocean. In the year 1638, near the island of St Michael, where the sea was known to be 120 feet deep, there arose, after an agitation of several weeks, an island about six miles round. It was again swallowed up in about the same space of time that had elapsed during its formation. In the year 1691, this volcano was in great agitation for a month. It convulsed the whole island of St Michael, and by the heat and violent commotion of the sea, as well as by the eruption of flames, ashes, and pumice, occasioned great damage; but in this case no island appeared. Similar eruptions were known in 1720, and in 1757. During the latter eruption, some of the islands were shaken to their foundations.

After this account of submarine volcanoes, of their effects, and of the islands formed by them, it would be unnecessary to enter into any detail of the submarine volcano which threw up an island off the coast of Iceland, in the year 1783. This island, the existence of which seemed to be fully ascertained, was again swallowed up in the ocean, and was seen no more.

243 Mud volcanoes.

Volcanoes of a very different kind have been described. The volcanoes to which we allude, have received the name of *mud volcanoes*, from ejecting a great quantity of mud. These, however, are similar to those which have been already described, in having volcanic motions and convulsive eruptions. The first volcano of this kind which was discovered is in the island of Sicily, near a place called Maccalouba, between Arragona and Girgenti. It is in a hill of a conical shape, truncated at the top, and 150 feet high. The summit is a plain, half a mile round, and the whole surface is covered with thick mud. The depth of the mud, which is supposed to be immense, is unknown. There is not the slightest appearance of vegetation upon it. In the rainy season the mud is much softened; the surface is even, and there is a general ebullition over it, which is accompanied with a very sensible rumbling noise. In the dry season, the mud acquires greater consistency, but without ceasing its motion. The plain assumes a form somewhat convex; a number of little cones are thrown up, which rarely rise to the height of two feet. Each of them has a crater, where a black mud is seen in constant agitation, and incessantly emitting bubbles of air. With these the latter insensibly rises, and as soon as the crater is full of it, it disgorges. The residue sinks, and the cone has a free crater until a new emission.

This hill is sometimes subject to alarming convulsions. Earthquakes are felt at the distance of two or three miles, accompanied with internal noises, resembling thunder. These increase for several days, and terminate in an eruption of a prodigious spout of mud, earth, and stones, which rises two or three hundred feet into the air. This explosion is repeated twice or thrice in the course of 24 hours. Some years pass over without any eruption, but it generally happens that the eruptions continue yearly for five years successively. An eruption from this mud volcano took place in 1777.

Phenomena somewhat similar have been described by Pallas, which he observed partly in the peninsula of the Kercha, the boundary of Europe to the south-east of Little Tartary, now Taurida, and partly in the island of Taman, which is separated from Kercha only by one of the mouths of the river Cuban. The island of Taman is situated in Asia. These places, he observes, are in flat countries where there are few hills, and those very little raised above the level of the sea. The whole is covered with beds of slime, mixed with sand, with some beds of marl and sea-shells. From this he concludes that no real volcanic pit can exist here. Copious springs of petroleum are found in several places, and also pools or syphons of various dimensions, through most of which a briny mud is disgorged in bubbles. Pallas observed several of these pools, both in the peninsula and in Taman. The last eruption which took place, he observes, was in 1794. This was the greatest and most copious that had been known. It proceeded from the top of a hill at the north point of Taman. The place where the new gulf opened was a pool, where the snow and rain water usually remained for a long time. The explosion came on with a noise like that of thunder, and with the appearance of a mass of fire in the form of a sheaf. This lasted only for about half an hour, and it was accompanied with a thick smoke; but the ebullition which threw up part of the liquid mud, continued till the next day, after which the mud ran slowly in streams down the hill. The mud discharged was of a soft clay, of a bluish ash colour, every where of the same nature, and mixed with brilliant sparks of mica, with a small quantity of marl, calcareous and sandy fragments of schistus, which seemed to have been torn from their beds.

Pallas supposes that a very deep coal mine had been for ages on fire, under Kercha and Taman, and that the sea having accidentally broken into the burning cavities of the mine, the expansion produced by the water converted into steam, and the struggle of the different aeriform substances to get free, forced the upper beds, broke them in pieces, and formed a passage to themselves. The vapours, as they escaped, carried the mud along with them. But others have supposed that these phenomena are not produced by fire; that the appearance of the sheaf of fire must have been extraneous, or, that it was only a quantity of inflammable air, which exploded when it came to the surface; or, perhaps it was altogether an illusion, from the appearance of the vapours which were emitted.

An account is given of a singular phenomenon, somewhat similar to the above, which was observed in 1711, at Bosely near Wenlock, in Shropshire. After a great hurricane, the inhabitants were awakened in the middle of the night by commotions of the earth, which were accompanied with noise. Some persons went to an eminence from which the noise proceeded, and they saw water oozing through the turf, while at the same time inflammable air was emitted. The water was not hot. This continued for some time, but at last it ceased to throw out any inflammable air for some years, previous to the year 1746, when a second eruption took place, attended with similar circumstances.

We shall not dwell longer on the history of volcanoes. For a particular account of the most remarkable eruptions of the principal volcanoes in the world, the reader is referred to the history given under ÆTNA, HECLA, and VESUVIUS. We shall now proceed to state some of the opinions and conjectures of philosophers,

phers, with regard to the cause of these extraordinary phenomena.

244 Causes of volcanoes.

Volcanic eruptions have been ascribed to the action of the waters of the sea, bursting in upon an immense quantity of fused or burning matter; to the action of central fires, and to the decomposition of different substances, by which a great quantity of heat and inflammable substances is produced.

Water, according to some philosophers, is absolutely necessary for the formation of volcanoes. This opinion is supported by the circumstance of almost all volcanoes being near the sea. According to this opinion, they were all formed under the surface of the waters of the ocean. The first explosion at the formation of a volcano, it is supposed, was preceded by an earthquake. The first eruptions would be extremely violent, and immense quantities of matter would be ejected. Torrents of lava would continue to be discharged for a long series of ages, and thus the foundations of the burning mountain are laid in the bottom of the ocean. But it becomes a question, in what way the internal fire was preserved from extinction by the incumbent waters of the ocean? To this M. Houel replies, that the fire having disposed the substances in fusion to make an eruption, next laid open the earth, and emitted as much matter as it could discharge, with a force sufficient to overcome the resistance of the column of water, which would oppose its ascent; but as the strength of the fire diminished, the matter discharged was no longer expelled beyond the mouth; but, by accumulating there, soon closed up the orifice. Thus, only small orifices would be left sufficient for giving vent to the vapours of the volcano, and from which only small bubbles of air could ascend to the surface of the water, until new circumstances, such as originally give occasion to the eruption of the volcano, again took place in the bowels of the earth, and produced new eruptions, either through the same or other mouths. The appearance of the sea over the new formed volcano, in its state of tranquillity, would then be similar to what it is betwixt the islands of Basilizzo and Pariaria. Columns of air bubbles are there ascending at the depth of more than 30 feet, and burst on their arriving at the surface. This air would continue to disengage itself with little disturbance as long as it issues forth only in small quantity, until, at the very instant of explosion, when prodigious quantities, generated in the burning focus, would make their way at once, and the same phenomena which originally took place would again make their appearance."

A volcano, while under water, cannot act precisely as it does in the open air. Its eruptions, though equally strong, cannot extend to so great a distance. The lava accumulates in greater quantity round the crater; the sand, ashes, and pozzolana are not carried away by the winds, but are deposited around its edges, and prevent the marine substances which are driven that way by the waters from entering. Thus they agglomerate with these bodies, and thus a pyramidal mount is formed of all the materials together.

In this manner M. Houel supposes that the mountain was gradually raised out of the sea by the accumulation of lava, &c. at every eruption, and that the cavern of the volcano was gradually enlarged, the lava being driven down into the bottom of the cavern by the continued action of the stones which the volcano is constantly throwing up; that it was there fused, and at last thrown out at the top of the mountain to accumulate on its sides. M. Houel's opinion about the volcanic fire we shall give in his own words.

"We cannot form any idea of fire subsisting alone, without any pabulum, and unconnected with any other principle. We never behold it but in conjunction with some other body, which nourishes and is consumed by it. The matter in fusion, which issues from the focus, is but the incombustible part of that which nourishes the fire, and into the bosom of which that active principle penetrates in search of pabulum. But as the fire acts only in proportion to the facility with which it can dissolve and evaporate, I am of opinion, that it is only the bottom of the volcano on which it acts; and that its action extends no farther than to keep these substances which it has melted in a constant state of ebullition. That fusible matter being discharged from the mouth of the volcano, and hardening as it is gradually cooled by the action of the air, produces that species of stones which are distinguished by the name of *lavas*. This lava, even when in the focus, and in a state of fluidity, must also possess a certain degree of solidity, on account of the gravity and density of its particles. It therefore opposes the fire with a degree of resistance which irritates it, and requires, to put it into a state of ebullition, a power proportioned to the bulk of the mass.

"That quantity of matter, when dissolved by the action of the fire, must constantly resemble any other thick substance in a state of ebullition. Small explosions are produced in various parts over the surface of every such substance while in a state of ebullition; and, by the bursting of these bubbles, a great number of small particles are scattered around. This is the very process carried on in the focus of a volcano, though on a scale immensely more large; and the vast explosions there produced expel every body which lies in their way with the utmost violence; nor is there any piece of lava which falls down from the upper part of the arch, of weight sufficient to resist this violent centrifugal force.

The pabulum by which the internal fire is supported, M. Houel thinks to be substances contained in the mountain itself, together with bitumen, sulphur, and other inflammable materials, which may from time to time flow into the focus of the volcano in a melted state through the subterraneous ducts, and the explosions he ascribes to water making its way in the same manner. The water is converted into steam, which fills the cavern and pushes the melted lava out at the crater; this opinion is corroborated by the copious smoke which always precedes an eruption. But, combined with the water, there is always a quantity of other substances, whose effects precede, accompany, or follow the eruptions, and produce all the various phenomena which they display. The eruption of water from Ætna in the year 1775, proceeded undoubtedly from this cause. The sea, or some of the reservoirs in Ætna or the adjacent mountains, by some means discharged a vast quantity of water into the focus of the volcano. That water was instantly resolved into vapour, which filled the whole cavern, and issued from the mouth of the crater. As soon as it made its way into the open atmosphere, it was condensed again into water, which streamed down the

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the sides of the mountain in a dreadful and destructive torrent.

Others have attempted to account for the existence of volcanic fire, on the supposition that it is derived from central fires, and to these it is supposed that volcanoes act the part of chimneys; while others are of opinion that they are owing to the chemical decomposition of different substances, by which inflammable matters are evolved, with a great deal of heat, and by means of the latter the combustible materials are kindled, and exhibit the phenomena which are thus proposed to be accounted for.

M. Patrin is one of the latest naturalists who, with the assistance of modern chemistry, has attempted to account for the phenomena of volcanoes on the principles of this science. For a full view of his theory, or rather of his fanciful conjectures on this subject, we must refer the reader to the work itself.* But the following is a recapitulation of the principles on which he gives this explanation. All volcanoes, he observes, in a state of activity, are in the vicinity of the sea, and are never found but in those places where sea salt is abundant. The volcanoes of the Mediterranean abstract the salt which the waters of the ocean hold in solution, and are constantly pouring in by the straits of Gibraltar. The strata of primitive schistus are the great laboratories in which volcanic matters are prepared, by a constant circulation of different fluids; but according to this theory, these strata contribute no part of their own substance. They suffer no waste in the process.

* *Hist. Nat. de Miner.* tom. v.

The sphere of the activity of volcanoes may be far extended in these strata, but they have no other outlet beside spiracles, by which the gaseous substances escape, of which one part is dissipated in the atmosphere, and the other becomes concrete by its combination with oxygen. The concretion of these fluids is supposed to be analogous to the concretion of the primitive matters of the globe, according to the theory of La Place; and the elective attractions determine, in the same way, the formation of stony crystals.

Volcanic eruptions are proportioned, in regard to their violence and duration, to the extent of the strata of schistus in which the volcanic fluids are accumulated. These fluids are,

1. *Muriatic acid*, which carries off the oxygen from the metallic oxides of the schistus.

2. *The oxygen of the atmosphere*, which constantly replaces in the metals that which was carried off by the muriatic acid.

3. *Carbonic acid gas*, which the water absorbs from the atmosphere, and conveys to the schistus, which always abounds in carbone.

4. *Hydrogen*, which proceeds from the decomposition of water. A part of this hydrogen is inflamed by electric explosions; the other united to carbonic acid forms oil, which becomes petroleum by its combination with sulphuric acid; and it is to this petroleum that the bitterness of sea water is owing.

5. *The electric fluid*, which is attracted from the atmosphere by the metals contained in the schistus. Sulphur seems to be the most homogeneous portion of this fluid, which has become concrete. Phosphorus is a modification of it, and it contributes to the fixation of oxygen. The sulphur formed in the schistus by means of the electric fluid, combines with the oxygen, and forms sulphuric acid, which decomposes the sea salt.

6. *The metalliferous fluid*. This forms the iron in lavas. It is the origin of metallic veins, and the colouring principle of organized bodies. This substance in its undecomposed state affords iron, but by decomposition it produces other metals. It is conjectured to be one of the principles of muriatic acid, and it contributes, along with phosphorus, to fix oxygen under an earthy form.

7. The last of the volcanic fluids is *azotic gas*. To this gas is owing the formation of the masses of carbonate of lime which are ejected by Vesuvius, and of the calcareous earth contained in lavas.

Such are the materials with which the author proposes to form the different substances which are produced in volcanoes, and by the operation of which he proposes to explain the phenomena of volcanic eruptions. Our readers will probably agree with us in thinking, that the present state of chemical science, even with the assistance of such hypothetical substances as the metalliferous fluids, is yet inadequate to give any degree of support to such opinions, even in the form of conjecture. We shall therefore dismiss it without farther remark.

245 Observations on the nature of the strata.

We shall now conclude this subject with some interesting observations by M. de Luc, on the nature of the strata in which volcanic fires exist.

" Volcanoes, he observes, have been more numerous on the surface of our continents, when they were under the waters of the ancient sea; and as this class of mountains, raised by subterranean fires, manifest themselves still on the shores of the present sea, and in the middle of its waters, it is of importance to geology and the philosophy of the earth to obtain as just ideas of them as possible.

" I have attended a great deal to this subject from my own observations; and I have shown, at different times, the errors into which several geologists and naturalists, in treating of it, have fallen.

" This class of mountains, in particular, requires that we should see them, that we should behold them during their eruptions, that we should have traced the progress of their lava, and have observed closely their explosions; that we should have made a numerous collection of the matters which they throw up under their different circumstances, that we might afterwards be able to study them in the cabinet, and to judge of their composition according to the phenomena which have been observed on the spot.

" This study is highly necessary when we apply it to geology and the philosophy of the earth, in order that we may avoid falling into those mistakes which make us ascribe to subterranean fires what does not belong to them, or which leads us to refuse them what really belongs to them.

" We read in the *Journal de Physique* for January 1804, under the title, *On the cause of Volcanoes*, the following assertions:

' What is the nature of the matters which maintain these subterranean fires? We have seen that Chimboraço, all these enormous volcanoes of Peru, and the Peak of Teneriffe, are composed of porphyry.

' The Puy-de-Dôme is also composed of porphyry, as well as the Mont d'Or and the Cantal.

' Ætna,

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'Ætna, Solfatara, and Vesuvius, are also of the porphyry kind.

'These facts prove that the most considerable volcanoes with which we are acquainted are of porphyry.'

"This opinion, that the fires of volcanoes have their centres in such or such a rock, and that their lavas are produced from these rocks, has always appeared to me not to be founded on any certain data. Opinions also on this subject have varied; some having placed the origin of lava in horn rock, others in granite or schist, and at present it is assigned to porphyry.

"I have always been of opinion that nothing certain could be determined in regard to this point. It ever remains uncertain whether the seat of the matters of which lava is formed be in compact rocks, or in strata in the state of softness, pulverulent, and muddy.

"Those who see lava issue from a volcano in its state of fusion and incandescence, and in its cooling, are convinced that the nature of every thing is changed, that it exhibits a paste in which nothing can be known, except the substances which the volcanic fires have not reduced to fusion.

"But these substances contained in the paste of lava, and those which are the most numerous, show us, that the strata from which they proceed cannot be similar to those exposed to the view, nor even to the most profound strata to which we can penetrate.

"Admitting the hypothesis, that the strata from which the lavas proceed are in a pulverulent and muddy state, containing elements of all these small crystals, one may conceive how they are formed there, insulated, grouped, or solitary, and are found then in the lava in that state of insolution.

"The fragments of natural rocks thrown up by Vesuvius are not of the same kind as the matters of which the lava is composed. Most of these fragments are micaceous rocks, with laminæ of greater or less size, and of a kind of granite called *sienite*. I have found some composed of white quartzy rock; it is found sometimes of calcareous rock.

"The most probable idea that can be formed in regard to the origin of these fragments is, that they have been carried from the borders of the strata through which the lava, that comes from great depths, has opened for itself a passage. These fragments are carried to the surface of the lava as far as the bottom of the chimney of the crater, whence they have been thrown out by explosions, mixed with fragments separated, or rather torn, from the lava; for it is not by the lava that they have been brought forth to view, but by explosions.

"Some of these fragments of natural rocks have not been attacked by the fire; others have more or less; which depends, no doubt, on the place which they occupied in the volcano, and on the time which they remained in it. The most of the latter have retained at their surface a crust of lava, and this crust contains substances which are not the same as that of the fragment it covers.

"On Vesuvius the strata pierced by eruptions are lower than the surface of the soil; in Auvergne and several places of Germany they are above; for this reason there are seen there in their place schists or granites, which the eruptions have broken to form for themselves a passage.

"No volcano rests on natural strata: they sometimes show themselves on the exterior; but they have been opened by eruptions, and their edges have remained in their place.

"The focus of no volcano exists or has existed in the cone which appears above the surface of the ground. They have been raised by eruptions, which, proceeding from great depths, have thrown them up through the upper strata. When it is said, therefore, that the volcanic mountains of Auvergne rest on granite, this is a mistake, and an incorrect expression has been used by those who have not formed a just idea of the phenomenon. Lava may have flowed upon granite or any other rock, and rested upon it; but this is never the case with the volcano itself: its bases are below all the rocks visible.

"It is from the bosom even of the lava, when in a state of fusion in the interior of the volcano, that all the explosions proceed. In that state of fusion they contain all the matters which produce fermentations, and the disengagement of expansible fluids.

"I have been enabled to ascertain this on Vesuvius as far as was possible. The continual noise which was heard through the two interior mouths of the crater which I had before my eyes, was that of an ebullition, accompanied with inflammable vapours, and the gerbes of burning matters which they threw up at intervals were separated pieces of the lava in its state of fusion. I saw several of them in the air change their form, and sometimes become flat on the bodies which they struck or embraced in falling. And among the most apparent of these fragments there are always a multitude of small ones of the size of peas and nuts, and still smaller ones, which show at their surface, by their asperities, all the characters of laceration.

"The name of *scoriæ* has been given to these fragments, to distinguish them from compact lava, though their composition be the same as that of the hardest lava; and it is for want of reflecting properly on this point that it has been said that it is the compact part only that we must observe, in order to judge of their nature. The pieces which I took from the flowing lava with an iron hook, have at their surface the same lacerations and the same asperities as the fragments thrown up by explosions, and both contain the same substances.

"This separation, by tearing off the parcels of the lava effected by fermentations and explosions which proceed from their bosom, serves to explain those columns, sometimes prodigious, of volcanic sand, which rise from the principal crater. When seen with a magnifying glass, this sand exhibits nothing but lava reduced very small, the particles of which, rough with inequalities, have the bright black colour and the varnish of recent lava.

"Parcels of substances which exist in our strata, such as fragments of quartz, scales of mica, and crystals of feldspar, are found sometimes in lava. Similar matters must no doubt be disseminated in the composition of our globe, without there being reason to conclude that the strata from which they proceed are the same as the exterior strata. It is neither in the granites, the porphyries,

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ries, nor the horn rock, and ſtill leſs in the ſchiſts and calcareous rocks, that the ſchorls of volcanoes, the leucites, and perhaps olivins, will be found. Theſe ſmall cryſtals are brought to view by the lava, otherwiſe they would be unknown to us.

"Theſe lavas contain a great deal of iron, which they acquire neither from the granite nor porphyries. Might not one ſee in the ferruginous ſand which is found in abundance on the borders of the ſea near Naples, and in the environs of Rome, ſpecimens of that kind of pulverulent ſtrata from which lava proceeds?

"I have here offered enough to prove that it cannot be determined that lava proceeds from ſtrata ſimilar to thoſe with which we are acquainted. The operations of volcanoes, thoſe vaſt laboratories of nature, will always remain unknown to us, and on this ſubject our conjectures will always be very uncertain.

What is the nature of that mixture which gives birth to theſe eruptions, that produce lava and throw up mountains? What we obſerve as certain is, that the introduction of the water of the ſea is neceſſary to excite theſe fermentations, as containing marine acid and other ſalts, which, united to the ſulphuric acid, the baſes of which are contained in abundance in the ſubterranean ſtrata, determine theſe fermentations, which produce the diſengagement of fire and other fluids, and all the grand effects that are the conſequence.

"Several naturaliſts have believed, and ſtill believe, that freſh or rain water is ſufficient for this purpoſe; but they are miſtaken: this opinion is contradicted by every fact known. To be convinced of this, nothing is neceſſary but to take a ſhort view of them. I have done it ſeveral times, as it is neceſſary to conſider them often. I ſhall here enumerate the principal ones:—No burning mountain exiſts in the interior part of the earth; and all thoſe which ſtill burn are, without exception, in the neighbourhood of the ſea, or ſurrounded by its waters. Among the deliqueſcent ſalts depoſited by the ſmoke of volcanoes, we diſtinguiſh chiefly the marine ſalt, united to different baſes. Several of the volcanoes of Iceland, and Hecla itſelf, ſometimes throw up eruptions of water, which depoſit marine ſalt in abundance. No extent of freſh water, however vaſt, gives birth to a volcano. Theſe facts are ſufficient to prove that the concurrence of ſea-water is abſolutely neceſſary to excite thoſe fermentations which produce volcanoes.

"I ſhall here repeat the diſtinction I have already made between burnt-out volcanoes and the ancient volcanoes, that I may range them in two ſeparate claſſes.

"When we ſimply give the name of *burnt-out* or *extinguiſhed* volcanoes to volcanic mountains which are in the middle of the continents, it is to repreſent them as having burnt while the land was dry, and inhabited as it is at preſent; which is not a juſt idea. Theſe volcanoes have burnt when the land on which they are raiſed was under the waters of the ancient ſea, and none of them have burnt ſince our continents became dry. It is even very apparent that moſt of them were extinct before the retreat of the ſea, as we find by numerous examples in the preſent ſea.

"Thoſe which I denominate extinct volcanoes are ſuch as no longer burn, though ſurrounded by the ſea, or placed on the borders of it. They would ſtill burn, were not the inflammable matters by which they were raiſed really exhauſted and conſumed. Of this kind is the volcano of Agde, in Languedoc. Of this kind alſo are many of the volcanic iſlands which have not thrown up fire ſince time immemorial.

"M. Humboldt, in his letters written from Peru, ſpeaks of the volcanoes which he viſited, but what he ſays is not ſufficiently preciſe to enable us to form a juſt idea of them. He repreſents Chimboraço as being compoſed of porphyry from its bottom to its ſummit, and adds, that the porphyry is 1900 toiſes in thickneſs; afterwards, he remarks, that it is almoſt improbable that Chimboraço, as well at Pichincha and Antiſana, ſhould be of a volcanic nature: 'The place by which we aſcended, (ſays he,) is compoſed of burnt and ſcorified rock, mixed with pumiceſtone, which reſembles all the currents of lava in this country.'

"Here are two characters very different. If Chimboraço be porphyry from the top to the bottom, it is not compoſed of burnt and ſcorified rocks, mixed with pumiceſtone; and if it be compoſed of burnt rocks, it cannot be porphyry. This expreſſion, *burnt and ſcorified rocks*, is not even exact, becauſe it excites the idea of natural rocks, altered in their place by fire, and they are certainly lava which has been thrown up by the volcano. But the truth muſt be, that Chimboraço, and all the other volcanoes of Peru, are compoſed of volcanic matters, from their baſe at the level of the ſea to the ſummit.

"I have juſt read in the *Annales du Muſéum d'Hiſtoire Naturelle* *, a letter of the ſame traveller, written from Mexico, on his return from Peru, where, ſpeaking of the volcanoes of Popayan, Paſto, Quito, and the other parts of the Andes, he ſays, 'Great maſſes of this foſſil (*obſidian*) have iſſued from the craters; and the ſides of theſe gulfs, which we cloſely examined, conſiſt of porphyry, the baſe of which holds a mean between obſidian and pitchſtone (*pechſtein*).' M. Humboldt therefore conſiders obſidian, or black compact glaſs, as a natural foſſil or rock, and not as volcanic glaſs."*

* N° xvii.

* *Journ. de Mines*, N° 95.

CORRIGENDA IN GEOLOGY.

N° 9. 2d par. *read*, Lehman was followed in his own country by Ferber, Gmelin, Born, and Werner; in Sweden, by Bergman, Cronſtedt, and Tilas; in Italy, by Arduini; &c.

N° 11. It was propoſed at firſt to divide the article into only three chapters; but from the length of what was intended as the firſt, and the number of ſections which it contained, it was afterwards thought better to divide it into two.

N° 65. *For* Ingleborough in Weſtmoreland, *read* Ingleborough in Yorkſhire.

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Fig. 1.

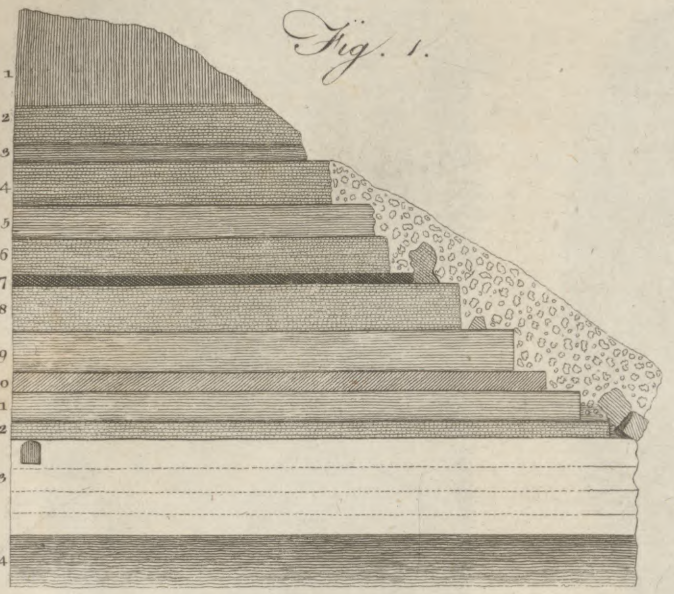

Fig. 2.

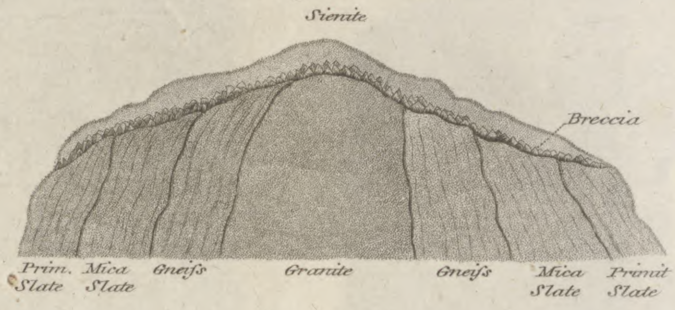

Fig. 3.

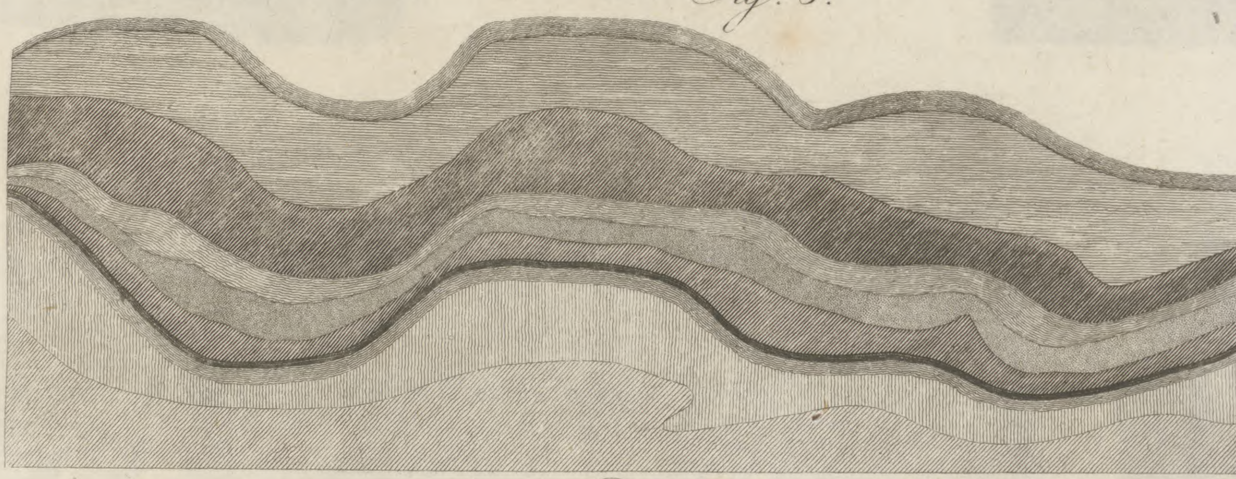

Fig. 4.

Fig. 5.

A. Bell Prin. Wal. Sculptor fecit.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 10.

Fig. 9.

A. Bell Prin. Wal. Sculptor fecit.

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GEOMANCY,

GEOMANCY, Geomantia, a kind of divination, performed by means of a number of little points, or dots, made on paper at random:- and conſidering the various lines and figures which thoſe points preſent; and thence forming a pretended judgment of futurity, and deciding any queſtion propoſed.

The word is formed of the Greek γη, *terra*, "earth;" and μαντεια, "divination;" it being the ancient cuſtom to caſt little pebbles on the ground, and thence to form their conjectures: inſtead of the points afterwards made uſe of.

Polydore Virgil defines geomancy a kind of divination performed by means of clefts or chinks made in the ground; and takes the Perſian Magi to have been the inventors thereof.

Geomancy.

GEOMETRY.

INTRODUCTION.

THERE is reaſon to believe that geometry, as well as moſt of the other ſciences, was firſt cultivated in Egypt; and, according to ſome authors, it had its origin in the neceſſity there was of aſſigning to the inhabitants every year their particular ſhares of land: for as the country was annually overflowed by the Nile, it has been taken for granted (perhaps without good reaſon), that the land-marks would be obliterated, and the poſſeſſions rendered undiſtinguiſhable from one another. Such is ſaid to have been the origin of land-meaſuring, the form under which geometry was firſt known, and from which it has taken its name; for geometry literally ſignifies *the meaſuring of the earth.*

The hiſtorian *Herodotus* refers the origin of geometry to the time when *Seſoſtris* interſected Egypt by numerous canals, and divided the country among the inhabitants; and this account of the beginning of the ſcience has been conſidered by ſome as very probable.

From Egypt gêometry was carried into Greece by *Thales* of Miletus about 600 years before the Chriſtian æra. This celebrated philoſopher is ſaid to have made numerous diſcoveries in geometry; and in particular to have firſt obſerved that any angle in a ſemicircle is a right angle; a diſcovery which gave him great joy, and for which he thanked the muſes by a ſacrifice.

Among the diſciples of *Thales* were *Anaximander* and *Anaxagoras:* the firſt of theſe wrote an elementary treatiſe or introduction to geometry, the earlieſt of which there is any mention in hiſtory; and the laſt is ſaid to have attempted the quadrature of the circle, a problem which has baffled the ſkill of mathematicians of every age.

Pythagoras followed *Thales*, and had the merit of diſcovering one of the moſt beautiful and important propoſitions of the whole ſcience, namely, that the ſquare of the hypothenuſe of a right-angled triangle was equal to the ſquares of the two other ſides. He is ſaid to have been ſo tranſported with joy at this diſcovery, that he ſacrificed a hundred oxen to the gods as a teſtimony of his gratitude. The truth of this anecdote has however been doubted, on account of the philoſopher's moderate fortune and religious opinions concerning the tranſmigration of ſouls.

Zenodorus is the earlieſt of the geometers whoſe writings have reached modern times, a part of them having been preſerved by Theon, in his commentary on Ptolemy.

Hippocrates of Chios cultivated geometry, and diſtinguiſhed himſelf by the quadrature of the curvilineal ſpace contained between half the circumference of one circle, and the fourth part of the circumference of another circle, their concavities being both turned the ſame way, and the radius of the former to that of the latter as 1 to $\sqrt{2}$. He alſo wrote elements of geometry which are now loſt.

The founding of the ſchool of Plato forms one of the earlieſt and moſt important epochs in the hiſtory of geometry; for to that philoſopher we are ſaid to be indebted for the diſcovery of the *Geometrical Analyſis*, by which the ſcience has been greatly extended, and which is indeed abſolutely neceſſary for the reſolution of problems of a certain degree of difficulty.

The Conic Sections, and the theory of *Geometrical Loci*, are commonly reckoned among the improvements which geometry received from his diſciples; and there is reaſon to ſuppoſe that theſe, as well as many other important diſcoveries which we have not room here to enumerate, were firſt ſuggeſted by the attempts of the geometers of the Platonic ſchool to reſolve two celebrated problems, namely, to triſect, or divide into three equal parts, a given angle; and to conſtruct a cube which ſhould be the double of another cube; which laſt problem *Hippocrates* had ſhewn to be equivalent to the finding of two mean proportionals between two given lines. The eſteem in which *Plato* held the ſcience of geometry is fully evinced by the following inſcription over the door of his ſchool: *Let no one enter here that is ignorant of geometry.*

The ſcience of geometry was likewiſe cultivated in all its branches by the philoſophers of the Alexandrian ſchool, among whom *Euclid* claims in a particular manner our attention. This celebrated mathematician lived about 300 years before the chriſtian æra, and probably ſtudied geometry at Athens under the diſciples of *Plato*. From Greece he went to Alexandria, allured thither no doubt by the fame of the celebrated ſchool of that city, and by the favours conferred by the firſt *Ptolemy* upon learned men. He compoſed elements of geometry in a ſyſtematic form, comprehending in them ſuch propoſitions belonging to the firſt principles of the ſcience as had been diſcovered by mathematicians previous to his time. This work has had the ſingular good fortune to preſerve the higheſt reputation in all ages and in all countries where ſcience has been cultivated, and it has ſerved as the groundwork of innumerable other treatiſes, few of which, if any, have excelled it. Many commentaries have been written on it, and it has been tranſlated into almoſt all the

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the European and Oriental languages. *Euclid* is likewise known to have written other works on geometry: of these we have his *Data*, which may be regarded as a continuation of his elements; and an account of a work of his on *porisms* (see PORISMS) preserved in the writings of *Pappus*, but which has suffered so much from time as to be almost unintelligible.

After *Euclid*, lived *Archimedes*, who cultivated and improved all the branches of the mathematics known at that period, and in a particular manner geometry. He was the first that found nearly the ratio of the diameter of a circle to its circumference, and he squared the parabola. He likewise wrote treatises on the Sphere and Cylinder, on Spirals, on Conoids and Spheroids, besides others on mixt Mathematics. He also extended and improved the Geometrical Analysis, the principles of which had been established in the school of *Plato*. Many of the writings of *Archimedes* have been lost; but such as remain prove him to have been one of the greatest geometers that ever lived, and indeed the NEWTON of antiquity.

Apollonius of Perga was nearly contemporary with *Archimedes*, that is, he flourished about the end of the second century before the christian æra. He studied geometry in the Alexandrian school under the successors of *Euclid*, and he greatly extended the theory of the conic sections (see introduction to CONIC SECTIONS). He also composed treatises on different parts of Geometrical Analysis, but of these only one has come down to us entire; it is entitled *de sectione rationis*, and was discovered in the Arabic tongue, from which it has been translated into Latin by *Dr Halley*. Such accounts however are preserved in the *mathematical collections of Pappus* of his other treatises, that several of them have been restored by modern mathematicians. We may mention in particular his treatises *de Locis Planis*, *de Sectione Spatii*, *de Sectione Determinata*, *de Tactionibus*, each of which is divided into two books.

Having mentioned *Archimedes* and *Apollonius*, by far the most illustrious mathematicians of the period in which they lived, we shall pass over several others who contributed nothing to the improvement of the science, and therefore are but little known to us. We shall however, briefly notice *Theodosius*, who lived about 50 years A. C. and who is the author of a work on Spherics, which is considered as one of the most valuable of the books on the ancient geometry.

Pappus and *Theon* of Alexandria deserve to be mentioned as among the most celebrated of the commentators and annotators of the ancient geometry. We are particularly indebted to Pappus (who lived about the middle of the fourth century) for our knowledge of various discoveries and treatises of the ancient geometers, which, but for the account he has given of them in his *mathematical collections*, would have been for ever lost to mathematicians of modern times.

Proclus, the head of the Platonic school at Athens, cultivated mathematics about the middle of the fifth century; and although it does not appear that he made any discoveries in the science, yet he rendered it some service by his example and instruction. He wrote a commentary on the first book of Euclid, which contains many curious observations respecting the history and metaphysics of mathematics.

We have now briefly noticed the principal epochs in the history of geometry, and the most celebrated men who have contributed to its improvement from the earliest periods of history to the end of the fifth century; but long before this time the æra of discovery seems to have been past, and the science on the decline. Still however the Alexandrian school existed, and it was possible that a *Euclid* or an *Apollonius* might again arise in that seminary. But the taking of Alexandria by the Arabs in the year 641 gave a death-blow to the sciences, not only in that capital, but throughout the whole Greek empire. The library, a treasure of infinite value, was burnt, and the stores of learning which had been accumulating for ages were annihilated for ever.

Although by this unfortunate event the sciences suffered an irreparable loss, it must be attributed to the fanaticism of the new religion which the conquerors had adopted, rather than to national ignorance or barbarity; for before that period, the sciences, when on the decline in Greece, had found an asylum among them, and about 120 years after the death of Mohammed they again took them under their protection.

The Arabs translated the greater part of the works of the Greek geometers, and chiefly those introductory to astronomy. They even began to study the more sublime geometry of the ancients; for *Apollonius's* Conic Sections became familiar to them, and some of the books of that work have only reached us in an Arabic version. They gave to Trigonometry its present simple and commodious form, and greatly simplified its operations by the introduction of sines instead of the chords of double arcs, which had been formerly used.

After geometry, as well as its kindred mathematical sciences, had remained for several centuries under the protection of the Arabs, it was again received into Spain, Italy, and the rest of Europe, about the year 1400. Among the earliest writers on the subject after this period, were *Leonardus Pisanus*, and *Lucas Paciolus* or *de Burgo*.

The limits within which we must necessarily confine this sketch of the history of the science, will not, however, allow us to enumerate all the improvements which it has received since the restoration of letters in Europe; for a list of the names of those who have contributed more or less to its extension, would include almost every mathematician of note from the time of Leonardus Pisanus to the present day.

The writings of the ancient geometers have been assiduously sought after, and held in great repute; for it appears that as far as they carried some of their theories, they left but little room for improvement, and of this remark we think the writings of Euclid, of Archimedes, and of Apollonius, afford remarkable instances. Euclid's elements of geometry have been considered, at least in this country, as one of the best books that could be put into the hands of the mathematical student, particularly that edition of its first six and eleventh and twelfth books which was given to the world by the late *Dr Simson*. An excellent system of geometry, comprehending the first six books of the illustrious ancient, together with three supplementary books, has of late years been published by *Mr Professor Playfair*, of the University of Edinburgh. We believe no modern system has excelled that of *Euclid* (as (as restored to its original purity by Dr Simson) in respect of logical accuracy and systematic arrangement. There is one however, which we must particularly mention on account of its great excellence, and the use we have made of it in the system we are now to present to our readers. It is that of Mr Legandre which we consider as the most complete and extensive that has yet appeared.

SECT. I. THE FIRST PRINCIPLES.

Definitions.

I. Geometry is a science which treats of the properties and relations of quantities having extension, and which are called magnitudes. Extension is distinguished into length, breadth, and thickness.

II. A *Point* is that which has position, but not magnitude.

III. A *Line* is that which has only length. Hence the extremities of a line are points, and the intersections of one line with another are also points.

IV. A *Straight* or *Right Line* is the shortest way from one point to another.

Plate CCXL. Fig. 1. V. Every line which is neither straight, nor composed of straight lines, is a *Curve Line*. Thus AB is a straight line, ACDB is a line made up of straight lines, and AEB is a curve line.

VI. A *Superficies*, or *Surface*, is that which has only length and breadth. Hence the extremities of a superficies are lines, and the intersections of one superficies with another are also lines.

VII. A *Plane Superficies* is that in which any two points being taken, the straight line between them lies wholly in that superficies.

VIII. Every superficies which is neither plane nor composed of plane superficies, is a *Curve Superficies*.

IX. A *Solid* is that which has length, breadth, and thickness. Hence the boundaries of a solid are superficies; and the boundary which is common to two solids, which are contiguous, is a superficies.

X. A *Plane Rectilineal Angle* is the inclination of two straight lines to one another, which meet together, but are not in the same straight line. The point in which the lines meet one another is called the *Vertex* of the angle.

Fig 2. When there is only one angle at a point, it may be expressed by the letter placed at that point; thus the angle contained by the lines EF and EG may be called the angle E: if, however, there be several angles, as at B, then each is expressed by three letters, one of which is the letter that stands at the vertex of the angle, and the others are the letters that stand somewhere upon the lines containing the angle, the letter at the vertex being placed between the other two. Thus the angle contained by the lines BA and BD is called the angle ABD or DAB.

Angles in common with other quantities admit of addition, subtraction, multiplication, and division. Thus the sum of the angles ABD and DBC is the angle ABC; the difference of the angle ABC and ABD is the angle DBC.

Fig. 3. XI. When a straight line standing on another straight line makes the adjacent angles equal to one another, each of them is called a *Right Angle*, and the straight line which stands on the other is called a *Perpendicular* to it. Thus, if DC meet AB, and make the angles ACD, DCB equal to one another; each of them is a right angle, and DC is a perpendicular to AB.

XII. An *Obtuse Angle* is that which is greater than a right angle, and an *Acute Angle* is that which is less than a right angle. Thus ABC being supposed a right angle, DBC is an obtuse angle, and EBC an acute angle. Fig. 4.

XIII. *Parallel Straight Lines* are such as are in the same plane, and which being produced ever so far both ways, do not meet. Fig. 5.

XIV. A *Plane Figure* is a plane terminated every where by lines.

If the lines be straight, the space which they enclose is called a *Rectilineal* figure, or a *Polygon*, and the lines themselves constitute the *Perimeter* of the polygon. Fig. 6.

XV. When a polygon has three sides (which is the smallest number it can have) it is called a *Triangle*; when it is has four, it is called a *Quadrilateral*; when it has five, a *Pentagon*; when six, a *Hexagon*, &c.

XVI. An *Equilateral* triangle is that which has three equal sides (fig. 7.); an *Isosceles* triangle is that which has only two equal sides (fig. 8.); and a *Scalene* triangle is that which has all its sides unequal (fig. 9.). Fig. 7. 8. 9.

XVII. A *Right-angled* triangle is that which has a right angle; the side opposite to the right angle is called the *Hypothenuse*. Thus in the triangle ABC, having the angle at B a right angle, the side AC is the hypothenuse. Fig. 10.

XVIII. An *Obtuse-angled* triangle is that which has an obtuse angle (fig. 9.); and an *acute-angled* triangle is that which has three acute angles (fig. 11.). Fig. 9. 11.

XIX. Of quadrilateral figures, a *square* is that which has all its sides equal, and all its angles right angles (fig. 12.). A *Rectangle* is that which has all its angles right angles, but not all its sides equal, (fig. 13.). A *Rhombus* is that which has all its sides equal, but its angles are not right angles, (fig. 14.). A *Parallelogram*, or *Rhomboid*, is that which has its opposite sides parallel (fig. 15.). A *Trapezoid* is that which has only two of its opposite sides parallel, (fig. 16.). Fig. 12. 13. 14. 15. 16.

XX. A *Diagonal* is a straight line which joins the vertices of two angles, which are not adjacent to each other; such is AC. Fig. 89.

XXI. An *Equilateral Polygon* is that which has all its sides equal; and an *Equiangular Polygon* is that which has all its angles equal. If a polygon be both equilateral and equiangular, it is called a *Regular Polygon*.

XXII. Two polygons are *equilateral* between themselves, when the sides of the one are equal to the sides of the other, each to each, and in the same order; that is, when in going about each of the figures in the same direction, the first side of the one is equal to the first side of the other; the second side of the one is equal to the

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the second side of the other; the third to the third, and so on. The same is to be understood of two polygons which are *equiangular* between themselves.

Explanation of Terms.

An *Axiom* is a proposition, the truth of which is evident at first sight.

A *Theorem* is a truth which becomes evident by a process of reasoning called *Demonstration.*

A *Problem* is a question proposed, which requires a solution.

A *Lemma* is a subsidiary truth employed in the demonstration of a theorem, or the solution of a problem.

The common name of *Proposition* is given indifferently to theorems, problems, and lemmas.

A *Corollary* is a consequence which follows from one or several propositions.

A *Scholium* is a remark upon one or more propositions that have gone before, tending to shew their connection, their restriction, their extension, or the manner of their application.

A *Hypothesis* is a supposition made either in the enunciation of a proposition, or in the course of a demonstration.

Explanation of Signs.

That the demonstrations may be more concise, we shall make use of the following signs borrowed from Algebra; and in employing them we shall take for granted that the reader is acquainted with at least the manner of notation and first principles of that branch of mathematics.

To express that two quantities are equal the sign $=$ is put between them; thus $A=B$, signifies that the quantity denoted by A is equal to the quantity denoted by B.

To express that A is less than B, they are written thus; $A \angle B$.

To express that A is greater than B, they are written thus; $A > B$.

The sign $+$ (read *plus*) written between the letters which denote two quantities, indicates that the quantities are to be added together; thus $A+B$ means the sum of the quantities A and B.

The sign — (read *minus*) written between two letters, means the excess of the one quantity above the other; thus $A-B$ means the excess of the quantity denoted by A above the quantity denoted by B. The signs $+$ and $-$ will sometimes occur in the same expression; thus $A+C-D$ means that D is to be subtracted from the sum of A and C, also $A-D+C$ means the same thing.

The sign $\times$ put between two quantities means their product, if they be considered as numbers; but if they be considered as lines, it signifies a rectangle having these lines for its length and breadth; thus $A\times B$ means the product of two numbers A and B; or else a rectangle having A and B for the sides about one of its right angles. We shall likewise indicate the product of two quantities, in some cases, by writing the letters close together; thus m A will be used to express the product of m and A, and so on with other expressions, agreeable to the common notation in algebra.

The expression A^2 means the square of the quantity A, and A^3 means the cube of A; also PQ^2, and PQ^3 mean, the one the square, and the other the cube, of a line whose extremities are the points P and Q. (First Principles.)

On the other hand, the sign $\sqrt{\ }$ indicates a root to be extracted; thus $\sqrt{A\times B}$ means the square root of the product of A and B.

AXIOMS.

1. Two quantities, each of which is equal to a third, are equal to one another.
2. The whole is greater than its part.
3. The whole is equal to the sum of all its parts.
4. Only one straight line can be drawn between two points.
5. Two magnitudes, whether they be lines, surfaces, or solids, are equal, when, being applied the one to the other, they coincide with one another entirely, that is, when they exactly fill the same space.
6. All right angles are equal to one another.

Note.—The references are to be understood thus: (7.) refers to the 7th proposition of the section in which it occurs; (4. 2.) means the 4th proposition of the 2d section; (2. cor. 28. 4.) means the 2d corollary to the 28th proposition of the 4th section.

THEOREM I.

A straight line CD, which meets with another AB, makes with it two adjacent angles, which, taken together, are equal to two right angles. Fig 17.

At the point C let CE be perpendicular to AB. The angle ACD is the sum of the angles ACE, ECD; therefore, $ACD+BCD$ is the sum of the three angles ACE, ECD, BCD. The first of these is a right angle, and the two others are together equal to a right angle; therefore, the sum of the two angles ACD, BCD, is equal to two right angles.

COR. 1. If one of the angles is a right angle, the other is also a right angle.

COR. 2. All the angles ACE, ECD, DCF, FCB, at the same point C, on the same side of the line AB, are, taken together, equal to two right angles. For their sum is equal to the two angles ACD, DCB. Fig. 18.

THEOREM II.

Two straight lines which coincide with each other in two points, also coincide in all their extent, and form but one and the same straight line.

Let the points which are common to the two lines be A and B; in the first place it is evident that they must coincide entirely between A and B; otherwise, two straight lines could be drawn from A to B, which is impossible (axiom 4.) Now let us suppose, if possible, that the lines when produced separate from each other at a point C, the one becoming ACD, and the other ACE. At the point C let CF be drawn, so as to make the angle ACF a right angle; then, ACE being a straight line, the angle FCE is a right angle (1. cor. 1.); and because ACD is a straight line, the angle Fig. 19.

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angle FCD is also a right angle, therefore the angle FCE is equal to FCD, a part to the whole, which is impossible; therefore the straight lines which have the common points A, B cannot separate when produced, therefore they must form one and the same straight line.

THEOREM III.

Fig. 20. If two adjacent angles ACD, DCB make together two right angles, the two exterior lines AC, CB, which form these angles, are in the same straight line.

FOR if CB is not the line AC produced, let CE be that line produced, then, ACE being a straight line, the angles ACD, DCE are together equal to two right angles (1.); but, by hypothesis, the angles ACD, DCB are together equal to two right angles, therefore ACD+DCB=ACD+DCE. From these equals take away the common angle ACD, and the remaining angles DCB, DCE are equal, that is, a part equal to the whole, which is impossible, therefore CB is the line AC produced.

THEOREM IV.

Fig. 21. If two straight lines AB, DE cut each other, the vertical or opposite angles are equal.

FOR since DE is a straight line, the sum of the angles ACD, ACE is equal to two right angles (1.), and since AB is a straight line, the sum of the angles ACE, BCE is equal to two right angles, therefore the sum ACD+ACE is equal to the sum ACE+BCE; from each of these take away the same angle ACE, and there remains the angle ACD equal to its opposite angle BCE.

In like manner, it may be demonstrated, that the angle ACE is equal to its opposite angle BCD.

COR. 1. From this it appears, that if two straight lines cut one another, the angles they make at the point of their intersection are, together, equal to four right angles.

COR. 2. And hence all the angles made by any number of lines meeting in one point are, together, equal to four right angles.

THEOREM V.

Fig. 22. Two triangles are equal, when they have an angle, and the two sides containing it of the one equal to an angle, and the two sides containing it of the other, each to each.

LET the triangles ABC, DEF have the angle A equal to the angle D, the side AB equal to DE, and the side AC equal to DF; the triangles shall be equal. For if the triangle ABC be applied to the triangle DEF, so that the point A may be on D, and the line AB upon DE, then the point B shall coincide with E, because AB=DE; and the line AC shall coincide with DF, because the angle BAC is equal to EDF; and the point C shall coincide with F, because AC=DF; and since B coincides with E, and C with F, the line BC shall coincide with EF, and the two triangles shall coincide exactly, the one with the other; therefore they are equal (ax. 5.)

COR. Hence it follows, that the bases, or third sides BC, EF of the triangles are equal, and the remaining angles B, C of the one are equal to the remaining angles E, F of the other, each to each, namely, those to which the equal sides are opposite.

THEOREM VI.

Two triangles are equal, when they have a side, and the two adjacent angles of the one equal to a side, and the two adjacent angles of the other, each to each. Fig. 22.

LET the side BC be equal to the side EF, the angle B to the angle E, and the angle C to the angle F, the triangle ABC shall be equal to the triangle DEF. For if the triangle ABC be applied to the triangle DEF, so that the equal sides BC, EF may coincide; then because the angle B is equal to E, the side BA shall coincide with ED, and therefore the point A shall be somewhere in ED; and because the angle C is equal to F, the side CA shall coincide with FD, and therefore the point A shall be somewhere in FD; now the point A being somewhere in the lines ED, and FD, it can only be at D their intersection; therefore the two triangles ABC, DEF must entirely coincide, and be equal to one another.

COR. Hence it appears that the remaining angles A, D of the triangles are equal, and the remaining sides AB, AC of the one are equal to the remaining sides DE, DF of the other, each to each, viz. those to which the equal angles are opposite.

THEOREM VII.

Any two sides of a triangle are together greater than the third. Fig. 22.

FOR the side BC, for example, being the shortest way between the points B, C, (def. 4.) must be less than BA+AC.

THEOREM VIII.

If from a point O, within a triangle ABC, there be drawn straight lines OB, OC to the extremities of BC one of its sides, the sum of these lines shall be less than that of AB, AC the two other sides. Fig. 23.

LET BO be produced to meet CA in D; because the straight line OC is less than OD+DC, to each of these add BO, and BO+OC∠BO+OD+DC; that is BO+OC∠BD+DC.

Again, since BD∠BA+AD, to each of these add DC and we have BD+DC∠BA+AC, but it has been shewn that BO+OC∠BD+DC, much more then is BO+OC∠BA+AC.

THEOREM IX.

If two sides AB, AC of a triangle ABC are equal to two sides DE, DF of another triangle DEF, each to each; but if the angle BAC contained by Fig. 24. Fig. 25. Fig. 26.

by the former is greater than the angle EDF contained by the latter; the third ſide BC of the firſt triangle ſhall be greater than the third ſide EF of the ſecond.

SUPPOSE AG drawn ſo that the angle $CAG=D$, take $AG=DE$ and join CG; then the triangle GAC is equal to the triangle EDF, (6.) and therefore $GC=EF$. Now there may be three caſes, according as the point G falls without the triangle BAC, or on the ſide BC, or within the ſame triangle.

Fig. 24. CASE I. Becauſe $GC<GI+IC$, and $AB<AI+IB$, (7.) therefore $GC+AB<GI+AI+IC+IB$, that is, $GC+AB<AG+BC$, from each of theſe unequal quantities take away the equal quantities AB, AG, and there remains $GC<BC$, therefore $EF<BC$.

Fig. 25. CASE II. If the point G fall upon the ſide BC, then it is evident that GC, or its equal EF, is leſs than BC.

Fig. 26. CASE III. Laſtly, if the point G fall within the triangle BAC, then $AG+GC<AB+BC$, (8.) therefore, taking away the equal quantities AG, AB, there remains $GC<BC$ or $EF<BC$.

COR. Hence, converſely, if EF be leſs than BC, the angle EDF is leſs than BAC; for the angle EDF cannot be equal to BAC, becauſe then (5.) EF would be equal to BC; neither can the angle EDF be greater than BAC, for then (by the theor.) EF would be greater than BC.

THEOREM X.

Fig. 22. Two triangles are equal, when the three ſides of the one are equal to the three ſides of the other, each to each.

LET the ſide $AB=DE$, $AC=DF$, and $BC=EF$; then ſhall the angle $A=D$, $B=E$, $C=F$.

For if the angle A were greater than D, as the ſides AB, AC, are equal to DE, DF, each to each, it would follow, (9.) that BC would be greater than EF, and if the angle A were leſs than the angle D, then BC would be leſs than EF; but BC is equal to EF, therefore the angle A can neither be greater nor leſs than the angle D, therefore it muſt be equal to it. In the ſame manner it may be proved, that the angle $B=E$, and that the angle $C=F$.

SCHOLIUM.

It may be remarked, as in THEOREM V. and THEOREM VI. that the equal angles are oppoſite to the equal ſides.

THEOREM XI.

Fig. 27. In an iſoſceles triangle the angles oppoſite to the equal ſides are equal to one another.

LET the ſide $AB=AC$, then ſhall the angle $C=B$. Suppoſe a ſtraight line drawn from A the *vertex* of the triangle to D the middle of its baſe; the two triangles ABD, ACD have the three ſides of the one equal to the three ſides of the other, each to each, namely AD common to both, $AB=AC$, by hypotheſis, and $BD=DC$, by conſtruction, therefore (preced. theor.) the angle B is equal to the angle C.

COR. Hence every equilateral triangle is alſo equiangular.

SCHOLIUM.

FROM the equality of the triangles ABD, ACD, it follows, that the angle $BAD=DAC$, and that the angle $BDA=ADC$; therefore theſe two laſt are right angles. Hence it appears, that a ſtraight line drawn from the vertex of an iſoſceles triangle to the middle of its baſe is perpendicular to that baſe, and divides the vertical angle into two equal parts.

In a triangle that is not iſoſceles, any one of its three ſides may be taken indifferently for a *baſe*; and then its *vertex* is that of the oppoſite angle. In an iſoſceles triangle, the baſe is that ſide which is not equal to the others.

THEOREM XII.

If two angles of a triangle are equal, the oppoſite ſides are equal, and the triangle is iſoſceles. Fig. 28.

LET the angle $ABC=ACB$, the ſide AC ſhall be equal to the ſide AB. For if the ſides are not equal, let AB be the greater of the two; take $BD=AC$, and join CD; the angle DBC is by hypotheſis equal to ACB, and the two ſides DB, BC are equal to the two ſides AC, BC, each to each; therefore the triangle DBC is equal to the triangle ACB; (5.) but a part cannot be equal to the whole; therefore the ſides AB, AC cannot be unequal, that is, they are equal, and the triangle is iſoſceles.

THEOREM XIII.

Of the two ſides of a triangle, that is the greater which is oppoſite to the greater angle; and converſely, of the two angles of a triangle, that is the greater which is oppoſite to the greater ſide. Fig. 29.

FIRST, let the angle $C>B$, then ſhall the ſide AB oppoſite to C be greater than the ſide AC oppoſite to B. Suppoſe CD drawn, ſo that the angle $BCD=B$; in the triangle BDC, BD is equal to DC, (12.) but $AD+DC>AC$, and $AD+DC=AD+DB=AB$, therefore $AB>AC$.

Next, let the ſide $AB>AC$, then ſhall the angle C oppoſite to AB, be greater than the angle B, oppoſite to AC. For if C were leſs than B, then, by what has been demonſtrated, $AB<AC$, which is contrary to the hypotheſis of the propoſition, therefore C is not leſs than B: and if C were equal to B, then it would follow that $AC=AB$, (12.) which is alſo contrary to the hypotheſis; therefore C is not equal to B, therefore it is greater.

THEOREM XIV.

From a given point A without a ſtraight line DE, no more than one perpendicular can be drawn to that line. Fig. 30.

FOR ſuppoſe it poſſible to draw two, AB, and AC; produce

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produce one of them AB, so that BF=AB, and join CF. The triangle CBF is equal to the triangle ABC, for the angle CBF is a right angle, as well as CBA, and the side BF=BA; therefore the triangles are equal, (5.) and hence the angle BCF=BCA; but the angle BCA is by hypothesis a right angle; therefore the angle BCF is also a right angle; hence AC and CF lie in a straight line, (3.) and consequently two straight lines ACF, ABF may be drawn between two points A, F, which is impossible, (ax. 4.) therefore it is equally impossible that two perpendiculars can be drawn from the same point to the same straight line.

Theorem XV.

Fig. 30. If from a point A, without a straight line DE, a perpendicular AB be drawn upon that line, and also different oblique lines AE, AC, AD, &c. to different points of the same line.

First, The perpendicular AB shall be shorter than any one of the oblique lines.

Secondly, The two oblique lines AC, AE, which meet the line DE on opposite sides of the perpendicular, and at equal distances BC, BE from it, are equal to one another.

Lastly, Of any two oblique lines AC, AD, or AE, AD, that which is more remote from the perpendicular is the greater.

Produce the perpendicular AB, so that BF=BA, and join FC, FD.

1. The triangle BCF is equal to the triangle BCA; for the right angle CBF=CBA, the side CB is common, and the side BF=BA, therefore the third side CF=AC, (5.) but AF⟨AC+CF, (7.) that is 2AB⟨2AC; therefore AB⟨AC, that is, the perpendicular is shorter than any one of the oblique lines.

2. If BE=BC, then, as AB is common to the two triangles ABE, ABC, and the right angle ABE=ABC, the triangles ABE, ABC shall be equal, (5.) and AE=AC.

3. In the triangle DFA, the sum of the lines AD, DF is greater than the sum of AC, CF, (8) that is, 2 AD⟩2 AC; therefore AD⟩AC, that is, the oblique line, which is more remote from the perpendicular, is greater than that which is nearer.

Cor. 1. The perpendicular measures the distance of any point from a straight line.

Cor. 2. From the same point, three equal straight lines cannot be drawn to terminate in a given straight line; for if they could be drawn, then, two of them would be on the same side of the perpendicular, and equal to each other, which is impossible.

Theorem XVI.

Fig. 31. If from C, the middle of a straight line AB, a perpendicular CD be drawn to that line. First, Every point in the perpendicular is equally distant from the extremities of the line AB. Secondly, Every point without the perpendicular is at unequal distances from the same extremities A, B.

1. Let D be any point in CD, then, because the two oblique lines DA, DB are equally distant from the perpendicular, they are equal to one another (15.), therefore every point in CD is equally distant from the extremities of AB.

2. Let E be a point out of the perpendicular; join EA, EB, one of these lines must cut the perpendicular in F; join BF, then AF=BF, and AE=BF+FE; but BF+FE⟩BE, (7.) therefore AE⟩BE, that is, E any point out of the perpendicular is at unequal distances from the extremities of AB.

Theorem XVII.

Plate CCXLI. Fig. 32.

Two right-angled triangles are equal, when the hypothenuse and a side of the one are equal to the hypothenuse and a side of the other, each to each.

Let the hypothenuse AC=DF, and the side AB=DE; the triangle ABC shall be equal to DEF. The proposition will evidently be true (10.), if the remaining sides BC, EF are equal. Now, if it be possible to suppose that they are unequal, let BC be the greater, take BG=EF, and join AG; then the triangles ABG, DEF, having the side AB=DE, BG=EF, and the angle B=E, will be equal to one another (5.), and will have the remaining side AG=DF; but by hypothesis DF=AC; therefore AG=AC; but AG cannot be equal to AC (15.), therefore it is impossible that BC can be unequal to EF, and therefore the triangles ABC, DEF are equal to one another.

Theorem XVIII.

Fig. 33. Two straight lines AC, ED, which are perpendicular to a third straight line AE, are parallel to each other.

For if they could meet at a point O, then two perpendiculars OA, OE, might be drawn from the same point O, to the straight line AE, which is impossible (14.).

In the next theorem, it is necessary to assume another axiom, in addition to those already laid down in the beginning of this section.

Axiom

Fig. 34. 7. If two points E, G in a straight line AB are situated at unequal distances EF, GH from another straight line CD in the same plane, these two lines, when indefinitely produced, on the side of the least distance GH, will meet each other.

Theorem XIX.

Fig. 35. If two straight lines AB, CD be parallel, the perpendiculars EF, GH to one of the lines, which are terminated by the other line, are equal, and are perpendicular to both the parallels.

For if EF and GH, which are perpendicular to CD, were unequal, the lines AB, CD would meet each other (by the above axiom) which is contrary to the supposition that they are parallel. And if EF, GH be not

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not perpendicular to AB, let EK be perpendicular to EF, meeting GH in K; then because EK and FH are perpendicular to EF, they are parallel (18.), and therefore, by what has been just shewn, the perpendiculars EF, KH must be equal; but by hypothesis EF=GH, therefore KH=GH, which is impossible; therefore EF is perpendicular to AB; and in the same way it may be shewn that GH is perpendicular to AB.

Cor. Hence it appears, that through the same point E, no more than one parallel can be drawn to the same straight line CD.

Theorem XX.

Fig. 36. Straight lines AB, EF, which are parallel to the same straight line CD, are parallel to each other.

For let HKG be perpendicular to CD, it will also be perpendicular to both AB and EF (19.), therefore these last lines are parallel to each other.

Theorem XXI.

Fig. 37. If a straight line EF meet two parallel straight lines AB, CD, it makes the alternate angles AEF, EFD equal.

Let EH and GF be perpendicular to CD, then these lines will be parallel (18.), and also at right angles to AB (19.), and therefore FH and GE are equal to one another (19.), therefore the triangles FGE, FHE, having the side FG=HE, and GE=FH, and FE common to both, will be equal; and hence the angle FEG will be equal to EFH, that is, FEA will be equal to EFD.

Cor. 1. Hence if a straight line KL intersect two parallel straight lines AB, CD, it makes the exterior angle KEB equal to the interior and opposite angle EFD on the same side of the line. For the angle AEF=KEB, and it has been shewn that AEF=EFD; therefore KEB=EFD.

Cor. 2. Hence also, if a straight line EF meet two parallel straight lines AB, CD, it makes the two interior angles BEF, EFD on the same side together, equal to two right angles. For the angle AEF has been shewn to be equal to EFD, therefore, adding the angle FEB to both, AEF+FEB=EFD+FEB; but AEF+FEB is equal to two right angles, therefore the sum EFD+FEB is also equal to two right angles.

Theorem XXII.

Fig. 38. If a straight line EF, meeting two other straight lines AB, CD, makes the alternate angles AEF, EFD equal, those lines shall be parallel.

For if AE is not parallel to CD, suppose, if possible, that some other line KE can be drawn through E, parallel to CD; then the angle KEF must be equal to EFD (21.), that is (by hypothesis), to AEF, which is impossible; therefore, neither KE, nor any other line drawn through E, except AB, can be parallel to CD.

Cor. If a straight line EF intersecting two other straight lines AB, CD, makes the exterior angle GEB equal to the interior and opposite angle EFD on the same side; or the two interior angles BEF, EFD on the same side equal to two right angles; in either case the lines are parallel. For, if the angle GEB=EFD, then also AEF=EFD, (4.) And if BEF+EFD= two right angles, then, because BEF+AEF=two right angles (1.), BEF+EFD=BEF+AEF, and taking BEF from both, EFD=AEF, therefore (by the theorem) in each case the lines are parallel.

Theorem XXIII.

If a side AC of a triangle ABC be produced towards D, the exterior angle BCD is equal to both the interior and opposite angles BAC, ABC. Fig. 39.

Let CE be parallel to AB, then the angle B=BCE, (21.) and the angle A=ECD, (1 cor. 21.) therefore B+A=BCE+ECD=BCD.

Cor. The exterior angle of a triangle is greater than either of the interior opposite angles.

Theorem XXIV.

The three interior angles of a triangle ABC taken together are equal to two right angles. Fig. 40.

For if AC be produced to D, then A+B=BCD, (23.); to each of these equal quantities add ACB, then shall A+B+ACB=BCD+BCA; but BCD+BCA = two right angles, (1.) therefore A+B+ACB = two right angles.

Cor. 1. If two angles of one triangle be equal to two angles of another triangle, each to each; the third angle of the one shall be equal to the third angle of the other, and the triangles shall be equiangular.

Cor. 2. If two angles of a triangle, or their sum, be given, the third angle may be found, by subtracting their sum from two right angles.

Cor. 3. In a right-angled triangle, the sum of the two acute angles is equal to a right angle.

Cor. 4. In an equilateral triangle, each of the angles is equal to the third part of two right angles, or to two thirds of one right angle.

Theorem XXV.

The sum of all the interior angles of a polygon is equal to twice as many right angles wanting four as the figure has sides. Fig. 41.

Let ABCDE be a polygon; from a point F within it draw straight lines to all its angles, then the polygon shall be divided into as many triangles as it has sides; but the sum of the angles of each triangle is equal to two right angles, (24.) therefore the sum of all the angles of the triangles is equal to twice as many right angles as there are triangles, that is, as the figure has sides; but the sum of all the angles of the triangles is equal

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equal to the sum of all the angles of the polygon, together with the sum of the angles at the point F, which last sum is equal to four right angles, (2 Cor. 4.) therefore the sum of all the angles of the polygon together with four right angles, is equal to twice as many right angles as the figure has sides, and consequently the sum of the angles of the polygon is equal to twice as many right angles, wanting four, as the figure has sides.

Cor. The four interior angles of a quadrilateral are taken together equal to four right angles.

Theorem XXVI.

Fig. 42. The opposite sides of a parallelogram are equal, and the opposite angles are also equal.

Draw the diagonal BD; the two triangles ADB, DBC have the side BD common to both, and AB, DC being parallel, the angle ABD=BDC (21.) also, AD, BC being parallel, the angle ADB=DBC, therefore the two triangles are equal (6.), and the side AB, opposite to the angle ADB, is equal to DC, opposite to the equal angle DBC. In like manner the third side AD is equal to the third side BC, therefore the opposite sides of a parallelogram are equal.

In the next place, because of the equality of the same triangles, the angle A is equal to the angle C, and also the angle ADC composed of the two angles ADB, BDC is equal to the angle ABC composed of the angles CBD, DBA; therefore the opposite angles of a parallelogram are also equal.

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Theorem XXVII.

If the opposite sides of a quadrilateral ABCD are equal, so that AB = DC, and AD = BC; then the equal sides are parallel, and the figure is a parallelogram. Fig. 42.

Draw the diagonal BD. The two triangles ABD, CDB have the three sides of the one equal to the three sides of the other, each to each, therefore the triangles are equal (10.); and the angle ADB, opposite to AB, is equal to DBC opposite to DC, therefore the side AD is parallel to BC (22.). For a similar reason AB is parallel to DC; therefore the quadrilateral ABCD is a parallelogram.

Theorem XXVIII.

If two opposite sides, AB, DC, of a quadrilateral are equal and parallel, the two other sides are in like manner equal and parallel; and the figure is a parallelogram. Fig. 42.

Draw the diagonal BD. Because AB is parallel to CD, the alternate angles ABD, BDC are equal, (21.); now the side AB=DC, and DB is common to the triangles ABD, BDC, therefore these triangles are equal, (5.) and hence the side AD=BC, and the angle ADB=DBC, consequently AD is parallel to BC, (22.) therefore the figure ABCD is a parallelogram.

SECT. II. OF THE CIRCLE.

Definitions.

Fig. 43. I. A *Circle* is a plane figure contained by one line which is called the *circumference*, and is such, that all straight lines drawn from a certain point within the figure to the circumference, are equal to one another.

And this point is called the *centre* of the circle.

II. Every straight line CA, CE, CD, &c. drawn from the centre to the circumference, is called a *radius* or *semidiameter*; and every straight line, such as AB, which passes through the centre, and is terminated both ways by the circumference, is called a *diameter*.

Hence it follows that all the radii of a circle are equal, and all the diameters are also equal, each being the double of the radius.

III. An *Arch* of a circle is any portion of its circumference, as FHG.

The *chord* or *subtense* of an arch is the straight line FG which joins its extremities.

IV. A *Segment* of a circle is the figure contained by an arch, and its chord. If the figure be the half of the circle it is called a *Semicircle*.

Note. Every chord corresponds to two arches, and consequently to two segments; but in speaking of these, it is always the smallest that is meant, unless the contrary be expressed.

V. A *Sector* of a circle is the figure contained by an arch DE and the two radii CD, CE, drawn to the extremities of the arch. If the radii be at right angles to each other it is called a *Quadrant*.

VI. A straight line is said to be *placed* or *applied* in a circle, when its extremities are in the circumference of the circle as FG. Plate CCXLIII.

VII. A rectilineal figure is said to be *inscribed* in a circle when the vertices of all its angles are upon the circumference of the circle; in this case the circle is said to be *circumscribed* about the figure. Fig. 115.

VIII. A straight line is said to *touch* a circle, or to be a *tangent* to a circle, when it meets the circumference in one point only; such, for example, is BD, fig. 49. The point A which is common to the straight line and circle is called *the Point of Contact*.

IX. A polygon is said to be *described* or *circumscribed* about a circle when all its sides are tangents to the circle; and in this case the circle is said to be *inscribed* in the polygon. Fig. 118.

Theorem I.

Plate CCXLI.

Any diameter AB, divides the circle and its circumference into two equal parts. Fig. 43.

For if the figure AEB be applied to AFB, so that the base AB may be common to both, the curve line AEB must fall exactly upon the curve line AFB; otherwise there would be points in the one or the other unequally distant from the centre, which is contrary to the definition of a circle.

Theorem

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Theorem II.

Fig. 44. Every chord is lefs than the diameter.

Let the radii CA, CD be drawn from the centre to the extremities of the chord AD; then the ftraight line AD is lefs than AC+CD, that is AD$\angle$AB.

Theorem III.

A ftraight line cannot meet the circumference of a circle in more than two points.

For if it could meet it in three, thefe three points would be equally diftant from the centre, and therefore three equal ftraight lines might be drawn from the fame point to the fame ftraight line, which is impoffible (2 cor. 15. 1.).

Theorem IV.

Fig. 45. In the fame circle, or in equal circles, equal arches are fubtended by equal chords, and, converfely, equal chords fubtend equal arches.

If the radius AC be equal to the radius EO, and the arch AMD equal to the arch ENG; the chord AD fhall be equal to the chord EG.

For the diameter AB being equal to the diameter EF, the femicircle AMDB may be applied exactly upon the femicircle ENGF, and then the curve line AMDB fhall coincide entirely with the curve line ENGF, but the arch AMD being fuppofed equal to ENG, the point D muft fall upon G, therefore the chord AD is equal to the chord EG.

Converfely, if the chord AD=EG, the arch AMD is equal to the arch ENG.

For if the radii CD, OG be drawn, the two triangles ACD, EOG have three fides of the one equal to three fides of the other, each to each, viz. AC=EO, CD=OG and AD=EG, therefore thefe triangles are equal, (10. 1.) and hence the angle ACD=EOG. Now if the femicircle ADB be placed upon EGF, becaufe the angle ACD=EOG, it is evident that the radius CD will fall upon the radius OG, and the point D upon G, therefore the arch AMD is equal to the arch ENG.

Theorem V.

Fig. 45. In the fame circle, or in equal circles, the greater arch is fubtended by the greater chord, and, converfely, (if the arch be lefs than half the circumference) the greater chord fubtends the greater arch.

For let the arch AH be greater than AD, and let the chords AD, AH, and the radii CD, CH be drawn. The two fides AC, AH, of the triangle ACH, are equal to the two fides AC, CD, of the triangle ACD; and the angle ACH is greater than ACD; therefore the third fide AH is greater than the third fide AD, (9. 1.) therefore the chord which fubtends the greater arch is the greater. Converfely, if the chord AH be greater than AD, it may be inferred (cor. 9. 1.) from the fame triangles that the angle ACH is greater than ACD, and that thus the arch AH is greater than AD.

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Note. Each of the arches is here fuppofed lefs than half the circumference; if they were greater, the contrary property would have place, the arch increafing as the chord diminifhes.

Theorem VI.

The radius CG, perpendicular to a chord AB, bifects the chord (or divides it into two equal parts), it alfo bifects the arch AGB fubtended by the chord. Fig 46.

Draw the radii CA, CB; thefe radii are two equal oblique lines in refpect of the perpendicular CD, therefore they are equally diftant from the perpendicular (15. 1.) that is AD=DB.

In the next place, becaufe CG is perpendicular to the middle of AB, every point in CG is at equal diftances from A and B, (16. 1.) therefore, if GA, GB be drawn, thefe lines are equal, and as they are the chords of the arches AG, BG, the arches are alfo equal. (4.)

Scholium.

Since the centre C, the middle D of the chord AB, and the middle G of the arch fubtended by that chord, are three points fituated in the fame ftraight line perpendicular to that chord; and that two points in a ftraight line are fufficient to determine its pofition; it follows, that a ftraight line which paffes through any two of thefe points muft neceffarily pafs through the third; and muft be perpendicular to the chord. It alfo follows, that a perpendicular to the middle of a chord paffes through the centre, and the middle of the arch fubtended by that chord.

Theorem VII.

If three points A, B, C, be taken in the circumference of a circle, no other circumference which does not coincide with the former, can be made to pafs through the fame three points. Fig. 47.

Let the chords AB, BC be drawn, and let OD, OF be drawn from the centre, perpendicular to, and confequently bifecting thofe chords. The centre of every circle paffing through A and B muft neceffarily be fomewhere in the perpendicular DO, (laft theor.) and in like manner the centre of every circle paffing through B and C, muft be fomewhere in the perpendicular OF, therefore the centre of a circle paffing through A, B, and C, muft be in the interfection of the perpendiculars DO, FO; and confequently can only be at one and the fame point O; therefore, only one circle can be made to pafs through the fame three points A, B, C.

Cor. One circumference of a circle cannot interfect another in more than two points, for if they could have three common points they would have the fame centre, and confequently would coincide with each other.

Theorem VIII.

Two equal chords are equally diftant from the centre, Fig 48.

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centre; and of unequal chords, that which is nearer the centre is greater than that which is more remote.

Let the chord AB=DE, suppose the chords bisected by the perpendiculars CF, CG from the centre, and draw the radii CA, CD. The right-angled triangles CAF, CDG have equal hypothenuses CA, CD; the side AF ($=\frac{1}{2}$AB) of the one is also equal to the side DG ($=\frac{1}{2}$DE) of the other, therefore, their remaining sides CF, CG (which are the distances of the chords from the centre) are equal (17. 1.).

Next let the chord AH be greater than DE; the arch AKH shall be greater than DME. Upon the arch AKH take ANB equal to DME; draw the chord AB, and suppose COF drawn from the centre perpendicular to AB, and CI perpendicular to AH. It is evident that CF$>$CO, and (15. 1.) CO$>$CI; much more then is CF$>$CI; but CF=CG, because the chords AB, DE are equal; therefore CG$>$CI; that is, the chord nearer the centre is greater than that which is farther from it.

Theorem IX.

Fig. 49. The perpendicular BD, drawn at the extremity of a radius CA, is a tangent to the circle.

For any oblique line CE is greater than the perpendicular CA, (15. 1.) therefore the point E is without the circle; therefore the line BD has but one point A common with the circumference, and consequently it is a tangent to the circle. (Def. 8.).

Scholium.

Through the same point A, only one tangent, AD, can be drawn to the circle. For if it be possible to draw another, let AG be that other tangent; draw CF perpendicular to AG; then CF shall be less than CA, (15. 1.) therefore F must be within the circle; and consequently AF when produced must necessarily meet the circle in another point besides A; therefore it cannot be a tangent.

Theorem X.

Fig. 50. and 51. If BC, the distance of the centres of two circles, be less than the sum of their radii; and also the greater radius less than the sum of the distance of their centres and the lesser radius; the two circles intersect each other.

For that the circles may intersect each other in a point A, it is necessary that the triangle ABC be possible; therefore, not only must CB be less than CA +AB, but also the greater radius AB must be less than AC+CB; (7. 1.) and it is evident, that as often as the triangle ABC can be constructed, the circumferences described on the centres B, C, shall intersect each other in two points A, D.

Theorem XI.

Fig. 52. If the distance CB of the centres of two circles be equal to the sum of the radii CA, BA, the circles shall touch each other externally.

It is evident that they have a common point A; but they cannot have more; for if they had two, then the distance of the centres must necessarily be less than the sum of the radii.

Theorem XII.

Fig. 53. If the distance CB of the centres of two circles be equal to the difference of the radii, the two circles shall touch each other internally.

In the first place, it is evident that the point A is common to them both; they cannot, however, have another; for that this may happen, it is necessary that the greater radius AB be smaller than the sum of the radius AC and the distance CB of the centre, (10.) which is not the case.

Cor. Therefore, if two circles touch each other, either internally or externally, their centres and the point of contact are in the same straight line.

Theorem XIII.

Fig. 54. In the same circle, or in equal circles, equal angles ACB, DCE, at the centres, intercept upon the circumference equal arches AB, DE. And, conversely, if the arches AB, DE are equal, the angles ACB, DCE are equal.

First, if the angle ACB be equal to DCE, the one angle may be applied upon the other; and as the lines containing them are equal, it is manifest that the point A will fall upon D, and the point B upon E; thus the arch AB will coincide with, and be equal to the arch DE.

Next, if the arch AB be equal to DE, the angle ACB is equal to DCE; for if the angles are not equal; let ACB be the greater; and let ACI be taken equal to DCE; then, by what has been already demonstrated, the arch AI=DE; but by hypothesis AB=DE; therefore, AI=AB which is impossible; therefore the angle ACB=DCE.

Theorem XIV.

Fig. 55. Fig. 56. The angle BCD at the centre of a circle is double the angle BAD at the circumference, when both stand on the same arch BD.

Fig. 55. First let the centre of the circle be within the angle BAD; draw the diameter AE. The exterior angle BCE of the triangle BCA is equal to both the inward and opposite angles BAC, CBA; (23. 1.) but the triangle BCA being isosceles, the angle BAC=CBA; therefore the angle BCE is double of the angle BAC. For the same reason, the angle DCE is double of the angle DAE, therefore the whole angle BCD is double of the whole angle BAD.

Fig. 56. Suppose in the next place that the centre is without the angle BAD; then, drawing the diameter AE, it may be demonstrated, as in the first case, that the angle ECD is double of the angle EAD, and that the angle

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angle ECB, a part of the firft, is double the angle EAB a part of the other; therefore the remaining angle BCD is double the remaining angle BAD.

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Fig. 57. Fig. 58. All angles BAD, BFD in the fame fegment BAFD of a circle are equal to one another.

Fig. 57. If the fegment be greater than a femicircle, from the centre C draw CB and CD; then the angles BAD and BFD being (by laft theorem) each equal to half BCD; they muft be equal to one another.

Fig. 58. But if the fegment BAFD be lefs than a femicircle, let H be the interfection of BF and AD; then, the triangles ABH and FDH having the angle AHB of the one equal to FHD of the other, (4. 1.) and ABH =FDH, (by cafe 1.) will have the remaining angles of the one equal to the remaining angles of the other; that is the angle BAH=HFD, or BAD=BFD.

THEOREM XVI.

Fig. 59. The oppofite angles of any quadrilateral figure ABCD defcribed in a circle are together equal to two right angles.

Draw the diagonals AC, BD; becaufe the angle ABD=ACD, and CBD=CAD, (laft theor.) the fum ABD+CBD=ACD+CAD; or ABC=ACD+CAD; to each of thefe equals add ADC, and ABC+ADC= ACD+CAD+ADC; but the laft three angles, being the angles of the triangle ADC, are taken together equal to two right angles, (24. 1.), therefore ABD+CBD= two right angles. In the fame manner, the angles BAD, BCD may be fhewn to be together equal to two right angles.

THEOREM XVII.

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Fig. 60. In a circle, the angle BAD in a femicircle is a right angle, but the angle ABD in a fegment greater than a femicircle is lefs than a right angle; and the angle AED in a fegment lefs than a femicircle is greater than a right angle.

Let C be the centre, join CA, and produce BA to F. Becaufe CB=CA, the angle CAB=CBA; (11. 1.) and becaufe CD=CA, the angle CAD =CDA, therefore, the whole angle BAD=CBA +CDA; but thefe two laft angles are together equal to DAF, (23. 1.) therefore the angle BAD=DAF; and hence each of them is a right angle.

And becaufe ABD+ADB is a right angle, therefore ABD, an angle in a fegment greater than a femicircle, is lefs than a right angle.

And becaufe ABDE is a quadrilateral in a circle, the oppofite angles B and E are equal to two right angles (laft theor.), but B is lefs than a right angle; therefore the angle E, which is in a fegment lefs than a femicircle, is greater than a right angle.

THEOREM XVIII.

Fig. 61. The angle BAC contained by AC, a tangent, and AB, a chord drawn from the point of contact, is equal to any angle ADB in the alternate fegment of the circle.

Draw the diameter AE, and join DE. The angles EAC, EDA, being right angles, (laft theor.) are equal to one another; and of thefe, EAB, a part of the one, is equal to EDB, a part of the other, (15.) therefore the remainder BAC, of the former is equal to the remainder BDA, of the latter.

SECT. III. OF PROPORTION.

Definitions.

I. When one magnitude contains another a certain number of times exactly, the former is faid to be a *multiple* of the latter, and the latter a *part* of the former

II. When feveral magnitudes are multiples of as many others, and each contains its parts the fame number of times, the former are faid to be *equimultiples* of the latter, and the latter *like parts* of the former.

III. Betwixt any two finite magnitudes of the fame kind there fubfifts a certain relation in refpect to quantity, which is called their *ratio*. The two magnitudes compared are called the *terms* of the ratio, the firft the *antecedent*, and the fecond the *confequent*.

IV. If there be four magnitudes, or quantities, A, B, C, D, and if A contain fome part of B juft as often as C contains a like part of D, then, the ratio of A to B is faid to be the fame with (or equal to) the ratio of C to D.

It follows immediately from this definition, that if A contain B juft as often as C contains D, then the ratio of A to B is equal to the ratio of C to D; for in that cafe it is evident that A will contain any part of B juft as often as C contains a like part of D.

V. When two ratios are equal, their terms are called *proportionals*.

To denote that the ratio of A to B is equal to the ratio of C to D, they are ufually written thus, A : B :: C : D, or thus, A : B = C : D, which is read thus; A is to B as C to D; fuch an expreffion is called an *analogy* or a *proportion*.

VI. Of four proportional quantities, the laft term is called a *fourth proportional* to the other three taken in order.

VII. Three quantities A, B, C, are faid to be proportionals, when the ratio of the firft A to the fecond B is equal to the ratio of the fecond B to the third C.

VIII. Of three proportional quantities, the middle term is faid to be a *mean proportional* between the other two, and the laft a *third proportional* to the firft and fecond.

IX. Quantities are faid to be *continual proportionals*, when the firft is to the fecond, as the fecond to the third, and as the third to the fourth, and fo on.

X. When there is any number of magnitudes A, B, C, D, of the fame kind, the ratio of the firft A to the laft D is faid to be compounded of the ratio of

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A to B, and of the ratio of B to C, and of the ratio of C to D.

XI. If three magnitudes A, B, C be continual proportionals; that is, if the ratio of A to B be equal to the ratio of B to C; then the ratio of the first A to the third C is said to be *duplicate* of the ratio of the first A to the second B. Hence, since by the last definition the ratio of A to C is compounded of the ratio of A to B and of B to C, a ratio which is compounded of two equal ratios is *duplicate* of either of them.

XII. If four magnitudes A, B, C, D be continual proportionals, the ratio of the first A to the fourth D is said to be *triplicate* the ratio of the first A to the second B. Hence a ratio compounded of three equal ratios is triplicate of any one of them.

XIII. *Ratio of Equality* is that which equal magnitudes bear to each other.

The next four definitions explain the names given by geometers to certain ways of changing either the order or magnitude of proportionals, so that they still continue to be proportional.

XIV. *Inverse Ratio* is when the antecedent is made the consequent, and the consequent the antecedent. See Theor. 3.

XV. *Alternate* proportion is when antecedent is compared with antecedent, and consequent with consequent. See Theor. 2.

XVI. *Compounded* ratio is when the sum of the antecedent and consequent is compared either with the antecedent, or with the consequent. See Theor. 4.

XVII. *Divided* ratio is when the difference of the antecedent and consequent is compared either with the antecedent or with the consequent. See Theor. 4.

Axioms.

1. Equal quantities have each the same ratio to the same quantity; and the same quantity has the same ratio to each of any number of equal quantities.

2. Quantities having the same ratio to one and the same quantity, or to equal quantities, are equal among themselves, and those quantities, to which one and the same quantity has the same ratio, are equal.

3. Ratios equal to one and the same ratio are also equal, one to the other.

4. If two quantities be divided into, or composed of parts that are equal among themselves, or all of the same magnitude, then will the whole of the one have the same ratio to the whole of the other, as the number of parts in the one has to the number of equal parts in the other.

Theorem I.

Equimultiples of any two quantities have to each other the same ratio as the quantities themselves.

Let A and B be any two quantities, and, m being ut to denote any number, let m A, m B be equimultiples of those quantities, m A shall have to m B the time ratio that A has to B.

Let the ratio of A to B be equal to the ratio one number p to another number q, that is, let contain p such equal parts as B contains q, (Ax. 4.) then, if x be put for one of those equal parts, we have

$$A=p\,x,\quad B=q\,x,$$

and consequently, multiplying both by the same number m,

$$m\,A=m\,p\,x,\quad m\,B=m\,q\,x,$$

or, which is evidently the same,

$$m\,A=p\times m\,x,\quad m\,B=q\times m\,x.$$

Hence it appears that m A contains the quantity $m\,x$ as a part p times; and that m B contains the same quantity q times; therefore the ratio of m A to m B is the same as the ratio of the number p to the number q (Ax. 4.); but the ratio of A to B is also equal to the ratio of p to q, (by hypothesis), therefore the ratio of m A to m B is equal to the ratio of A to B (Ax. 3.).

Cor. Hence like parts of quantities have to each other the same ratio as the wholes: that is, $\frac{A}{m}:\frac{B}{m}::$ A : B; for A and B are equimultiples of $\frac{A}{m}$ and $\frac{B}{m}$.

Theorem II.

If four quantities of the same kind be proportionals, they shall also be proportionals by alternation.

Let A, B, C, D be four quantities, of the same kind, and let A : B :: C : D; then shall A : C :: B : D.

Let the equal ratios of A to B, and of C to D, be the same as the ratio of the number p to the number q; then A will contain p such equal parts as B contains q, (Ax. 4.) and C will, in like manner, contain p such equal parts as D contains q; let each of the equal parts thus contained in A and B be x, and let each of those contained in C and D be y, then

$$A=p\,x,\quad B=q\,x,\quad C=p\,y,\quad D=q\,y.$$

Now as $A=p\,x$, and $C=p\,y$; it is manifest that A and C are equimultiples of x and y, therefore the ratio of A to C is equal to the ratio of x to y, (1.) and as $B=q\,x$, and $D=q\,y$, B and D are in like manner equimultiples of x and y; therefore the ratio of B to D is equal to the ratio of x to y; therefore the ratio of A to C is equal to the ratio of B to D.

Cor. If the first of four proportionals be greater than the third, the second is greater than the fourth; and if the first be less than the third, the second is less than the fourth.

Theorem III.

If four quantities be proportionals, they are also proportionals by inversion.

Let A : B :: C : D; then shall B : A :: D : C.

For let the equal ratios of A to B, and of C to D, be the same as the ratio of the number p to the number q, then as B will contain q such equal parts as A contains

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tains p (Ax. 4.), B will be to A as q is to p, and as D will contain q such equal parts as C contains p, D will be to C also as q to p, therefore the ratio of B to A is equal to the ratio of D to C (Ax. 3.)

Theorem IV.

If four quantities be proportionals, they are also proportionals by composition, and by division.

Let A : B :: C : D, then will

$A+B : A :: C+D : C$, and $A+B : B :: C+D : D$;
also $A-B : A :: C-D : D$, and $A-B : B :: C-D : D$.

Let us suppose, as in the two preceding theorems, that the ratios of A to B, and of C to D are each equal to the ratio of the number p to the number q, so that A contains p such equal parts as B contains q, and C contains p such equal parts as D contains q; and let x as before denote each of the equal parts contained in A and B, and y each of the equal parts contained in C and D; then, since

$$A=px, \quad B=qx, \quad C=py, \quad D=qy,$$

therefore $A+B=px+qx=(p+q)x$;
$C+D=py+qy=(p+q)y$.

Now as A+B contains x $p+q$ times, and A contains the same quantity p times, and B contains it q times, (by the 4th axiom),

$A+B : A :: p+q : p$, and $A+B : B :: p+q : q$,

and as C+D contains y $p+q$ times, and C contains it p times, and D contains it q times,

$C+D : C :: p+q : p$, and $C+D : D :: p+q : q$.

Thus it appears, that the ratios of A+B to A, and of C+D to C, are equal to the same ratio, namely, that of $p+q$ to p; therefore (Ax. 3.) $A+B : A :: C+D : C$. It also appears that the ratios of A+B to B, and C+D to D are each equal to the ratio of $p+q$ to q; therefore (Ax. 3.) $A+B : B :: C+D : D$.

In the same manner the second part of the theorem may be proved, namely, that

$A-B : A :: C-D : C$ and $A-B : B :: C-D : D$.

Theorem V.

If four quantities be proportionals, and there be taken any equimultiples of the antecedents, and also any equimultiples of the consequents; the resulting quantities will still be proportionals.

Let A : B :: C : D, and mA, mC be any equimultiples of the antecedents, and nB, nD any equimultiples of the consequents; then as mA : nB :: mC : nD

The quantities p, q, x and y being supposed to express the same things as in the foregoing theorems; because

$$A=px, \quad B=qx, \quad C=py, \quad D=qy,$$

therefore, multiplying the antecedents by the number m, and the consequents by n,

$$mA=mpx, \quad nB=nqx,$$
$$mC=mpy, \quad nD=nqy,$$

and hence the ratio of mA to nB is equal to the ratio of the number mp to the number nq, (Ax. 4.) and the ratio of mC to nD, is equal to the same ratio of mp to nq, therefore (Ax. 3.) mA : nB :: mC : nD.

Theorem VI.

If there be any number of quantities, and as many others, which, taken two and two, have the same ratio; the first shall have to the last of the first series the same ratio which the first of the other series has to the last.

First, let there be three quantities A, B, C, and other three H, K, L, and let A : B :: H : K, and B : C :: K : L, then will A : C :: H : L.

A,	B,	C,
H,	K,	L

For let the equal ratios of A to B, and of H to K, be the same with the ratio of a number p to another number q, so that x and y being like parts of A and H, and also like parts of B and K, as in the former theorems,

$$A=px, \quad B=qx, \quad H=py, \quad K=qy.$$

Also let C contain q equal parts, each equal to v, and let L contain q equal parts, each equal to z, so that

$$C=qv, \quad L=qz;$$

then, because B : C :: K : L, that is, $qx : qv :: qy : qz$, and qx and qv are equimultiples of x and v, also qy and qz are equimultiples of y and z, therefore (1. & Ax. 3.) $x : v :: y : z$, hence (by last theorem) $px : qv :: py : qz$, that is, (because $A=px$, $C=qv$, $H=py$, $L=qz$) A : C :: H : L.

Next, let these four quantities, A, B, C, D, and other four H, K, L, M, such, that A : B :: H : K, and B : C :: K : L, and C : D :: L : M, then will A : D :: H : M.

A,	B,	C,	D,
H,	K,	L,	M.

For, because A : B :: H : K, and B : C :: K : L; therefore, by the first case, A : C :: H : L; and because C : D :: L : M, therefore, by the same case, A : D :: H : M. The demonstration applies in the same manner to any number of quantities.

Cor. Hence it appears, that ratios compounded of the same number of like or equal ratios are equal to one another.

Note.—When four quantities are proportionals in the manner explained in this theorem, they are said to be so from *equality of distance*; and it is usual for mathematical writers to say that they are so, *ex æquali* or *ex æquo*.

Theorem VII.

If there be any number of quantities, and as many others, which taken two and two in a cross order have the same ratio; the first shall have to the last of the first series the same ratio which the first has to the last of the other series.

First,

First, let there be three quantities A, B, C, and other three H, K, L, ſuch that A : B :: K : L, and B : C :: H : K; then will A : C :: H : L.

A,	B,	C
H,	K,	L.

For let the equal ratios of A to B, and of K to L be equal to the ratio of the number p to the number q, ſo that as before

$$A=px, \quad B=qx, \quad K=py, \quad L=qy.$$

Alſo, let C be ſuppoſed to contain q equal parts, each equal to z, and let H contain p equal parts, each equal to v, ſo that

$$C=qz, \quad H=pv;$$

Then, becauſe B : C :: H : K, that is, $qx : qz :: pv : py$; therefore (1. & Ax. 3.) $x : z :: v : y$, and conſequently (5.) $px : qz :: pv : qy$, that is (becauſe $px=A$, $qz=C$, $pv=H$, $qy=L$) A : C :: H : L.

Next, let there be four quantities A, B, C, D, and other four H, K, L, M, ſuch, that A : B :: L : M, and B : C :: K : L, and C : D :: H : K, then will A : D :: H : M; for becauſe A : B :: L : M, and B : C :: K : L; by the foregoing caſe A : C :: K : M; and again becauſe C : D :: H : K; therefore, by ſame caſe, A : D :: H : M. The demonſtration applies in the ſame manner to any number of quantities.

A,	B,	C,	D
H,	K,	L,	M.

Note.—In this theorem, as in the laſt, the four quantities A, D, H, M, are ſaid to be proportionals from *equality of diſtance*; but becauſe in this caſe the proportions are taken in a croſs order, it is common to ſay, that they are ſo, *ex æquali*, *in proportione perturbata*, or *ex æquo inverſely*.

Theorem VIII.

If to the two conſequents of four proportionals there be added any two quantities that have the ſame ratio to the reſpective antecedents, theſe ſums and the antecedents will ſtill be proportionals.

Let A : B :: C : D
and A : B′ :: C : D′

(where B′ and D′ denote two quantities diſtinct from thoſe denoted by B and D); then will

$$A : B+B' :: C : D+D'.$$

For ſince A : B :: C : D, by inverſion, (3.) B : A :: D : C, but A : B′ :: C : D′, therefore (6.) B : B′ :: D : D′, and by compoſition, (4.) and inverſion B : B+B′ :: D : D+D′, and ſince A : B :: C : D; therefore (6.) A : B+B′ :: C : D+D′.

Cor. 1. If inſtead of two quantities B′, D′, there be any number B′, B″, &c. and D′, D″, &c. which taken two and two have the ſame ratio to the antecedents A, C, that is, if

A : B :: C : D,
A, B′ :: C : D′,
A : B″ :: C : D″;

then will A : B+B′+B″ :: C : C+D′+D″.

For ſince A : B+B′ :: C : D+D′ (by the theor.)
and A : B″ :: C : D″,

therefore, by the propoſition,

$$A : B+B'+B'' :: C : D+D'+D''.$$

Cor. 2. If any number of quantities of the ſame kind be proportionals, as one of the antecedents is to its conſequent, ſo is the ſum of all the antecedents to the ſum of all the conſequents.

Let A : B :: C : D :: E : F,

then becauſe A : A :: B : B,
and A : C :: B : D,
and A : E :: B : F;

therefore, A : A+C+E :: B : B+D+F; and by alternation,

$$A : B :: A+C+E : B+D+F.$$

In treating of proportion we have ſuppoſed that the antecedent contains ſome part of the conſequent a certain number of times exactly, which part is therefore a common meaſure of the antecedent and conſequent. But there are quantities which cannot have a common meaſure, and which are therefore ſaid to be *incommenſurable*; ſuch, for example, are the ſides of two ſquares one of which has its ſurface double that of the other.

Although the ratio of two incommenſurable quantities cannot be expreſſed in numbers, yet we can always aſſign a ratio in numbers which ſhall be as near to that ratio as we pleaſe. For let A and B be any two quantities whatever, and ſuppoſe that x is ſuch a part of A that $A=px$; then if q denote the number of times that x can be taken from B, and d the remainder, we have $B=qx+d$, and $qx=B-d$; and becauſe $p:q::px:qx$, therefore $p:q$ :: A : B—d. Now as d is leſs than x, by taking x ſufficiently ſmall d may be leſs than any propoſed quantity, ſo that B—d may differ from B by leſs than any given quantity; therefore two numbers p and q may always be aſſigned, ſuch, that the ratio of p to q ſhall be the ſame as the ratio of A to a quantity that differs leſs from B than by any given quantity, however ſmall that quantity may be.

Hence we may conclude, that whatever has been delivered in this ſection relating to commenſurable quantities, may be conſidered as applying equally to ſuch as are incommenſurable.

SECT. IV. THE PROPORTIONS OF FIGURES.

Definitions.

I. *Equivalent Figures* are ſuch as have equal ſurfaces.

Two figures may be equivalent, although very diſſimilar; thus a circle may be equivalent to a ſquare, a triangle to a rectangle, and ſo of other figures.

We ſhall give the denomination of *equal* figures to thoſe

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those which, being applied the one upon the other, coincide entirely; thus, two circles having the same radius are equal; and two triangles having three sides of the one equal to three sides of the other, each to each, are also equal.

II. Two figures are *similar*, when the angles of the one are equal to the angles of the other, each to each; and the *homologous* sides proportionals. The homologous sides are those which have the same position in the two figures; or which are adjacent to the equal angles. The angles themselves are called *homologous angles*.

Two equal figures are always similar, but similar figures may be very unequal.

III. In two different circles, *similar sectors*, *similar arches*, *similar segments*, are such as correspond to equal angles at the centre. Thus the angle A being equal to the angle O, the arch BC is similar to the arch DE, and the sector ABC to the sector ODE, &c. Fig. 62.

Fig. 63. IV. The *Altitude of a parallelogram* is the perpendicular which measures the distance between the opposite sides or bases AB, CD. Plate CCXLII.

Fig. 64. V. The *Altitude of a triangle* is the perpendicular AD drawn from the vertical angle A upon the base BC.

Fig. 65. VI. The *Altitude of a trapezoid* is the perpendicular EF drawn between its two parallel bases AB, CD.

VII. The *Area* and the surface of a figure are terms of nearly the same signification. The term *area*, however, is more particularly used to denote the superficial quantity of the figure in respect of its being measured, or compared with other surfaces.

Theorem I.

Fig. 66. Parallelograms which have equal bases and equal altitudes are equivalent.

Let AB be the common base of the parallelograms ABCD, EBAF, which being supposed to have the same altitude, the sides DC, FE opposite to the bases will lie in DE a line parallel to AB. Now, from the nature of a parallelogram, AD=BC, and AF=BE; for the same reason DC=AB, and FE=AB; therefore, DC=FE, and taking away DC and FE from the same line DE, the remainders CE and DF are equal; hence the triangles DAF, CBE have three sides of the one equal to three sides of the other, each to each; and consequently are equal (10. 1.). Now if from the quadrilateral ABED, the triangle ADF be taken away, there will remain the parallelogram ABEF; and if from the same quadrilateral ABED, the triangle CBE, equal to the former, be taken away, there will remain the parallelogram ABCD; therefore the two parallelograms ABCD, ABEF, which have the same base, and the same altitude, are equivalent.

Cor. Every parallelogram is equivalent to a rectangle of the same base and altitude.

Theorem II.

Fig. 67. Every triangle ABC is the half of a parallelogram ABCD, having the same base and altitude.

For the triangles ABC, ACD are equal (28. 1.).

Cor. 1. Therefore a triangle ABC is the half of a rectangle BCEF of the same base and altitude.

Cor. 2. All triangles having equal bases, and equal altitudes, are equivalent.

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Theorem III.

Two rectangles of the same altitude are to each other as their bases. Fig. 68.

Let ABCD, AEFD be two rectangles, which have a common altitude AD; the rectangle ABCD shall have to the rectangle AEFD the same ratio that the base AB has to the base AE.

Let the base AB have to the base AE the ratio of the number p (which we shall suppose 7) to the number q (which may be 4) that is, let AB contain p (7.) such equal parts as AE contains q (4.), then, if perpendiculars be drawn to AB and AE at the points of division, the rectangles ABCD and AEFD will be divided, the former into p, and the latter into q rectangles, which will be all equal (1.) for they have equal bases, and the same altitude; thus the rectangle ABCD will also contain p such equal parts as the rectangle AEFD contains q; therefore, the rectangle ABCD is to AEFD as the number p to the number q (Ax. 4.3.) that is, as the base AB to AE.

Theorem IV.

Any two rectangles are to each other as the products of any numbers proportional to their sides. Fig. 71.

Let the numbers m, n, p, q, have among themselves the same ratios that the sides of the rectangles ABCD, AEFG have to each other; that is, let AB contain m such equal parts, whereof AD contains n; and AE contains p, and AF contains q; then shall ABCD : AEFG :: $mn : pq$.

Let the rectangles be so placed that the sides AB, AE may be in a straight line, then AD and AG will also lie in a straight line (3.1.). Now (3.)

ABCD : AEHD :: AB : AE :: $m : p$,

but $m : p :: nm : np$, (1. 3.)

therefore ABCD : AEHD :: $nm : np$.

Again, AEHD : AEFG :: AD : AG :: $n : q$;

but $n : q :: pn : pq$;

therefore, AEHD : AEFG :: $pn : pq$;

and it was shewn that

ABCD : AEHD :: $nm : np$ or pn,

therefore, (6. 3.) ABCD : AEFG :: $mn : pq$.

Scholium.

Hence it appears, that the product of the base by the altitude of a rectangle may be taken for its measure, observing that by such product is meant that of the number of linear units in the base by the number of linear units in the altitude. This measure is however not absolute, but relative, for it must be supposed, that in comparing one rectangle with another, the sides of both are measured by the same linear unit. For example, if the base of a rectangle, A, be three units, and its altitude 10, the rectangle is represented by 3×10 or 30; this number considered by itself has no meaning,

meaning, but if we have a second rectangle B, the base of which is twelve units, and altitude seven, this second rectangle shall be represented by the number 12×7 or 84, and hence it may be concluded that the two rectangles are to each other as 30 to 84; therefore, if in estimating any superficies the rectangle A be taken for the measuring unit, the rectangle B shall have for its absolute measure $\frac{84}{30}$, that is, it shall be $\frac{84}{30}$ superficial units.

It is more common, as well as more simple, to take for a superficial unit a square, the side of which is an unit in length; and then the measure which we have regarded only as relative becomes absolute; for example the number 30, which is the measure of the rectangle A, represents 30 superficial units or 30 squares, each having its side equal to an unit. To illustrate this see fig. 72.

Theorem V.

Fig. 67. The area of any parallelogram is equal to the product of its base by its altitude.

For the parallelogram ABCD is equivalent to the rectangle FBCE, which has the same base BC, and the same altitude AO (Cor. 1.) but the measure of the rectangle is $BC \times AO$, (4.) therefore the area of the parallelogram is $BC \times AO$.

Cor. Parallelograms having the same base, or equal bases, are to each other as their altitudes; and parallelograms having the same altitude are to each other as their bases; for in the former case put B for the common base and A and A′ for the altitudes, then the areas of the figures are $B \times A$ and $B \times A'$; and it is manifest that $B \times A : B \times A' :: A : A'$; and in the latter case, putting A for the common altitude, and B and B′ for the bases, it is evident that $B \times A : B' \times A :: B : B'$.

Theorem VI.

Fig. 67. The area of a triangle is equal to the product of its base by the half of its altitude.

For the triangle ABC is half of the parallelogram ABCD, which has the same base BC, and the same altitude AO (2.), but the area of the parallelogram is $BC \times AO$ (5.), therefore that of the triangle is $\frac{1}{2}$ $BC \times AO$, or $BC \times \frac{1}{2}AO$.

Cor. Two triangles of the same altitude are to each other as their bases; and two triangles having the same base are to each other as their altitudes.

Theorem VII.

Fig. 73. The area of a trapezoid ABCD is equal to the product of its altitude EF by half the sum of its parallel sides AB, CD.

Through the point I, the middle of BC, draw KL parallel to the opposite side AD, and produce DC to meet KL. In the triangles IBL, ICK, IB is equal to IC by construction, and the angle CIK=BIL, and the angle ICK=IBL (21. 1.) therefore these triangles are equal; and hence the trapezoid ABCD is equivalent to the parallelogram ALKD, and has for its measure $AL \times EF$. But AL=DK, and because the triangle IBL is equal to the triangle KCI, the side BL=CK, therefore $AB+CD=AL+DK=2AL$; hence AL is half the sum of the parallel sides AB, CD; and as the area of the trapezoid is equal to $FE \times AL$, it is also equal to $FE \times \left(\frac{AB+CD}{2}\right)$.

Theorem VIII.

If four straight lines AB, AC, AD, AE, be proportionals; the rectangle ABFE, contained by the two extremes, is equivalent to the rectangle ACGD contained by the means. And conversely, if the rectangle contained by AB, AE, the extremes, be equivalent to the rectangle contained by AC, AD the means, the four lines are proportionals. Fig. 69.

Let the rectangles be so placed as to have the common angle A, and let BF, DG intersect each other in H. Because the rectangles ABHD, ACGD have the same altitude AD,

ABHD : ACGD : : AB : AC; (3),

and because the rectangles ABHD, ABFE have the same altitude AB, for the same reason

ABHD : ABFE : : AD : AE;

but by hypothesis AB : AC : : AD : AE, therefore (Ax. 3. 3.) ABHD : ACGD : : ABHD : ABFE, therefore (Ax. 2. 3.) the rectangle ACGD=ABFE.

Next suppose that the rectangle ACGD=ABFE; then ABHD : ACGD : : ABHD : ABFE. (Ax. 1. 3.) but ABHD : ACGD : : AB : AC, (3) and ABHD : ABFE : : AD : AE, therefore AB : AC : : AD : AE.

Cor. If three straight lines be proportionals, the rectangle contained by the extremes is equal to the square of the mean; and if the rectangle contained by the extremes be equal to the square of the mean, the three straight lines are proportionals.

Theorem IX.

If four straight lines be proportionals, and also other four, the rectangles contained by the corresponding terms shall be proportionals; that is, if AB : BC : : CD : DE, and BF : BG : : DH : DI, then shall *rectangle* AF : *rect.* BM : : *rect.* CH : *rect.* DQ. Fig. 70.

For in BG and DI, produced if necessary, take BF=BF, and DH=DH, and let FP be parallel to BC, and HN to DE; then (3.)

rect. AF : *rect.* BP : : AB : BC,
and *rect.* CH : *rect.* DN : : CD : DE;

but AB : BC : : CD : DE, (by hypothesis) therefore,

rect. AF : *rect.* BP : : *rect.* CH : *rect.* DN;

now (3.) *rect.* BP : *rect.* BM : : BF : BG, and *rect.* DN : *rect.* DQ : : DH : DI; but BF : BG : : DH : DI, (by hypoth.) therefore,

rect. BP : *rect.* BM : : *rect.* DN : *rect.* DQ;

but

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but it has been shewn that

rect. AF : *rect.* BP : : *rect.* CH : *rect.* DN,

therefore (6. 3.)

rect. AF : *rect.* BM : : *rect.* CH : *rect.* DQ.

Cor. Hence the squares of four proportional straight lines are themselves proportionals.

Theorem X.

Fig. 74. If a straight line AC be divided into any two parts at B, the square made upon the whole line AC shall be equal to the squares made upon the two parts AB, BC, together with twice the rectangle contained by these two parts: which may be expressed thus, $AC^2=AB^2+BC^2+2AB\times BC$.

Suppose the square ACDE to be constructed; take AF=AB, draw FG parallel to AC, and BH parallel to CD.

The square ACDE is made up of four parts; the first ABIF is the square upon AB, because AF=AB; the second IGDH is the square upon BC, for AC=AE, and AB=AF, therefore AC—AB=AE—AF, that is BC=EF; but BC=IG, and EF=DG, (26. 1.) therefore IGDH is the square upon BC, and the remaining two parts are the two rectangles BCGI, FEHI, which have each for their measure $AB\times BC$, therefore the square upon AC is equal to the squares upon AB and BC, and twice the rectangle $AB\times BC$.

Theorem XI.

Fig. 75. If a straight line AC be the difference of two straight lines AB, BC; the square made upon AC shall be equal to the excess of the two squares upon AB and BC above twice the rectangle contained by AB and BC; that is,

$$AC^2=AB^2+BC^2-2AB\times BC.$$

Construct the square ABIF, take AE=AC, and draw CG parallel to BI, and HK parallel to AB; and complete the square EFLK. The two rectangles CBIG, GLKD have each $AB\times BC$ for their measure; and if these be taken from the whole figure ABILKEA, that is from AB^2+BC^2, there will remain the square ACDE, that is, the square upon AC.

Theorem XII.

Fig. 76. The rectangle contained by the sum and the difference of two straight lines is equal to the difference of the squares upon those lines; that is,

$$(AB+BC)\times(AB-BC)=AB^2-BC^2.$$

Construct upon AB and AC the squares ABIF, ACDE; produce AB, so that BK=BC, and complete the rectangle AKLE. The base AK of the rectangle is the sum of the two lines AB, BC; and its altitude AE is the difference of the same lines; therefore, the rectangle AKLE=(AB+BC)(AB—BC); but the same rectangle is composed of two parts ABHE+BHLK, of which, BHLK is equal to the rectangle EDGF, for BH=DE, and BK=FE; therefore, AKLE=ABHE+EDGF; but these two parts constitute the excess of the square ABIF above the square DHIG, the former of which is the square upon AB, and the latter the square upon BC, therefore $(AB+BC)\times(AB-BC)=AB^2-BC^2$.

Theorem XIII.

Fig. 77. The square upon the hypothenuse of a right-angled triangle is equal to the sum of the squares upon the two other sides.

Let ABC be a right-angled triangle; having formed the squares upon its three sides, draw a perpendicular AD from the right angle upon the hypothenuse, and produce it to E, and draw the diagonals AF, CH. The angle ABF is evidently the sum of ABC and a right angle, and the angle HBC is also the sum of ABC and a right angle; therefore the angle ABF=HBC; now AB=AH, for they are sides of the same square, and BC=BF for the same reason, therefore the triangles ABF, HBC have two sides, and the included angle of the one equal to two sides and the included angle of the other, each to each, therefore the triangles are equal, (5. 1.) but the triangle ABF is the half of the rectangle BDEF (which for brevity's sake we shall call BE) because it has the same base BF, and the same altitude BD, (2.) and the triangle HBC is in like manner half of the square AH, for the angles BAC, BAL being both right angles, CA and AL constitute a straight line parallel to BH, (3. 1.) and thus the triangle HBC, and the square AH have the same base HB, and the same altitude AB; from which it follows that the triangle is half of the square (2.). It has now been proved that the triangle ABF is equal to the triangle HBC; and that the rectangle BE is double of the former, and the square AH double of the latter; therefore the rectangle BE is equal to the square AH. It may be demonstrated in like manner that the rectangle CDEG, or CE, is equal to the square AI; but the rectangles BE, CE make up the square BCGF, therefore, the square BCGF upon the hypothenuse is equal to the squares ALHB, AKIC upon the other two sides.

Theorem XIV.

Fig. 78. In a triangle ABC, if the angle C is acute, the square of the opposite side AB is less than the squares of the sides which contain the angle C; and if AD a perpendicular be drawn to BC from the opposite angle, the difference shall be equal to twice the rectangle $BC\times CD$; that is

$$AB^2=AC^2+CB^2-2\,BC\times CD.$$

First. Suppose AD to fall within the triangle, then BD=BC—CD, and consequently (11.) $BD^2=BC^2+CD^2-2BC\times CD$; to each of these equals add AD^2; then, observing that $BD^2+DA^2=BA^2$, and $CD^2+DA^2=CA^2$,

$$AB^2=BC^2+CA^2-2\,BC\times CD.$$

Next, suppose AD to fall without the triangle, so that BD=CD—BC, and therefore $BD^2=CD^2+BC^2-2\,BC\times CD$, (11.) to each of these add AD^2 as before,

before, and we get

$$AB^2=BC^2+CA^2-2\,BC\times CD.$$

THEOREM XV.

Fig. 79. In a triangle ABC, if the angle C is obtuse, the square of the opposite side AB is greater than the sum of the squares of the sides which contain the angle C; and if AD a perpendicular be drawn to BC from the opposite angle, the difference shall be equal to twice the rectangle $BC\times CD$, that is

$$AB^2=AC^2+BC^2+2\,BC\times CD.$$

FOR $BD=BC+CD$, and therefore (10.) $BD^2=BC^2+CD^2+2\,BC\times CD$; to each of these equals add AD^2, then, observing that $AD^2+DB^2=AB^2$, and $AD^2+DC^2=AC^2$,

$$AB^2=BC^2+CA^2+2\,BC\times CD.$$

SCHOLIUM.

It is only when a triangle has one of its angles a right angle, that the sum of the squares of two of its sides can be equal to the square of the third side; for if the angle contained by those sides be acute, the sum of their squares is greater than the square of the opposite side, and if the angle be obtuse, that sum is less than the square of the opposite side.

THEOREM XVI.

Fig. 80. If a straight line AE be drawn from the vertex of any triangle ABC to the middle of its base BC; the sum of the squares of the sides is equal to twice the square of half the base, and twice the square of the line drawn from the vertex to the middle of the base; that is, $AB^2+AC^2=2\,BE^2+2\,AE^2$;

DRAW AD perpendicular to BC, then

$$AB^2=BE^2+EA^2-2\,BE\times ED, \ (14.)$$
$$\text{and } AC^2=CE^2+EA^2+2\,CE\times ED, \ (15.)$$

therefore, by adding equals to equals, and observing that $BE=CE$, and therefore $BE^2=CE^2$, and $2\,BE\times ED=2\,CE\times ED$,

$$AB^2+AC^2=2.\,BE^2+2\,AE^2.$$

THEOREM XVII.

Fig. 81. A straight line DE drawn parallel to one of the sides of a triangle ABC divides the other two sides AB, AC proportionally, so that AD : DB : : AE : EC.

JOIN BE and CD. The triangles BDE, CDE, having the same base DE, and the same altitude, are equivalent, (2.) and the triangles ADE, BDE, having the same altitude, are to one another as their bases, (6.) that is, ADE : BDE : : AD : DB; the triangles ADE, CDE, having also the same altitude, are to one another as their bases; that is ADE : CDE : : AE : EC, but the triangle BDE has been proved equal to CDE; therefore, because of the common ratio in the two proportions, we have (Ax. 3. 3.)

AD : DB : : AE : EC.

COR. Hence by composition AB : AD : : AC : AE; and AB : BD : : AC : CE.

THEOREM XVIII.

Conversely, if two of the sides AB, AC of a triangle are divided proportionally by the straight line DE, so that AD : DB : : AE : EC, then shall the line DE be parallel to the remaining side BC. Fig. 81.

FOR if DE is not parallel to BC, suppose some other line DO to be parallel to BC; then, AB : BD : : AC : CO (17.) and since by hypothesis AD : DB : : AE : EC, and consequently, by composition, AB : BD : : AC : CE, therefore, AC : CO : : AC : CE; therefore, CO=CE (2 Ax. 3.) which is impossible; therefore DO is not parallel to BC.

COR. If it be supposed that BA : AD : : CA : AE, still DE will be parallel to BC; for by division BD : AD : : CE : AE, this proportion being the same as in the Theorem, the conclusion must be the same.

THEOREM XIX.

A straight line AD, which bisects the angle BAC of a triangle, divides the base BC into two segments proportional to the adjacent sides BA, AC; that is, BD : DC : : BA : AC. Fig. 82.

THROUGH the point C draw CE parallel to AD, so as to meet BA produced. In the triangle BCE, the line AD is parallel to one of its sides CE, therefore BD : DC : : BA : AE; now the triangle CAE is isosceles, for, because of the parallels AD, CE, the angle ACE=DAC, and the angle AEC=BAD, (21. 1.) but by hypothesis DAC=BAD; therefore ACE=AEC; and consequently AE=AC, (12. 1.) therefore, substituting AC instead of AE in the above proportion, it becomes BD : DC : : BA : AC.

THEOREM XX.

If two triangles be equiangular, their homologous sides are proportional, and the triangles are similar. Fig. 84.

LET ABC, CDE be two equiangular triangles, which have the angle BAC=CDE, ABC=DCE, and ACB=DEC; the homologous sides, or the sides adjacent to the equal angles, shall be proportional; that is, BC : CE : : AB : CD : : AC : DE.

Place the homologous sides BC, CE in the same direction, and produce the sides BA, ED, till they meet in F. Because BCE is a straight line, and the angle BCA is equal to CED, the lines CA, EF are parallel, (22. 1.) and in like manner, because the angle ABC=DCE, the lines BF, CD are parallel; therefore the figure ACDF is a parallelogram, and hence AF=CD, and CA=DF (26. 1.). In the triangle BFE the line AC is parallel to the side FE, therefore BC : :

Proportions of Figures.

BC : CE : : BA : AF; or since AF=CD, BC : CE : : BA : CD. Again, in the same triangle, because CD is parallel to the side BF, BC : CE : : FD : DE, or, since FD=AC, BC : CE : : AC : DE; having now shewn that BC : CE : : BA : CD, and that BC : CE : : AC : DE, it follows that BA : CD : : AC : DE; therefore the equiangular triangles BAC, CDE have their homologous sides proportional, and hence (def. 2.) the triangles are similar.

Scholium.

It is manifest, that the homologous sides are opposite to the equal angles.

Theorem XXI.

Fig. 83. If two triangles have their homologous sides proportional, they are equiangular and similar.

Suppose that BC : EF : : AB : DE : : AC : DF; then shall A=D, B=E, C=F. At the point E make the angle FEG=B, and at the point F make EFG=C; then the third angle G shall be equal to the third angle A, and the two triangles ABC, GEF shall be equiangular; therefore, by the last theorem BC : EF : : AB : GE; but by hypothesis BC : EF : : AB : DE, therefore GE=DE (Ax. 2. 3.). In like manner, because by the same theorem BC : EF : : CA : FG; and by hypothesis BC : EF : : CA : FD; therefore FG=FD; but it was shewn that EG=ED, therefore, the triangles GEF, DEF, having the sides of the one equal to those of the other, each to each, are equal, but, by construction, the triangle GEF is equiangular to ABC, therefore also the triangles DEF, ABC are equiangular and similar.

Theorem XXII.

Fig. 85. Two triangles which have an angle of the one equal to an angle of the other, and the sides about these angles proportional, are similar.

Let the angle A=D, and let AB : DE : : AC : DF, the triangle ABC is similar to DEF. Take AG=DE, and draw GH parallel to BC, then the angle AGH=ABC, (21. 1.) therefore the triangle AGH is equiangular to ABC, and consequently (20.) AB : AG : : AC : AH; but by hypothesis AB : DE : : AC : DF, and by construction AG=DE, therefore AH=DF; the two triangles AGH, DEF are therefore equal, (5. 1.) but the triangle AGH is similar to ABC, therefore DEF is similar to ABC.

Theorem XXIII.

Fig. 86. In a right-angled triangle, if a perpendicular AD be drawn from the right angle upon the hypothenuse, then,

1. The triangles ABD, CAD on each side of the perpendicular are similar to the whole triangle BAC, and to one another.
2. Each side AB or AC is a mean proportional between the hypothenuse BC, and the adjacent segment BD or DC.
3. The perpendicular AD is a mean proportional between the two segments BD, DC.

1. The triangles BAD, BAC have the common angle B; besides, the right angle BAC is equal to the right angle BDA, therefore the third angle BAD of the one, is equal to the third angle BCA of the other; therefore, these triangles are equiangular and similar; and in the same manner it may be shewn, that the triangle DAC is equiangular and similar to BAC; therefore the three triangles are equiangular and similar to each other.

2. Because the triangle BAD is similar to the triangle BAC, their homologous sides are proportional. Now the side BD of the lesser triangle is homologous to the side BA of the greater, because they are opposite to the equal angles BAD, BCA; in like manner BA, considered as a side of the lesser triangle, is homologous to the side BC of the greater, each being opposite to a right angle; therefore, BD : BA : : BA : BC. In the same manner it may be shewn that CD : CA : : CA : CB, therefore each side is a mean proportional between the hypothenuse and the segment adjacent to that side.

3. By comparing the homologous sides of the two similar triangles ABD, ACD, it appears that BD : DA : : DA : DC; therefore the perpendicular is a mean proportional between the segments of the hypothenuse.

Theorem XXIV.

Two triangles, which have an angle of the one equal to an angle of the other, are to each other as the rectangles of the sides which contain the equal angles; that is, the triangle ABC is to the triangle ADE, as the rectangle AB×AC to the rectangle AD×AE. Fig. 87.

Join BE; because the triangles ABE, ADE have a common vertex E, they have the same altitude, therefore ABE : ADE : : AB : AD, (Cor. to 6.) but AB : AD : : AB×AE : AD×AE, (3.) therefore,

ABE : ADE : : AB×AE : AD×AE.

In the same manner it may be demonstrated that

ABC : ABE : : AB×AC : AB×AE;

Therefore (6. 3.) ABC : ADE : : AB×AC : AD×AE.

Cor. Therefore the two triangles are equivalent, if the rectangle AB×AC=AD×AE, or (8.) if AB : AD : : AE : AC, in which case, the sides about the equal angles are said to be *reciprocally* proportional.

Scholium.

What has been proved of triangles is also true of parallelograms, they being the doubles of such triangles.

Theorem XXV.

Two similar triangles are to each other as the squares of their homologous sides. Fig. 85.

Let

3

Proportions of Figures.

Let the angle A=D, the angle B=E, and therefore the angle C=F,

then (20.) AB : DE : : AC : DF;

now AB : DE : : AB : DE,

for the two ratios are identical, therefore, (9)

$AB^2 : DE^2 :: AB \times AC : DE \times DF$;

but ABC : DEF : : $AB \times AC : DE \times DF$, (24.)

therefore ABC : DEF : : $AB^2 : DE^2$, (Ax. 3. 3.)

therefore the two similar triangles ABC, DEF, are to each other as the squares of the homologous sides AB, DE, or as the squares of any of the other homologous sides.

Theorem XXVI.

Fig. 89. Similar polygons are composed of the same number of triangles which are similar and similarly situated.

In the polygon ABCDE, draw from one of the angles A the diagonals AC, AD to all the other angles. In the polygon FGHIK, draw in like manner from the angle F, homologous to A, the diagonals FH, FI to the other angles.

Because the polygons are similar, the angle ABC is equal to its homologous angle FGH (Def. 2.) also the sides AB, BC are proportional to FG, GH, so that AB : FG : : BC : GH, therefore the triangles ABC, FGH are similar (22.); therefore the angle BCA=GHF, and these being taken from the equal angles BCD,GHI, the remainders ACD, FHI are equal; but the triangles ABC, FGH being similar, AC : FH : : BC : GH, besides, because of the similarity of the polygons, BC : GH : : CD : HI; therefore AC : FH : : CD : HI; now it has been already shewn that the angle ACD=FHI, therefore the triangles ACD, FHI are similar (22.) It may be demonstrated in the same manner that the remaining triangles are similar, whatever be the number of sides of the polygon; therefore two similar polygons are composed of the same number of triangles, similar to each other, and similarly situated.

Theorem XXVII.

Fig 89. The perimeters of similar polygons are as the homologous sides, and the polygons themselves are as the squares of the homologous sides.

For, since by the nature of similar figures AB : FG : : BC : GH : : CD : HI, &c. therefore, (2. cor. 8. 3.) AB+BC+CD, &c. the perimeter of the first figure, is to FG+GH+HI, &c. the perimeter of the second, as the side AB to its homologous side FG.

Again, because the triangles ABC, FGH are similar, ABC : FGH : : $AC^2 : FH^2$ (25.), in like manner ACD : FHI : : $AC^2 : FH^2$, therefore,

ABC : FGH : : ACD : FHI.

By the same manner of reasoning,

ACD : FHI : : ADE : FIK,

and so on if there be more triangles; hence, from this series of equal ratios, it follows (2. cor. 8. 3.) that ABC+ACD+ADE, or the polygon ABCDE, is to FGH+FHI+FIK, or the polygon FGHIK, as one of the antecedents ABC is to its consequent FGH, or as AB^2 to FG^2; therefore, similar polygons are to each other as the squares of their homologous sides.

Cor. I. If three similar figures have their homologous sides equal to the three sides of a right-angled triangle, the figure having the greatest side shall be equal to the two others; for these three figures are proportional to the squares of their homologous sides, and the square of the hypothenuse is equal to the squares of the other two sides.

Cor. 2. Similar polygons have to each other the duplicate ratio of their homologous sides. For let L be a third proportional to the homologous sides AB, FG, then (Def. 11. 3.) AB has to L the duplicate ratio of AB to FG; but AB : L : : $AB^2 : AB \times L$ (3), or, since $AB \times L = FG^2$, (Cor. to 8) AB : L : : $AB^2 : FG^2$: : ABCDE : FGHIK, therefore the figure ABCDE has to the figure FGHIK, the duplicate ratio of AB to FG.

Theorem XXVIII.

The segments of two chords AB, CD, which cut each other within a circle, are reciprocally proportional, that is AO : DO :: CO : OB. Fig. 88.

Join AC and BD; and because the triangles AOC, BOD have the angles at O equal (4. 1.), and the angle A=D and the angle C=B (15. 2.) the triangles are similar; therefore the homologous sides are proportional, (20.) that is, AO : DO :: CO : BO.

Cor. Hence $AO \times BO = CO \times DO$, (8.) that is, the rectangle contained by the segments of the one chord is equal to the rectangle contained by the segments of the other.

Theorem XXIX.

If from a point O without a circle, two straight lines be drawn, terminating in the concave arch BC; the whole lines shall be reciprocally proportional to the parts of them without the circle, that is OB : OC :: OD : OA. Fig. 90.

Join AC, BD; then the triangles OAC, OBD have the common angle O, also the angle B=C (15. 2.), therefore the triangles are similar, and the homologous sides are proportional, that is, OB : OC :: OD : OA.

Cor. Therefore (8.) $OA \times OB = OC \times OD$, that is, the rectangles contained by the whole lines, and the parts of them without the circle, are equal to one another.

Theorem XXX.

If from a point O without a circle a straight line OA be drawn touching the circle, and also a straight line OC cutting it, the tangent shall be a mean proportional between the whole line which Fig. 91.

Problems.

which cuts the circle, and the part of it without the circle, that is, OC : OA :: OA : OD.

For if AC, AD be joined, the triangles OAD, OCA, have the angle at O common to both, alſo the angle ACD or ACO is equal to DAO (18. 2.), therefore the triangles are ſimilar (20.) and conſequently CO : OA :: OA : OD.

Cor. Therefore (cor. to 8.) $CO \times OD = OA^2$, that is, the ſquare of the tangent is equal to the rectangle contained by the whole line which cuts the circle, and the part of it without the circle.

Theorem XXXI.

Fig. 92. In the ſame circle, or in equal circles, any angles ACB, DEF are to each other as the arches AB, DF of the circles intercepted between the lines which contain the angles.

Suppose the arch AB to have to the arch DF the ratio of the number p to the number q; then the arch AB being ſuppoſed divided into equal parts Ag, gh, hB, the number of which is p, the arch DF ſhall contain q equal parts Dk, kl, lm, mn, nF, each of which is equal to any one of the equal parts into which AB is divided. Draw ſtraight lines from the centres of the circles to the points of diviſion, theſe lines will divide ACB into p angles and DEF into q angles, which are all equal (13. 2.) therefore, the angle ACB has to the angle DEF the ratio of the number p to the number q, which ratio is the ſame as that of the arch AB to the arch DF.

Cor. Hence it appears that angles may be meaſured and compared with each other by means of arches of circles deſcribed on the vertices of the angles as centres, obſerving, however, that the radii of the circles muſt be equal.

SECT. V. PROBLEMS.

Problem I.

Plate CCXLIII. Fig. 93. To biſect a given ſtraight line AB; that is, to divide it into two equal parts.

From the points A and B as centres, with any radius greater than the half of AB, deſcribe arches, cutting each other in D and D on each ſide of the line AB. Draw a ſtraight line through the points D, D, cutting AB in C; the line AB is biſected in C.

For the points D, D, being equally diſtant from the extremities of the line AB, are each in a ſtraight line perpendicular to the middle of AB, (16. 1.), therefore the line DCD is that perpendicular, and conſequently C is the middle of AB.

Problem II.

Fig. 94. To draw a perpendicular to a given ſtraight line BC, from a given point A in that line.

Take the points B and C at equal diſtances from A; and on B and C as centres, with any radius greater than BA, deſcribe arches, cutting each other in D; draw a ſtraight line from A through D, which will be the perpendicular required. For the point D, being at equal diſtances from the extremities of the line BC, muſt be in a perpendicular to the middle of BC (16.1.), therefore AD is the perpendicular required.

Problem III.

Fig. 95. To draw a perpendicular to a given line, BD, from a given point A without that line.

On A as a centre, with a radius ſufficiently great, deſcribe an arch, cutting the given line in two points B, D; and on B and D as centres, with a radius greater than the half of BD, deſcribe two arches, cutting each other in E; draw a ſtraight line through the points A and E, meeting BD in C; the line AC is the perpendicular required.

For the two points A and E are each at equal diſtances from B and D; therefore, a line paſſing through A and E is perpendicular to the middle of BD, (16.1.).

Problem IV.

At a given point A, in a given line AB, to make an angle equal to a given angle K. Fig. 96.

On K as a centre, with any radius, deſcribe an arch to meet the lines containing the angle K, in L and I; and on A as a centre, with the ſame radius, deſcribe an indefinite arch BO; on B as a centre, with a radius equal to the chord LI, deſcribe an arch, cutting the arch BO in D; draw AD, and the angle DAB ſhall be equal to K.

For the arches BD, LI having equal radii and equal chords, the arches themſelves are equal (4. 2.), therefore the angles A and K are alſo equal (13. 2.).

Problem V.

To biſect a given arch AB, or a given angle C. Fig. 97.

First. To biſect the arch AB, on A and B as centres, with one and the ſame radius, deſcribe arches to interſect in D; join CD, cutting the arch in E, and the arch AE ſhall be equal to EB.

For, ſince the points C and D are at equal diſtances from A, and alſo from B, the line which joins them is perpendicular to the middle of the chord AB (16. 1.), therefore, the arch AB is biſected at E, (6.2.).

Secondly. To biſect the angle C; on C as a centre, with any diſtance, deſcribe an arch, meeting the lines containing the angle in A and B; then find the point

D

Problems. D as before, and the line CD will manifestly bisect the angle C, as required.

SCHOLIUM.

By the same construction we may bisect each of the arches AE, EB; and again we may bisect each of the halves of these arches, and so on; thus by successive subdivisions, an arch may be divided into four, eight, sixteen parts, &c.

PROBLEM VI.

Fig. 98. Through a given point A, to draw a straight line parallel to a given straight line BC.

On A as a centre, with a radius sufficiently large, describe the indefinite arch EO; on E for a centre, with the same radius, describe the arch AF; in EO take ED equal to AF, draw a line from A through D, and AD will be parallel to BC.

For if AE be joined, the angle EAD is equal to AEB (13. 2.), and they are alternate angles, therefore, AD is parallel to BC, (22. 1.).

PROBLEM VII.

Fig. 99. To construct a triangle, the sides of which may be equal to three given lines A, B, C.

Take a straight line, DE, equal to one of the given lines A; on D as a centre, with a radius equal to another of the lines B, describe an arch; on E as a centre, with a radius equal to the remaining line C, describe another arch, cutting the former in F; join DF and EF, and DEF will be the triangle required, as is sufficiently evident.

SCHOLIUM.

It is necessary that the sum of any two of the lines be greater than the third line (7. 1.).

PROBLEM VIII.

Fig. 100. To construct a parallelogram, the adjacent sides of which may be equal to two given lines A, B, and the angle they contain equal to a given angle C.

Draw the straight line DE=A; make the angle GDE=C, and take DG=B; describe two arches, one on G as a centre, with a radius GF=DE, and the other on E, with a radius EF=DG; then DEFG shall be the parallelogram required.

For by construction the opposite sides are equal, therefore, the figure is a parallelogram, (27. 1.) and it is so constructed, that the adjacent sides and the angle they contain have the magnitudes given in the problem.

Cor. If the given angle be a right angle, the figure will be a rectangle; and if the adjacent sides be also equal, the figure will be a square.

Problems.

PROBLEM IX.

To find the centre of a given circle, or of a circle of which an arch is given. Fig. 101.

Take any three points A, B, D, in the circumference of the circle, or in the given arch, and having drawn the straight lines AB, BD, bisect them by the perpendiculars EG, FH; the point C where the perpendiculars intesect each other is the centre of the circle, as is evident from Theorem VI. sect. 2.

SCHOLIUM.

By the very same construction a circle may be found that shall pass through three given points A, B, C; or that shall be described about a given triangle ABC.

PROBLEM X.

To draw a tangent to a given circle through a given point A. Fig. 102, 103.

If the given point, A, be in the circumference (fig. 102.), draw the radius AC; and through A, draw AD perpendicular to AC, and AD will be a tangent to the circle. (9.2.). But if the given point A be without the circle, (fig. 103.) draw AC to the centre, and bisect AC in O, and on O as a centre, with OA or OC as a radius, describe a circle which will cut the given circle in two points D and D′; join AD and AD′, and each of the lines AD, AD′, will be a tangent to the circle.

For, draw the radii CD, CD′, then each of the angles ADC, AD′C is a right angle, (17.2.); therefore AD and AD′ are both tangents to the circle, (9.2.).

Cor. The two tangents AD, AD′ are equal to one another. (17. 1.).

PROBLEM XI.

To inscribe a circle in a given triangle ABC. Fig. 104.

Bisect A and B any two angles of the triangle by the straight lines AO, BO, which meet each other in O; from O draw OD, OE, OF, perpendiculars to its sides; these lines shall be equal to one another.

For in the triangles ODB, OEB, the angle ODB =OEB, and the angle OBD=OBE; therefore, the remaining angles BOD, BOE, are equal; and as the side OB is common to both triangles, they are equal to one another, (6. 1.), therefore the side OD=OE; in the same manner it may be demonstrated, that OD =OF; therefore the lines OD, OE, OF, are equal to one another, and consequently a circle described on O as a centre, with OD as a radius, will pass through E and F; and as the sides of the triangle are tangents to the circle, (9. 2.) it will be inscribed in the triangle.

PROBLEM XII.

Upon a given straight line AB, to describe a segment Fig. 105.

ment of a circle that may contain an angle equal to a given angle C.

Produce AB towards D, and at the point B make the angle DBE equal to the given angle C; draw BO perpendicular to BE, and GO perpendicular to the middle of AB, meeting BO in O; on O as a centre, with OB as a radius, describe a circle, which will pass through A, and AMB shall be the segment required.

For since FE is perpendicular to BO, FE is a tangent to the circle, therefore the angle EBD (which is equal to C by construction) is equal to any angle AMB in the alternate segment (18. 2.).

Problem XIII.

Fig. 106. Fig. 107. To divide a straight line, AB, into any proposed number of equal parts; or into parts having to each other the same ratios that given lines have.

First, Let it be proposed to divide the line AB, (fig. 106.) into five equal parts. Through the extremity A draw an indefinite line AG, take AC of any magnitude, and take CD, DE, EF, and FG, each equal to AC, that is, take AG equal to five times AC; join GB, and draw CI parallel to GB, the line AI shall be one-fifth part of AB, and AI being taken five times in AB, the line AB shall be divided into five equal parts.

For since CI is parallel to GB, the sides AG and AB are cut proportionally in C and I; but AC is the fifth part of AG; therefore AI is the fifth part of AB.

Next, let it be proposed to divide AB (fig. 107.) into parts, having to each other the ratios that the lines P, Q, R, have. Through A draw AG, and in AG take AC=P, CD=Q, DE=R; join EB, and draw CI and DK parallel to EB; the line AB shall be divided as required.

For, because of the parallels CI, DK, EB, the parts AI, IK, KB, have to each other the same ratios that the parts AC, CD, DE, have, (17. 4.) which parts are by construction equal to the given lines P, Q, R.

Problem XIV.

Fig. 108. To find a fourth proportional to three given lines, A, B, C.

Draw two straight lines DE, DF, containing any angle; on DE take DA=A, and DB=B, and on DF take DC=C; join AC, and draw BX parallel to AC; then, BX shall be the fourth proportional required.

For, because BX is parallel to AC, DA : DB :: DC : DX (17. 4.) that is, A : B :: C : DX, therefore DX is a fourth proportional to A, B, and C.

Cor. The same construction serves to find a third proportional to two lines A and B; for it is the same as a fourth proportional to the lines A, B, and B.

Problem XV.

Fig. 109. To find a mean proportional between two straight lines, A, B.

Upon any straight line DF take DE=A, and EF =B; and on DF as a diameter describe a semicircle DGF; draw EG perpendicular to DF, meeting the circle in G; the line EG shall be the mean proportional required.

For, if DG, FG, be joined, the angle DGF is a right angle, (17. 2.) therefore, in the right-angled triangle DGF, GE is a mean proportional between DE and EF, (23. 4.).

Problem XVI.

To divide a given straight line AB into two parts, so that the greater may be a mean proportional between the whole line and the other part. Fig. 110.

At B, one of the extremities of the line, draw BC perpendicular to AB, and equal to the half of AB; on C as a centre, with CB as a radius, describe a circle; join AC, meeting the circle in D; make AF=AD, and AB shall be divided at F in the manner required.

For since AB is perpendicular to the radius, it is a tangent to the circle (9. 2.), and if AC be produced to meet the circle in E, AB : AF :: AE : AB, (30. 4.) and by division, AB—AF : AF :: AE—AB : AB; but AB—AF=BF, and since DE=2BC=AB, therefore AE—AB=AD=AF, therefore BF : AF :: AF : AB.

Scholium.

When a line is divided in this manner it is said to be divided in *extreme and mean ratio*.

Problem XVII.

To make a square equivalent to a given parallelogram or to a given triangle. Fig. 112. Fig. 123.

First, let ABCD be a given parallelogram, (fig. 112.) the base of which is AB, and altitude DE; find XY a mean proportional between AB and DE, (by problem 15.) and XY shall be the side of the square required.

For since by construction AB : XY :: XY : DE, therefore, $XY^2 = AB \times DE$ (8. 4.) = parallelogram ABCD (5. 4.).

Next, let ABC be a given triangle (fig. 113.) BC its base, and AD its altitude; find XY a mean proportional between half the base and the altitude, and XY shall be the side of the square required.

For since $\frac{1}{2}B$: XY :: XY : AD; therefore (8. 4.) $XY^2 = \frac{1}{2}BC \times AD$=triangle ABC (6. 4.).

Problem XVIII.

Upon a given line EF, to construct a rectangle EFGX equivalent to a given rectangle ABCD. Fig. 114.

Find a fourth proportional to the three lines EF, AB and AD; (by problem 14.) draw EX perpendicular to EF, and equal to that fourth proportional, and complete the rectangle EFGX, which will have the magnitude required.

For since EF : AB :: AD : EX, therefore (8. 4.) $EF \times EX = AB \times AD$, that is, the rectangle EFGX is equal to the rectangle ABCD.

Problem

Problem XIX.

Fig. 111. To make a triangle equivalent to a given polygon ABCDE.

First, draw the diagonal CE, so as to cut off the triangle CDE; draw DG parallel to CE, to meet AE produced in G; join CG, and the given polygon ABCDE shall be equivalent to another polygon ABCG which has one side fewer.

For since DG is parallel to CE, the triangle CGE is equivalent to the triangle CDE, (2. cor. 2. 4.) to each add the polygon ABCE, and the polygon ABCDE shall be equivalent to the polygon ABCG.

In like manner, if the diagonal CA be drawn, also BF parallel to CA, meeting EA produced, and CF be joined, the triangle CFA is equivalent to the triangle CBA, and thus the polygon ABCDE is transformed to the triangle CFG.

In this way a triangle may be found equivalent to any other polygon, for by transforming the figure into another equivalent figure that has one side fewer, and repeating the operation, a figure will at last be found which has only three sides.

Scholium.

As a square may be found equivalent to a triangle, by combining this problem with Prob. XVII. a square may be found equivalent to any rectilineal figure whatever.

Problem XX.

Plate CCXLII. Fig. 89. Upon a given line FC to construct a polygon similar to a given polygon ABCDE.

Draw the diagonals AC, AD; at the point F, make the angle GFH=BAC, and at the point G make the angle FGH=ABC; thus a triangle FGH will be constructed similar to ABC. Again, on FH construct in like manner a triangle FIH, similar to ADC and similarly situated; and on FI construct a triangle FKI similar to AED and similarly situated; and these triangles FGH, FHI, FIK shall form a polygon FGHIK similar to ABCDE (26. 4.).

Problem XXI.

Plate CCXLIII. Fig. 115. To inscribe a square in a given circle.

Draw two diameters AC, BD, so as to intersect each other at right angles; join the extremities of the diameters A, B, C, D, and the figure ABCD shall be a square inscribed in the circle.

For the angles AOB, BOC, &c. being all equal, the chords AB, BC, CD, DA are equal; and as each of the angles of the figure ABCD is in a semicircle, it is a right angle, (17. 2.) therefore the figure is a square.

Problem XXII.

Fig. 116. To inscribe a regular hexagon and also an equilateral triangle in a given circle.

From any point A in the circumference, apply AB and BC each equal to AO the radius; draw the three diameters AD, BE, CF, and join their adjacent extremities by the lines AB, BC, &c. and the figure ABCDEF thus formed is the hexagon required.

For the triangles AOB, BOC being by construction equilateral, each of the angles AOB, BOC is one-third of two right angles, (4. cor. 24. 1.) and since AOB+BOC+COD= two right angles, therefore, COD= one-third of two right angles, therefore the three angles AOB, BOC, COD, are equal, and as these are equal to the angles AOF, FOE, EOD; the six angles at the centre are all equal; therefore, the chords AB, BC, CD, DE, EF, FA are all equal; thus the figure is equilateral. It is also equiangular, for the angles FAB, ABC, &c. are in equal segments, each having for its base the chord of two-sixths of the circumference, therefore, the angles A, B, &c. are equal (15. 2.)

If straight lines be drawn joining A, C, E, the vertices of the alternate angles of the hexagon, there will be formed an equilateral triangle inscribed in a circle; as is sufficiently evident.

Scholium.

As the form of reasoning by which it has been shewn that an equilateral hexagon inscribed in a circle is also equiangular, will apply alike to any equilateral polygon; it may be inferred, that every equilateral polygon inscribed in a circle is also equiangular.

Problem XXIII.

To inscribe a regular pentagon in a given circle. Fig. 117.

Draw any radius AO, and divide it into two parts AF, FO, such, that AO : OF :: OF : AF; (16.) from A place AG in the circumference equal to OF; join OG, and draw the chord AHB perpendicular to OG, the chord AB shall be a side of the pentagon required.

Join GF, and because AO : OF :: OF : AF, and that AG=OF, therefore, AO : AG :: AG : AF; now the angle A is common to the two triangles OAG, GAF, and it has been shewn that the sides about that angle in the two triangles are proportionals; therefore (22. 4.) the triangles are similar, and the triangle AOG being isosceles, the triangle AGF is also isosceles; so that AG=GF; but AG=FO, (by construction) therefore, GF=FO, and the angle FOG=FGO, and FOG + FGO =2 FOG; but AFG = FOG + FGO, (23. 1.) and AFG=FAG, therefore, FAG= 2 FOG; hence in the isosceles triangle AOG, each of the angles at the base is double the vertical angle AOG, therefore the sum of all the angles is equal to five times the vertical angle AOG; but the sum of all the angles is equal to two right angles, (24. 1.) therefore the angle AOG is one-fifth of two right angles, and consequently AOB=2 AOG=two-fifths of two right angles equal one-fifth of four right angles, therefore the arch AB is one-fifth of the whole circumference. If we now suppose straight lines BC, CD, DE, to be applied in the circle each equal to AB, the chord of one-fifth of the circumference, and AE to be joined, the figure thus formed will be an equilateral pentagon, and it is also equiangular (Schol. 22.)

Of the Quadrature of the Circle.

Problem XXIV.

Fig. 118. Having given ABCD, &c. a regular polygon inscribed in a circle, to describe a regular polygon of the same number of sides about the circle.

Draw GH a tangent to the circle at T the middle of the arch AB; do the same at the middle of each of the other arches BC, CD, &c. these tangents shall form a regular polygon GHIK, &c. described about the circle.

Join OG, OH, &c. also OT and ON. In the triangles OTH, ONH, the side OT=ON, and OH is common to both, and OTH, ONH, are right angles, therefore the triangles are equal (17. 1.) and the angles TOH=NOH; now B is the middle of the arch TN, therefore OH passes through B; and in the same manner it appears that I is in the line OC produced, &c. Now because OT bisects the arch AB it is perpendicular to the chord AB (6. 2.), therefore GH is parallel to AB (9. 2. and 18. 1.), and HI to BC, therefore the angle GHO=ABO, and IHO=CBO, and hence GHI=ABC; and in like manner it appears, that HIK=BCD, &c. therefore the angles of the circumscribed polygon are equal to those of the inscribed polygon. And because of the parallels, GH : AB :: OH : OB, and HI : BC :: OH : OB, therefore, GH : AB :: HI : BC; but AB=BC; therefore GH=HI. For the same reason HI=IK, &c. therefore, the polygon is regular, and similar to the inscribed polygon.

SECT. VI. OF THE QUADRATURE OF THE CIRCLE.

Axiom.

Fig. 120. IF ABC be an arch of a circle, and AD, CD be two tangents at its extremities, intersecting each other in D; the sum of the tangents AD, DC is greater than the arch ABC.

Fig. 118. Cor. Hence the perimeter of any polygon described about a circle, is greater than the circumference of the circle.

Proposition I. Theorem.

Fig. 119. Equilateral polygons, ABCDEF, GHIKLM, of the same number of sides inscribed in circles are similar, and are to one another as the squares of the radii of the circles.

As each of the polygons is by hypothesis equilateral, it will also be equiangular (Schol. 22. 5.). Let us suppose, for example, that the polygons are hexagons; then, as the sum of the angles is the same in both, viz. eight right angles (25. 1.), the angle A will be one-sixth part of eight right angles, and the angle G will be the same; therefore A=G; in like manner B=H, C=K, &c. and as the figures are equilateral, AB : GH :: BC : HI :: CD : IK, &c. therefore (2. def. 4.) the figures are similar. Draw AO, BO, GP, HP to the centres of the circles; then, because the angle AOB is the same part of four right angles that the arch AB is of the whole circumference; and the angle GPH the same part of four right angles that GH is of the whole circumference (13. 2.) the angles AOB, GPH are each the same part of four right angles; therefore they are equal; the isosceles triangles AOB, GPH are therefore similar, (22. 4.) and consequently AB : GH :: AO : GP, therefore (9. and 27. 4.) polygon ABCDEF : polygon GHIKLM :: $AO^2 : GP^2$.

Prop. II. Theorem.

Fig. 121. A circle being given, two similar polygons may be found, the one inscribed in the circle, and the other described about it, which shall differ from each other by a space less than any given space.

Let AG be the side of a square equal to the given space; and let ABG be such an arch of the given circle, that AG is its chord. Bisect the fourth part of the circumference, (5. 5.) then bisect one of its halves, and proceed in this manner, till, by repeated bisections, there will at length be found an arch AB less than AG. As the arch thus found will be contained in the circumference a certain number of times exactly, its chord AB is the side of a regular figure inscribed in the circle; apply lines in the circle, each equal to AB, thus forming the regular figure ABC, &c. and describe a regular figure DEF, &c. of the same number of sides about the circle. Then, the excess of the circumscribed figure above the inscribed figure shall be less than the square upon AG. For draw lines from D and E to O the centre; these lines will pass through A and B (24. 5.); also, a line drawn from O, to H the point of contact of the line DE, will bisect AB, and be perpendicular to it; and AB will be parallel to DE. Draw the diameter AL, and join BL, which will be parallel to HO (18. 4.). Put P for the circumscribed polygon, and p for the inscribed polygon; then, because the triangles ODH, OAK are evidently like parts of P and p, P : p :: ODH : OAK (1. 3.); but the triangles ODH, OAK being similar, ODH : OAK :: $OH^2 : OK^2$ (25. 4.), and on account of the similar triangles OAK, LAB, OA^2 or $OH^2 : OK^2 :: LA^2\ LB^2$ (20. and 9. 4.); therefore, $P : p :: LA^2 : LB^2$, and by division and inversion, $P : P-p :: LA^2 : LA^2-LB^2$, or AB^2; but LA^2, that is, the square described about the circle, is greater than the equilateral polygon of eight sides described about the circle, because it contains that polygon, and for the same reason the polygon of eight sides is greater than the polygon of sixteen sides, and so on; therefore $LA^2 > P$, and as it has been proved that $P : P-p :: LA^2 : AB^2$, of which proportion, the first term P is less than the third LA^2; therefore (2. 3.) the second $P-p$ is less than the fourth AB^2, but $AB^2 < AG^2$, therefore $P-p < AG^2$.

Cor. 1. Because the polygons P and p differ from one another more than either of them differs from the circle, the difference between each of them, and the circle, is less than the given space, viz. the square of AG. And therefore, however small any space may be, be, a polygon may be inscribed in the circle, and another described about it, each of which shall differ from the circle by less than the given space.

Cor. 2. A space which is greater than any polygon that can be inscribed in a circle, but which is less than any polygon that can be described about it, is equal to the circle itself.

Prop. III. Theorem.

Fig. 121. The area of any circle is equal to a rectangle contained by the radius, and a straight line equal to half the circumference.

Let ABC, &c. be any equilateral polygon inscribed in the circle, and DEF, &c. a similar polygon described about it; draw lines from the extremities of AB and DE a side of each polygon to O the centre; and let OKH be perpendicular to these sides. Put P for the perimeter of the polygon DEF, &c. and p for the perimeter of the polygon ABC, &c. and n for the number of the sides of each. Then, because $n \times \frac{1}{2}\text{DE} = \frac{1}{2}\text{P}$, $n \times \frac{1}{2}\text{DE} \times \text{OH} = \frac{1}{2}\text{P} \times \text{OH}$, but $n \times \frac{1}{2}\text{DE} \times \text{OH} = n \times$ triangle DOE = polygon DEE, &c. therefore, $\frac{1}{2}\text{P} \times \text{OH} =$ polygon DEF, &c.; and in like manner it appears, that $\frac{1}{2}p \times \text{OK} =$ polygon ABC, &c. Now let Q denote the circumference of the circle, then, because $\frac{1}{2}\text{Q} > \frac{1}{2}p$, and OH > OK, therefore $\frac{1}{2}\text{Q} \times \text{OH} > \frac{1}{2}p \times \text{OK}$, that is $\frac{1}{2}\text{Q} \times \text{OH}$ is greater than the inscribed polygon. Again, because $\frac{1}{2}\text{Q} < \frac{1}{2}\text{P}$ (axiom), therefore $\frac{1}{2}\text{Q} \times \text{OH} < \frac{1}{2}\text{P} \times \text{OH}$, that is, $\frac{1}{2}\text{Q} \times \text{OH}$ is less than the circumscribed polygon: Thus it appears that $\frac{1}{2}\text{Q} \times \text{OH}$ is greater than any polygon inscribed in the circle, but less than any polygon described about it; therefore, $\frac{1}{2}\text{Q} \times \text{OH}$ is equal to the circle (2.)

Prop. IV. Theorem.

Fig. 119. The areas of circles are to one another as the squares of their radii.

Let ABCDEF and GHIKLM be equilateral polygons of the same number of sides inscribed in the circles, and OA, PG their radii; and let Q be such a space, that $\text{AO}^2 : \text{GP}^2 ::$ circle ABD : Q; then, because $\text{AO}^2 : \text{GP}^2 ::$ polygon ABCDEF : polygon GHIKLM, and $\text{AO}^2 : \text{GP}^2 ::$ circle ABE : Q, therefore polygon ABCDEF : polygon GHIKLM :: circle ABE : Q; but circle ABE > polygon ABCDEF, therefore Q > polygon GHIKLM; that is, Q is greater than any polygon inscribed in the circle GHL. In the same manner it is demonstrated that Q is less than any polygon described about the circle GHL; therefore Q is equal to the circle GHL (2.). And because $\text{AO}^2 : \text{GP}^2 ::$ circle ABD : Q, therefore $\text{AO}^2 : \text{GP}^2 ::$ circle ABE : circle GHL.

Cor. 1. The circumferences of circles are to one another as their radii. Put M for half the circumference of the circle ABE and N for half the circumference of GKL; then, circle ABE : circle GHL :: $\text{AO}^2 : \text{GP}^2$; but $\frac{1}{2}\text{M} \times \text{AO} =$ circle ABE, also $\frac{1}{2}\text{N} \times \text{GP} =$ circle GHL, (3.) therefore $\frac{1}{2}\text{M} \times \text{AO} : \frac{1}{2}\text{N} \times \text{GP} :: \text{AO}^2 : \text{GP}^2$, and by alternation $\frac{1}{2}\text{M} \times \text{AO} : \text{AO}^2 :: \frac{1}{2}\text{N} \times \text{GP} : \text{GP}^2$, therefore (3. 4.) $\frac{1}{2}\text{M} : \text{AO} :: \frac{1}{2}\text{N} : \text{GP}$, and again by alternation $\frac{1}{2}\text{M} : \frac{1}{2}\text{N} :: \text{AO} : \text{GP}$, therefore M : N :: AO : GP.

Cor. 2. A circle described with the hypothenuse of a right-angled triangle as a radius, is equal to two circles described with the other two sides as radii. Let the sides of the triangle be a, b and the hypothenuse h, and let the circles described with these lines as radii be A, B and H.

because $\text{A} : \text{H} :: a^2 : h^2$
and $\text{B} : \text{H} :: b^2 : h^2$,
therefore $\text{A} + \text{B} : \text{H} :: a^2 + b^2 : h^2$ (8. 3.)
but $a^2 + b^2 = h^2$ (13. 4.), therefore A + B = H.

Prop. V. Problem.

Fig. 122. Having given the area of a regular polygon inscribed in a circle, and also the area of a similar polygon described about it; to find the areas of regular inscribed and circumscribed polygons, each of double the number of sides.

Let AB be the side of the given inscribed polygon, and EF parallel to AB that of the similar circumscribed polygon, and C the centre of the circle; if the chord AM, and the tangents AP, BQ be drawn, the chord AM shall be the side of the inscribed polygon of double the number of sides; and PQ or 2PM that of the similar circumscribed polygon. Put A for the area of the polygon, of which AB is a side, and B for the area of the circumscribed polygon; also a for the area of the polygon of which AM is a side, and b for the area of the similar circumscribed polygon; then A and B are by hypothesis known, and it is required to find a and b.

I. The triangles ACD, ACM, which have a common vertex A, are to one another as their bases CD, CM; besides, these triangles are to one another as the polygons, of which they form like parts, therefore A : a :: CD : CM. The triangles CAM, CME, which have a common vertex M, are to each other as their bases CA, CE; they are also to one another as the polygons a and B, of which they are like parts; therefore, a : B : : CA : CE; but because of the parallels DA, ME, CD : CM : : CA : CE; therefore, A : a : : a : B; therefore, the polygon a, which is one of the two required, is a mean proportional between the two known polygons A and B, so that $a = \sqrt{\text{A} \times \text{B}}$.

II. The triangles CPM, CPE, having the same altitude CM, are to one another as PM to PE. But as CP bisects the angle MCE, PM : PE : : CM : CE (19. 4.) : : CD : CA : : A : a; therefore, CPM : CPE : : A : a; and consequently CPM + CPE, or CME : CPM : : A + a : A, and CME : 2 CPM : : A + a : 2 A; but CME and 2 CPM, or CMPA, are to one another as the polygons B and b, of which they are like parts; therefore, A + a : 2 A : : B : b. Now the polygon a has been already found, therefore by this last proportion the polygon b is determined; that is, $b = \frac{2\,\text{A} \times \text{B}}{\text{A} + a}$.

Prop. VI. Problem.

To find nearly the ratio of the circumference of a circle to its diameter.

Let the radius of the circle = 1, then, the sides of the inscribed square being the hypothenuse of a right-angled triangle of which the radii are the sides, (see fig.

fig. 115.) the area of the infcribed fquare will be 2; (13. 4.) and the circumfcribed fquare, being the fquare of the diameter, will be 4. Now, retaining the notation of laft problem, if we make A=2 and B=4, the formulæ $a=\sqrt{A\times B}$, $b=\frac{2A\times B}{A+a}$ give us $a=2.8284271$, &c. the area of the infcribed octagon, and $b=3.3137085$, &c. the area of the circumfcribed octagon. By fubftituting thefe numbers in the formula, inftead of A and B, we fhall obtain the areas of the infcribed and circumfcribing polygons of 16 fides; and thence we may find thofe of 32 fides, and fo on as in the following table:

N° *of fides.*	*Ins. Polygons.*	*Circ. Polygons.*
4	2.0000000	4.0000000
8	2.8284271	3.3137085
16	3.0614674	3.1825979
32	3.1214451	3.1517249
64	3.1365485	3.1441184
128	3.1403311	3.1432236
256	3.1412772	3.1417504
512	3.1415138	3.1416321
1024	3.1415729	3.1416025
4096	3.1[illegible]159[illegible]4	3.1415933
8192	3.14159[illegible]3	3.1415928
16384	3.1415925	3.1415927
32768	3.14[illegible]5926	3.1415926

Hence it appears that areas of a regular polygon of 32768 fides infcribed in the circle, and of a fimilar polygon defcribed about it, differ fo little from each other that the numbers which exprefs them are the fame as far as the eighth decimal place. And as the circle is greater than the one polygon, and lefs than the other, its area will be nearly 3.1415926. But the area is the product of the radius and the half of the circumference; therefore, the radius being unity or half the circumference is 3.1415926 nearly; and the radius is to half the circumference, or the diameter is to the circumference, nearly as 1 to 3.1415926.

Scholium.

In this way the ratio of the diameter to the circumference may be found to any degree of accuracy; but neither by this, nor any other method yet known, can the ratio be exactly determined.

Archimedes by means of infcribed and circumfcribed polygons of 96 fides, found that the diameter is to the circumference as 7 to 22, nearly, which ratio is nearer to the truth than can be expreffed by any fmaller numbers; and Metius found it to be more nearly as 113 to 355. Both of thefe expreffions are convenient on account of the fmallnefs of the numbers, but later mathematicians have carried the approximation to a much greater degree of accuracy. Thus, it has been found that the diameter being 1, the circumference is greater than 3.14159265358979932, but lefs than the fame number having its laft figure increafed by unity; and fome have even had the patience to carry the approximation as far as the 150th place of decimals.

SECT. VII.

Definitions.

I. A ftraight line is *perpendicular*, or at right angles, to a plane, when it is perpendicular to every ftraight line meeting it in that plane. The plane is alfo perpendicular to the line.

II. A line is *parallel* to a plane, when they cannot meet each other, although both be produced. The plane is alfo parallel to the line.

III. Parallel planes are fuch as cannot meet each other, though produced.

IV. It will be demonftrated (Theor. 3.) that the common fection of two planes is a ftraight line; this being premifed, the *inclination* of two planes is the angle contained by two ftraight lines drawn perpendicular to the line, which is their common fection, from any point in it, the one perpendicular being drawn in the one plane, and the other in the other plane.

This angle may be either acute or obtufe.

V. If it be a right angle the two planes are perpendicular to each other.

VI. A *folid angle* is that which is made by the meeting of more than two plane angles, which are not in the fame plane, in one point. Thus the folid angle S is formed by the plane angles ASB, BSC, CSD, DSA.

Theorem I.

One part of a ftraight line cannot be in a plane and another part above it.

For from the definition of a plane (7. def. 1.) it is manifeft that if a ftraight line coincide with a plane in two points it muft be wholly in the plane.

Theorem II.

Two ftraight lines which cut each other in a plane determine its pofition; that is, the plane can coincide with thefe lines only in one pofition. Plate CCXLIV. Fig. 123.

Let the ftraight lines AB, AC cut each other in A; conceive a plane to pafs through AB, and to be turned about that line, till it pafs through the point C; and this it can manifeftly do only in one pofition; then, as the points A and C are in the plane, the whole line AC muft be in the plane; therefore there is only one pofition in which the plane can coincide with the fame two lines AB, AC.

Cor. Therefore, a triangle ABC, or three points A, B, C not in a ftraight line, determine the pofition of a plane.

Theorem III.

If two planes AB, CD interfect each other, their interfection is a ftraight line. Fig. 123.

Let E and F be two points in the line of common fection, and let a ftraight line EF be drawn between them; then the line EF muft be in the plane AB, (7.

2

(7. def. 1.) and the same line must also be in the same plane CD, therefore it must be the common section of them both.

THEOREM IV.

Fig. 125. If a straight line AP is perpendicular to two straight lines PB, PC at P the point of their intersection; it will also be perpendicular to the plane MN, in which these lines are.

DRAW any other line PQ in the plane MN, and from Q any point in that line draw QD parallel to PB; make DC=DP; join CQ, meeting PB in B; and join AB, AQ, AC. Because DQ is parallel to PB, and PD=DC; therefore BQ=QC, and BC is bisected in Q: Hence in the triangle BAC,

$$AB^2+AC^2=2AQ^2+2BQ^2, \text{ (16. 4.)}$$

and in the like manner, in the triangle PBC,

$$PB^2+PC^2=2PQ^2+2CQ^2;$$

therefore, taking equal quantities from equal quantities, that is, subtracting the two last quantities, which are put equal to each other, from the two first, and observing, that as APB, APC are by hypothesis right-angled triangles, $AB^2-BP^2=AP^2$, and $AC^2-CP^2=AP^2$, we have

$$AP^2+AP^2=2AQ^2-2PQ^2,$$

and therefore $AP^2=AQ^2-PQ^2$, or $AP^2+PQ^2=AQ^2$; therefore the triangle APQ is right-angled at P, (schol. 15. 4.) and consequently AP is perpendicular to the plane MN (Def. 1.).

COR. 1. The perpendicular AP is shorter than any oblique line AQ, therefore it measures the distance of the point A from the plane.

COR. 2. From the same point P in a plane no more than one perpendicular can be drawn. For if it be possible that there can be two perpendiculars, conceive a plane to pass through them, and to intersect the plane MN in the straight line PQ; then these perpendiculars will be in the same plane, and both perpendicular to the same line PQ, at the same point P in that line, which is impossible.

It is also impossible that from a point without a plane two perpendiculars can be drawn to the plane; for if the straight lines AP, AQ could be two such perpendiculars, then the triangle APQ would have two right angles, which is impossible.

THEOREM V.

Fig. 126. If a straight line AP be perpendicular to a plane MN, every straight line DE parallel to AP is perpendicular to the same plane.

LET a plane pass through the parallel lines AP, DE, and intersect the plane MN in the line PD; through D draw BC at right angles to PD; take DC=DB, and join PB, PC, AB, AC, AD. Because DB=DC, therefore PB=PC; (cor. 5. 1.) and because AP is perpendicular to the plane MN, so that APB, APC are right angles, AB=AC, (cor. 5. 1.) therefore ABC is an isosceles triangle; and since its base BC is bisected at D, BC is perpendicular to AD; (schol. 11. 1.) but by construction BC is perpendicular to PD; therefore (4.) BC or BD is perpendicular to the plane passing through the lines AD and PD, or AP and DE; hence ED is perpendicular to DE, but PD is also perpendicular to DE, (19. 1.) therefore DE is perpendicular to the two lines DP, DB; and therefore it is perpendicular to the plane MN passing through them.

COR. 1. Conversely, if the straight lines AP, DE are perpendicular to the same plane MN, they are parallel; for if not, through D draw a parallel to AP; this parallel will be perpendicular to the plane MN, (by the theorem) therefore, from the same point D two perpendiculars may be drawn to a plane, which is impossible (4.).

COR. 2. Two straight lines A and B which are parallel to a third line C, though not in the same plane, are parallel to each other. For suppose a plane to be perpendicular to the line C, the lines A and B parallel to this perpendicular are perpendicular to the same plane; therefore, by the preceding corollary they are parallel between themselves.

THEOREM VI.

Two planes MN, PQ, perpendicular to the same straight line AB, are parallel to each other. Fig. 127.

FOR, if they can meet each other, let O be a point common to both, and join OA, OB; then the line AB, which is perpendicular to the plane MN, must be perpendicular to AO, a line drawn in the plane MN from the point in which AB meets that plane. For the same reason AB is perpendicular to BO; therefore, OA, OB are two perpendiculars drawn from the same point O, to the same straight line AB, which is impossible.

THEOREM VII.

The intersections EF, GH of two parallel planes MN, PQ with a third plane FG, are parallel: Fig. 128.

FOR if the lines EF, GH, situated in the same plane, are not parallel, they must meet if produced; therefore, the planes MN, PQ, in which they are, must also meet, which is contrary to the hypothesis of their being parallel.

THEOREM VIII.

Any straight line AB, perpendicular to MN one of two parallel planes MN, PQ, is also perpendicular to PQ the other plane. Fig. 127.

FROM B draw any straight line BC in the plane PQ, and let a plane pass through the lines AB, BC, and meet the plane MN in the line AD, then AD will be parallel to BC, (7.) and since AB is perpendicular to the plane MN, it must be perpendicular to the line AD, therefore, it is also perpendicular to BC; (19. 1.) hence (Def. 1.) the line AB is perpendicular to the plane PQ.

THEOREM IX.

Parallel straight lines EG, FH, comprehended between two parallel planes MN, PQ, are equal. Fig. 128.

LET a plane pass through the lines EG, FH, and meet

meet the parallel planes in EF and GH; then EF and GH are parallel (7.) as well as EG and FH; therefore, EGHF is a parallelogram, and EFG=H.

Cor. Hence two parallel planes are everywhere at the ſame diſtance from each other. For, if EF and GH are perpendicular to the two planes, they are parallel, (1. cor. 5.) therefore they are equal.

Theorem X.

Fig. 129. If two ſtraight lines CA, EA, meeting one another, be parallel to two other lines DB, FB, that meet one another, though not in the ſame plane with the firſt two; the firſt two and the other two ſhall contain equal angles, and the plane paſſing through the firſt two ſhall be parallel to the plane paſſing through the other two.

Take AC=BD, AE=BF, and join CE, DF, AB, CD, EF. Becauſe AC is equal and parallel to BD, the figure ABDC is a parallelogram; therefore, CD is equal and parallel to AB. For a ſimilar reaſon EF is equal and parallel to AB; therefore alſo CE is equal and parallel to DF (2 cor. 5. and 28. 1.); therefore the triangles CAE, DBF are equal, (10. 1.) hence the angle CAE=DBF.

In the ſecond place, the plane ACE is parallel to the plane BDF: For ſuppoſe that the plane parallel to BDF, paſſing through the point A, meets the lines CD, EF in any other points than C and E (for example in G and H,) then (9.) the three lines AB, GD, FH are equal; but the three lines AB, CD, EF have been ſhewn to be equal; therefore, CD=GD, and FH=EF, which is abſurd, therefore the plane ACE is parallel to BDF.

Theorem XI.

Fig. 130. If a ſtraight line AP be perpendicular to a plane MN, any plane APB, paſſing through AP, ſhall be perpendicular to the plane MN.

Let BC be the interſection of the planes AB, MN; if in the plane MN the line DE be drawn perpendicular to BP, the line AP, being perpendicular to the plane MN, ſhall be perpendicular to each of the ſtraight lines BC, DE; therefore the angle APD is a right angle; now PA and PD are drawn in the planes AB, MN perpendicular to their common ſection, therefore (5. Def.) the planes AB, MN are perpendicular to each other.

Scholium.

When three ſtraight lines, ſuch as AP, BP, DP, are perpendicular to each other, each is perpendicular to the plane of thetwo other lines.

Theorem XII.

Fig. 130. If the plane AB is perpendicular to the plane MN; and in the plane AB a ſtraight line PA be drawn perpendicular to BP, the common interſection of the planes, then ſhall PA be perpendicular to the plane MN.

For, if in the plane MN, a line PD be drawn perpendicular to PB, the angle APD ſhall be a right angle, becauſe the planes are perpendicular to each other, therefore, the line AP is perpendicular to the two lines PB, PD, therefore it is perpendicular to their plane MN.

Cor. If the plane AB be perpendicular to the plane MN, and from any point P, in their common interſection, a perpendicular be drawn to the plane MN; this perpendicular ſhall be in the plane AB; for if it is not, a perpendicular AP may be drawn in the plane AB to the common interſection BP, which will be at the ſame time perpendicular to the plane MN; therefore, at the ſame point P, there may be two perpendiculars to a plane NM, which is impoſſible (4.).

Theorem XIII.

If two planes AB, AD are perpendicular to a third, their common interſection AP is perpendicular to the third plane. Fig. 130.

For, if through the point P, a perpendicular be drawn to the plane MN, this perpendicular ſhall be in the plane AB, and alſo in the plane AD, (cor. 12.) therefore it is at their common interſection AP.

Theorem XIV.

If two ſtraight lines be cut by parallel planes, they ſhall be cut in the ſame ratio. Fig. 131.

Let the line AB meet the planes MN, PQ, RS in A, E, B; and let CD meet them in C, F, D, then ſhall AE : EB :: CF : FD. For draw AD meeting the plane PQ in G, and join AC, EG, GF, BD; the lines EG, BD, being the common ſections of the plane of the triangle ABD and the parallel planes PQ, RS, are parallel (7.) and in like manner it appears, that AC, GF are parallel; therefore AE : EB (:: AG : GD) :: CF : FD.

Theorem XV.

If a ſolid angle be contained by three plane angles, the ſum of any two of theſe is greater the third. Fig. 132

It is evidently only neceſſary to demonſtrate the theorem, when the plain angle which is compared with the ſum of the other two is greater than either of them; for, if it were equal to or leſs than one of them, the theorem would be manifeſt: therefore let S be a ſolid angle formed by three plane angles ASB, ASC, BSC, of which ASB is the greateſt. In the plane ASB make the angle BSD=BSC; draw any ſtraight line ADB, and having taken SC=SD, join AC, BC; the triangles BSC, BSD having two ſides, and the included angle of the one equal to two ſides, and the included angle of the other, each to each, are equal (5. 1.), therefore BD=BC; now AB ∠ AC+BC, therefore, taking BD from the firſt of theſe unequal quantities, and BC from the ſecond, we get AD ∠ AC; and as the triangles ASD, ASC have SD=SC, and SA common to both, and AD ∠ AC, therefore (9. 1.) the angle ASD ∠ ASC; and, adding DSB to the one, and CSB to the other, ASB ∠ ASC+BSC.

Theorem XVI.

If each of two ſolid angles be contained by three Fig. 133. plane

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plane angles equal to one another, each to each, the planes in which the equal angles are, have the ſame inclination to one another.

Let the angle ASB=DTE, the angle ASC =DTF, and the angle BSC=ETF; the two planes ASB, ASC, ſhall have to each other the ſame inclination as the two planes DTE, DTF.

Take A any point in SA, and in the two planes ASB, ASC, draw AB and AC perpendiculars to AS, then (def. 4.) the angle BAC is the inclination of theſe planes; again, take TD=SA, and in the planes TDE, TDF draw DE and DF perpendiculars to TD, and the angle EDF ſhall be the inclination of theſe other planes; join BC, EF. The triangles ASB, DTE have the ſide AS=DT, the angle SAB=TDE and ASB=DTE, therefore the triangles are equal, and thus AB=DE, and SB=TE: In like manner it appears that the triangles ASC, DTF are equal, and therefore, that AC=DF, and SC=TF. Now the triangles BSC, ETF, having BS=TE, SC=TF, and the angle BSC=ETF, are alſo equal, and therefore BC=EF; but it has been ſhewn that AB=DE, and that AC=DF; therefore the triangles BAC, EDF are equal, and conſequently the angle BAC=EDF; that is, the inclination of the planes ASB and ASC is equal to the inclination of the planes DTE and DTF. In the ſame manner it may be proved that the other planes have the ſame inclination to one another.

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Scholium.

If the three plane angles which contain the ſolid angles, are equal each to each, and if beſides the angles are alſo *diſpoſed in the ſame order* in the two ſolid angles, then theſe angles when applied to one another will coincinde, and be equal. But if the plane angles be *diſpoſed in a contrary order*, the ſolid angles will not coincide, although the theorem is equally true in both caſes. In this laſt caſe the ſolid angles are called *Symmetrical angles*.

SECT. VIII. OF SOLIDS BOUNDED BY PLANES.

Definitions.

I. A Solid is that which has length, breadth, and thickneſs.

II. A *Priſm* is a ſolid contained by plane figures, of which two that are oppoſite are equal, ſimilar, and parallel; and the others are parallelograms.

Fig. 134. To conſtruct this ſolid, let ABCDE be any polygon; if in a plane parallel to ABC there be drawn ſtraight lines FG, GH, HI, &c. equal and parallel to the ſides AB, BC, CD, &c. ſo as to form a polygon FGHIK equal to ABCDE, and ſtraight lines AF, BG, CH, &c. be drawn, joining the vertices of the homologous angles in the two planes; the planes or faces ABGF, BCHG, &c. thus formed will be parallelograms; and the ſolid ABCDEFGHIK contained by theſe parallelograms and the two polygons, is the priſm itſelf.

III. The equal and parallel polygons ABCDE, FGHIK are called the *Baſes* of the priſm, and the diſtance between the baſes is its *Altitude*.

Fig. 135. IV. When the baſe of a priſm is a parallelogram, and conſequently the figure has all its faces parallelograms, it is called a *parallelopiped*. A parallelopiped is *rectangular* when all its faces are rectangles.

V. A *Cube* is a rectangular parallelopiped contained by ſix equal ſquares.

Plate CCXLV. Fig. 144. VI. A *Pyramid* is a ſolid contained by ſeveral planes, which meet in the ſame point A, and terminate in a polygonal plane BCD.

VII. The polygon ABCDE is called the *Baſe* of of the pyramid; the point S is its *Vertex;* and a perpendicular let fall from the vertex upon the baſe is called its *Altitude*.

VIII. Two ſolids are *ſimilar*, when they are contained by the ſame number of ſimilar planes, ſimilarly ſituated, and having like inclinations to one another.

Theorem I.

Plate CCXLIV. Fig. 134.

Two priſms are equal when the three planes which contain a ſolid angle of the one are equal to the three planes which contain a ſolid angle of the other, each to each, and are ſimilarly ſituated.

Let the baſe ABCDE be equal to the baſe *a b c d e*, the parallelogram ABGF equal to the parallelogram *a b g f*, and the parallelogram BCHG equal to the parallelogram *b c h g;* the priſm ABCI ſhall be equal to the priſm *a b c i*.

For let the baſe ABCDE be applied to its equal the baſe *a b c d e*, ſo that they may coincide with each other; then, as the three plane angles which form the ſolid angle B are equal to the three plane angles which form the angle *b*, each to each, viz, ABC=*a b c* ABG=*a b g*, and GBC=*g b c*, and as theſe angles are ſimilarly ſituated, the ſolid angles B and *b* are equal (15. 7.) therefore the ſide BG ſhall fall upon the ſide *b g;* and becauſe the parallelograms ABGF, *a b g f* are equal, the ſide FG ſhall fall upon its equal *f g;* in like manner it may be ſhewn, that GH falls upon *g h*, therefore the upper baſe FGHIK coincides entirely with its equal *f g h i k*, and the two ſolids coincide with each other, or occupy the ſame ſpace, therefore the priſms are equal.

Scholium.

A priſm is entirely determined, when its baſe ABCDE is known, and its edge BG is given in magnitude and poſition; for if through the point G, GF be drawn equal and parallel to AB, and GH equal and parallel to BC, and the polygon FGHIK be deſcribed equal to ABCDE (20.5.), it is evident that the points

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points FKI will have determinate positions; therefore any two prisms constructed with the same *data* cannot be unequal.

Theorem II.

Fig. 135. In any parallelopiped the opposite planes are equal and parallel.

From the nature of the solid (4. def.) the bases ABCD, EFGH are equal parallelograms, and their sides are parallel, therefore the planes AC, EG are parallel; and because AD is equal and parallel to BC, and AE is equal and parallel to BF, the angle DAE =CBF, and the plane DAE is parallel to the plane CBF, (10. 7.) therefore also the parallelogram DAEH is equal to the parallelogram CBFG. It may in like manner be demonstrated, that the opposite parallelograms ABFE, DCGH are equal and parallel.

Cor. Hence, in a parallelopiped, any one of the six planes which contain it may be taken for its base.

Theorem III.

Fig. 136. The plane BDHF, which passes through two parallel opposite edges BF, DH, of a parallelopiped AG, divides it into two triangular prisms ABDHEF, GHFBCD, equal to one another.

For the triangles ABD, EFH, having their sides equal and parallel, are equal, and the lateral faces ABFE, ADHE, BDHF are parallelograms; therefore the solid ABDHEF is a prism; for like reasons the solid GHFBCD is a prism. Again, because the plane angles which contain the solid angle at G are equal to those which contain the solid angle at A, viz. the angle FGH=DAB, FGC=DAE, and HGC =BAE, the planes in which these angles are have the same inclination to one another, (16.7.) as, however, these angles are not disposed in the same order, but in a contrary order, the solid angles cannot be made to coincide with one another, and consequently the prisms cannot be proved equal by superposition, as in Theorem I. Their equality may however be established by reasoning thus:

The inclination of each of any two adjacent faces of a prism to the base, and the length of an edge being given, the prism is evidently restricted to one determinate magnitude; and it will evidently have the same magnitude whichsoever of the two sides of the base it may stand upon; that is, whether it be constructed above or below the base. Now if the upper base FGH of the one prism be applied to the lower base DAB of the other, so that the sides FG, GH, FH may be upon the sides DA, AB, DB equal to them, then the prism GHFBCD will have the position ABDHEF′; and the two faces ABF′E′, ADH′E′ of the prism below the base will have each the same inclination to it, as the equivalent faces ABFE, ADHE of the prism above the base; and the edge AE′ is equal to the edge AE; therefore the conditions which determine the magnitude of both prisms are identical, and consequently the prisms are equal.

Theorem IV.

If two parallelopipeds AG, AL have a common base ABCD, and have their upper bases in the same plane, and between the same parallel straight lines EK, HL, the two parallelopipeds are equivalent to each other. Fig. 137. Fig. 138.

Because AE is parallel to BF, and HE to GF, the angle AEI=BFK, HEI=GFK, and HEA =GFB; of these six angles the three first form the solid angle E, and the three others form the solid angle F; therefore, since the plane angles are equal each to each, and similarly situated, the solid angles E and F are equal. Now if the prism AEIDHM be applied to the prism BFKCGL, so that their bases AEI, BFK, which are equal, may coincide with each other, then, because the solid angle E is equal to the solid angle F, the side EH shall fall upon FG, and this is all that is necessary to prove that the two prisms coincide entirely, for the base AEI and the edge EH determine the prism AEM, and the base BFK and the edge FG determine the prism BFL; therefore the prisms are equal. But if from the solid AEL, the prism AEM be taken away, here will remain the parallelopiped AIL; and if from the same solid AEL, the prism BFL be taken away, there will remain the parallelopiped AEG; therefore the parallelopipeds AIL, AEG are equivalent to each other.

Theorem V.

Parallelopipeds upon the same base, and having the same altitude, are equivalent to one another. Fig. 139.

Let ABCD be the common base of the two parallelopipeds AG, AL, which, because they have the same altitude, will have their upper bases in the same plane; then, because EF and AB are equal and parallel, as also IK and AB; EF is parallel to IK, (cor. 2. 5. 7.) for a similar reason GF is parallel to LK. Let the sides EF, HG, as also the sides LK, IM, be produced, so as to form by their intersections the parallelogram NOPQ; it is manifest that this parallelogram is equal to each of the bases EFGH, IKLM. Now, if we suppose a third parallelopiped, which, with the same lower base ABCD, has for its upper base NOPQ, this third parallelopiped will be equivalent to the parallelopiped AG, (4.) for the same reason the third parallelopiped will be equivalent to the parallelopiped AL; therefore the two parallelopipeds AG, AL, which have the same base and the same altitude, are equivalent to one another.

Theorem VI.

Any parallelopiped AG is equivalent to a rectangular parallelopiped, having the same altitude, and an equivalent base. Fig. 139. 140.

At the points A, B, C, D, let AI, BK, CL, DM, be drawn perpendicular to the plane ABCD, and terminating in the plane of the upper base; then, IK, KL, KL, LM, MI, being joined, a parallelopiped AL will thus be formed, which will manifeſtly have its lateral faces AK, BL, CM, DI rectangles; and if the baſe AC is alſo a rectangle, the ſolid AL will be a rectangular parallelopiped equivalent to the parallelopiped AG. But if ABCD is not a rectangle, (fig. 140.) draw AO and BN perpendicular to CD, and OQ and NP perpendicular to DC, meeting ML in Q and P; the ſolid ABNOIKPQ will manifeſtly be a rectangular parallelopiped, which will be equal to the parallelopiped AL, for they have the ſame baſe ABKI, and the ſame altitude, viz. AO; therefore the rectangular parallelopiped AP is equivalent to the parallelopiped AG, (fig. 139.) and they have the ſame altitude, and the baſe ABNO of the former is equivalent to the baſe ABCD of the latter.

Theorem VII.

Fig. 134. Any ſection NOPQR of a priſm, made by a plane parallel to its baſe ABCDE, is equal to the baſe.

For the parallels AN, BO, CP contained between the parallel planes ABC, NOP are equal (9. 7.); and thus all the figures ABON, BCPO, &c. are parallelograms; hence the ſide ON=AB, OP=BC, PQ=CD, &c. alſo, the equal ſides are parallel, therefore, the angle ABC=NOP, the angle BCD=OPQ, &c. therefore the two polygons ABCDE, NOPQR, have their ſides and angles equal, each to each; therefore, they are equal.

Plate CCXLV.

Theorem VIII.

Fig. 141. Two rectangular parallelopipeds AG, AL, which have the ſame baſe ABCD, are to each other as their altitudes AE, AI.

Suppose that the altitudes AE, AI are to each other as the numbers p and q, ſo that AE will contain p ſuch equal parts as AI contains q. Let AE and AI be divided into p and q equal parts reſpectively, and let planes paſs through the points of diviſion parallel to the baſe ABCD; thus the parallelopiped AG will be divided into p ſolids, which will alſo be parallelopipeds having equal baſes (7.) and equal altitudes, therefore, they will be equal among themſelves; and in like manner the parallelopiped AL will be divided into q equal ſolids; and as each of the ſolids in AG is equal to each of the ſolids in AL, the parallelopiped AG will contain p ſuch equal parts as the parallelopiped AL contains q; therefore the parallelopiped AG will be to the parallelopiped AL as the number p to the number q, that is, as AE the altitude of the former to AI the altitude of the latter.

Theorem IX.

Fig. 142. Two rectangular parallelopipeds AG, AK, which have the ſame altitude AE, are to each other as their baſes ABCD, AMNO.

Let the two ſolids be placed, the one by the ſide of the other, as repreſented in the figure, and let the plane ONKL be produced, ſo as to meet the plane DCGH in PQ, thus forming a third parallelopiped AQ, which may be compared with each of the parallelopipeds AG, AK. The two ſolids AG, AQ, having the ſame baſe ADHE, are to each other as their altitudes AB, AO, (8.) and, in like manner, the two ſolids AQ, AK, having the ſame baſe AOLE, are to each other as their altitudes AD, AM; that is,

ſolid AG : *ſol.* AQ :: AB : AO
ſol. AQ : *ſol.* AK :: AD : AM;

but AB : AO :: *baſe* AC : *baſe* AP (3. 4.)
and AD : AM :: *baſe* AP : *baſe* AN,

therefore,

ſol. AG : *ſol.* AQ :: *baſe* AC : *baſe* AP,
ſol. AQ : *ſol.* AK :: *baſe* AP : *baſe* AN,

therefore (7. 3.)

ſol. AG : *ſol.* AK :: *baſe* AC : *baſe* AN.

Theorem X.

Rectangular parallelopipeds are to each other as the products of the numbers proportional to their baſes and altitudes, or as the products of the numbers proportional to their three dimenſions. Fig. 142.

Let AG be a parallelopiped, the three dimenſions of which are expreſſed by the lines AB, AD, AE, and AZ another parallelopiped the dimenſions of which are expreſſed by the lines AO, AM, AX. Let the two ſolids AG, AZ be ſo placed, that their ſurfaces may have a common angle BAE; produce ſuch of the planes as are neceſſary ſo as to form a third parallelopiped AK, having the ſame altitude as the parallelopiped AG. By the laſt propoſition

ſol. AG : *ſol.* AK :: *baſe* AC : *baſe* AN,

and by the laſt theorem but one,

ſol. AK : *ſol.* AZ :: AE : AX,

but, conſidering the baſes AC, AN as meaſured by numbers, as alſo the altitudes AE, AX,

baſe AC : *baſe* AN :: AE × *baſe* AC : AE × *baſe* AN
and AE : AX :: AE × *baſe* AN : AX × *baſe* AN

therefore,

ſol. AG : *ſol.* AK :: AE × *baſe* AC : AE × *baſe* AN,
ſol. AK : *ſol.* AZ :: AE × *baſe* AN : AX × *baſe* AN,

therefore, (7. 3.)

ſol. AG : *ſol.* AZ :: AE × *baſe* AC : AX × *baſe* AN;

which proportion, by ſubſtituting for the baſes AC, AN their numerical values AB × AD and AO × AM becomes

ſol. AG : *ſol.* AZ :: AB × AD × AE : AO × AM × AX.

Scholium.

Hence it appears that the product of the baſe of a rectangular parallelopiped by its altitude or the product of its three dimenſions, may be taken for its numerical meaſure;

measure; and it is upon this principle that all other solids are estimated. When two parallelopipeds are compared together by means of their bases and altitudes, their bases must be considered as measured by the same superficial unit, and their altitudes by the same linear unit; thus if spaces P and Q denote two parallelopipeds, and the base of P contain three such equal spaces as that of Q contains four; and the altitude of P contains two such equal lines, as that of Q contains five, then, P : Q :: 3×2 : 4×5 :: 6 : 20.

If all the dimensions of each solid are used in comparing them together, then the same linear unit must be employed in estimating all the dimensions of both solids; thus, if the length, breadth, and height of the solid P be four, three, and six linear units, respectively; and those of Q, seven, two, and five, of the same unit; then P : Q :: 4×3×6 : 7×2×5 :: 72 : 70.

As lines are compared together by considering how often each contains some other line taken as a measuring unit, and surfaces by considering how often each contains a square whose side is that unit; so solids may be compared, by considering how often each contains a cube, the side or edge of which is the same linear unit. Accordingly, the dimensions of the parallelopipeds P and Q being as we have just now supposed, the proportion P : Q :: 72 : 70 may be considered as indicating that P contains 72 such equal cubes as Q contains 70.

The magnitude of a solid, its bulk, or its extension constitutes its *solidity*, or its *content*; thus we say, that the solidity or the content of a rectangular parallelopiped is equal to the product of its base by its altitude; or to the product of its three dimensions.

Theorem XI.

The solidity of any parallelopiped, or in general of any prism, is equal to the product of its base by its altitude.

1. Any parallelopiped is equivalent to a rectangular parallelopiped of the same altitude, and an equivalent base (6.); and it has been shewn, that the solidity of such a parallelopiped is equal to the product of its base and altitude.

2. Every triangular prism is the half of a parallelopiped of the same altitude, but having its base double that of the prism (3.); therefore, the solidity of the prism is half that of the parallelopiped, or it is half the product of the base of the parallelopiped by its altitude, that is, it is equal to the product of the base of the prism by its altitude.

3. Any other prism may be divided into as many triangular prisms as the polygon which forms its base can be divided into triangles, but the solidity of each of these is equal to the product of its base by their common altitude; therefore, the solidity of the whole prism is equal to the product of the sum of all their bases by the common altitude, or it is equal to the product of the base of the prism, which is the sum of them all, by its altitude.

Cor. Two prisms having the same altitude are to each other as their bases; and two prisms having the same base are to each other as their altitudes.

Theorem XII.

Similar prisms are to one another as the cubes of their homologous sides.

Fig. 143.

Let AG, IP be two similar prisms, of which AB, IK are two homologous sides, the prism AG is to the prism IP as the cube of AB to the cube of IK. Let E and N be two homologous angles of the prisms, and ES, NV perpendiculars to the planes of their bases; join IV; take IR=AE, and in the plane INV draw RT perpendicular to IV; then RT shall be perpendicular to the plane IL (11. and 12. of 7.), also RT shall be equal to ES; for if the solid angles A and I were applied the one to the other, the planes which contain them would coincide (schol. 16. 7.), and the point E would fall upon the point R, and therefore the perpendicular ES would coincide with the perpendicular RT (2. cor. 4. 7.) Now the content of a prism being the product of its base by its altitude (11.), it follows that *prism* AG : *prism* IP :: ES× *base* AC :: NV× *base* IL; but *base* AC : *base* IL :: AB^2 : IK^2 (27. 4.) and therefore, considering the lines expressed by numbers, ES× *base* AC or RT × *base* AC : NV × *base* IL :: RT×AB^2 : NV×IK^2 (5. 3.), therefore, *prism* AG : *prism* IP :: RT×AB^2 : NV×IK^2; but RT : NV :: RI or AE : NI (20. 4.) :: AB : IK (def. of sim. figs.), and consequently RT×AB^2 : NV×IK^2 :: AB^3 : IK^3 (5. 3.); therefore, *prism* AG : *prism* IP :: AB^3 : IK^3.

Cor. Similar prisms are to one another in the triplicate ratio of the homologous sides. For let Y and Z be two such lines that AB : IK :: IK : Y :: Y : Z, then the ratio of AB to Z is triplicate the ratio of AB to IK (12. def. 3.). Now, since AB : IK :: IK : Y, therefore AB^2 : IK^2 :: IK^2 : Y^2, (9 4.) and, multiplying the antecedents by AB, and consequents by IK, AB^3 : IK^3 :: AB×IK^2 : IK×Y^2 :: AB×IK : Y^2, but Y^2=IK×Z (8. 4.); therefore AB^3 :: IK^3 :: AB×IK : IK×Z :: AB : Z, but *prism* AG : *prism* IP :: AB^3 : IK^3 therefore *prism* AG : *prism* IP :: AB : Z, which last ratio is triplicate the ratio of AB to IK.

Theorem XIII.

If a triangular pyramid ABCD be cut by a plane *b c d* parallel to its base, the section *b c d* is similar to the base BCD.

Fig. 144.

For because the planes *b c d*, BCD are parallel, their intersections *b c*, BC with a third plane BAC are parallel (7. 7.); and, for a like reason, *c d* is parallel to CD, and *d b* to DB; therefore the angle *b c d*=BCD, *c d b*=CDB, and *d b c*=DBC (10. 7.); hence the triangles *b c d*, BCD are equiangular, and consequently similar.

Cor. 1. If two triangular pyramids ABCD, EFGH, which have equal bases, and equal altitudes, be cut by planes *b c d*, *f g h* that are parallel to the bases, and at equal distances from them, the sections are equal. For conceive the bases of the pyramids to be in the same plane, then their vertices will be in a plane parallel to their bases, and the sections *b c d*, *f g h* will also be in a plane parallel to their bases, therefore, AB : A *b* :: EF:

Of Solids bounded by Planes.

EF : Ef (14. 7.), but because the triangles ABC, Abc are similar, AB : Ab :: BC : bc, and, in like manner EF : Ef :: FG : fg, therefore, BC : bc :: FG : fg, and $BC^2 : bc^2 :: FG^2 : fg^2$ (9. 4.); but $BC^2 : bc^2$ :: *triangle* BCD : *trian.* bcd, and $FG^2 : fg^2$ :: *trian.* FGH : *trian.* fgh (25. 4.); therefore, *trian.* BCD : *trian.* bcd :: *trian.* FGH : *trian.* fgh, but *trian.* BCD = *trian.* FGH (by hyp.) therefore *trian.* bcd = *trian.* fgh.

Scholium.

It is easy to see that what is here demonstrated of triangular pyramids, is equally true of polygonal pyramids having equal bases and altitudes.

Theorem XIV.

Fig. 145. A series of prisms of the same altitude may be circumscribed about any pyramid ABCD, such that the sum of the prisms shall exceed the pyramid by a solid less than any given solid Z.

Let Z be equal to a prism standing on the same base with the pyramid, viz. the triangle BCD, and having for its altitude the perpendicular drawn from a certain point E in the line AC upon the plane BCD. It is evident that CE multiplied by a certain number m will be greater than AC; divide CA into as many equal parts as there are units in m, and let these be CF, FG, GH, HA, each of which will be less than CE. Through each of the points F, G, H, let planes be made to pass parallel to the plane BCD, making with the sides of the pyramid the sections FPQ, GRS, HTU, which will be all similar to one another, and to the base BCD (13.) From the point B draw in the plane of the triangle ABC the straight line BK parallel to CF, meeting FP produced in K. In like manner, from D draw DL parallel to CF, meeting FQ in L; join KL, and it is plain that the solid KBCDLF is a prism. By the same construction let the prisms PM, RO, TV be described. Also let the straight line IP, which is in the plane of the triangle ABC be produced till it meet BC in h; and let the line MQ be produced till it meet DC in g. Join hg, then hCgQFP is a prism; and is equal to the prism PM (cor. 11.) In the same manner is described the prism mS equal to the prism RO, and the prism qU equal to the prism TV. The sum, therefore, of all the inscribed prisms hQ, mS and qU is equal to the sum of the prisms PM, RO and TV, that is, to the sum of all the circumscribed prisms except the prism BL; wherefore, BL is the excess of the prisms circumscribed about the pyramid above the prisms inscribed within it. But the prism BL is less than the prism which has the triangle BCD for its base, and for its altitude the perpendicular from E upon the plane BCD, which prism is, by hypothesis, equal to the given solid Z; therefore the excess of the circumscribed above the inscribed prisms is less than the solid Z. But the excess of the circumscribed prisms above the inscribed is greater than their excess above the pyramid ABCD, because ABCD is greater than the sum of the inscribed prisms; much more therefore is the excess of the circumscribed prisms above the pyramid less than the solid Z. A series of prisms of the same altitude has therefore been circumscribed about the pyramid ABCD exceeding it by a solid less than the given solid Z.

Theorem XV.

Pyramids that have equal bases and altitudes are equal to one another. Fig. 146.

Let ABCD, EFGH be two pyramids that have equal bases BCD, FGH, and also equal altitudes; the pyramid ABCD is equal to the pyramid EFGH.

If they are unequal, let the pyramid EFGH exceed the pyramid ABCD by the solid Z. Let a series of prisms of the same altitude be circumscribed about the pyramid ABCD that shall exceed it by a solid less than Z, (14.) and let another series equal in number to the former, and having all the same altitude, be described about the pyramid EFGH; then, because the pyramids have equal altitudes, the altitude of each of the prisms described about the one pyramid is equal to the altitude of each of the prisms described about the other pyramid; therefore the sections of the pyramids which are the bases of the corresponding prisms will be at equal distances from the bases of the pyramids, and hence these sections will be equal; (1. cor. 13.) and because the prisms have all the same altitude, the corresponding prisms will be equal, and the sum of the prisms described about the pyramid ABCD will be equal to the sum of the prisms described about the pyramid EFGH. Let the pyramid EFGH be denoted by P, and the pyramid ABCD by p, and put Q for the sum of the prisms described about P, and q for the prisms described about p: Then by hypothesis $Z = P - p$, and by construction $Z > q - p$, therefore $P - p > q - p$, and consequently $P > q$, but it has been shewn that $q = Q$, therefore $P > Q$, that is, the pyramid EFGH is greater than the sum of the prism described about it, which is impossible, therefore the pyramids ABCD, EFGH are not unequal, that is, they are equal.

Theorem XVI.

Every prism having a triangular base may be divided into three pyramids that have triangular bases, and that are equal to one another. Fig. 147.

Let ABC, DEF be the opposite bases of a triangular prism. Join AE, EC, CD; and because ABED is a parallelogram, of which AE is the diameter, the triangle ADE is equal to the triangle ABE; therefore the pyramid of which the base is the triangle ADE and vertex the point C, is equal to the pyramid of which the base is the triangle ADE, and vertex the point C. But the pyramid of which the base is the triangle ABE and vertex the point C, that is the pyramid ABCE, is equal to the pyramid DEFC, (15.) for they have equal bases, viz. the triangles ABC, DFE, and the same altitude, viz. the altitude of the prism ABCDEF. Therefore, the three pyramids ADEC, ABEC, DFEC are equal to one another; but these pyramids make up the whole prism ABCDEF; therefore, the prism ABCDEF is divided into three equal pyramids.

Cor. 1. From this it is manifest that every pyramid

mid is the third part of a prism which has the same base and the same altitude with it; for if the base of the prism be any other figure than a triangle, it may be divided into prisms having triangular bases.

Cor. 2. Pyramids having equal altitudes are to one another as their bases; because the prisms upon the same bases, and of the same altitude, are to one another as their bases.

SECT. IX. OF CYLINDERS, CONES, AND THE SPHERE.

Definitions.

I. A *Cylinder* is a solid figure described by the revolution of a right-angled parallelogram about one of its sides, which remains fixed.

The *Axis* of the cylinder is the fixed straight line about which the parallelogram revolves.

The *Bases* of the cylinder are the circles described by the two revolving opposite sides of the parallelogram.

II. A *Cone* is a solid figure described by the revolution of a right-angled triangle about one of the sides containing the right angle, which side remains fixed.

The *Axis* of the cone is the fixed line about which the triangle revolves.

The *Base* of the cone is the circle described by that side containing the right angle which revolves.

III. A *Sphere* is a solid figure described by the revolution of a semicircle about a diameter.

The *Axis* of a sphere is the fixed line about which the semicircle revolves.

The *Centre* of a sphere is the same with that of the semicircle.

The *Diameter* of a sphere is any straight line which passes through the centre, and is terminated both ways by the superficies of the sphere.

IV. *Similar* cones and cylinders are those which have their axes and diameters of their bases proportional.

Theorem I.

Fig. 148. If from any point E in the circumference of the base of a cylinder ABCD, a perpendicular EF be drawn to the plane of the base AEB, the straight line EF is wholly in the cylindric superficies.

Let HG be the axis, and AGHD the rectangle, which by its revolution describes the cylinder. Because HG is perpendicular to AG in every position of the revolving rectangle, it is perpendicular to the plane of the circle described by AG; and because AD, the line which describes the cylindric superficies, is parallel to GH, it is also perpendicular to the plane of that circle. (5. 7.) Now when by the revolution of the rectangle AGHD the point A coincides with the point E, the line EF will coincide with AD, and thus will be wholly in the cylindric superficies; for otherwise two perpendiculars might be drawn to the same plane, from the same point, which is impossible (2 cor. 4. 7.).

Theorem II.

Fig. 149. A cylinder and a parallelopiped having equivalent bases and the same altitude are equal to one another.

2

Let ABCD be a cylinder, and EF a parallelopiped having equivalent bases, viz. the circle AGB and the parallelogram EH, and having also equal altitudes; the cylinder ABCD is equal to the parallelopiped EF. If not, let them be unequal; and first let the cylinder be less than the parallelopiped EF; and from the parallelopiped EF let there be cut off a part EQ by a plane PQ parallel to NF, equal to the cylinder ABCD. In the circle AGB inscribe the polygon AGKBLM that shall differ from the circle by a space less than the parallelogram PH, (1 cor. 2. 6.) and cut off from the parallelogram EH a part OR equal to the polygon AGKBLM, then it is manifest that the parallelogram OR is greater than the parallelogram OP, therefore the point R will fall between P and N. On the polygon AGKBLM let an upright prism be constituted of the same altitude with the cylinder, which will therefore be less than the cylinder, because it is within it; (1.) and if through the point R a plane RS parallel to NF be made to pass, it will cut off the parallelopiped ES equal to the prism AGBC, because its base is equal to that of the prism, and its altitude is the same. But the prism AGBC is less than the cylinder ABCD, and the cylinder ABCD is equal to the parallelopiped EQ, by hypothesis; therefore, ES is less than EQ, and it is also greater, which is impossible. The cylinder ABCD therefore is not less than the parallelopiped EF; and in the same manner it may be shewn not to be greater than EF, therefore they are equal.

Theorem III.

Fig. 150. If a cone and cylinder have the same base and the same altitude, the cone is the third part of the cylinder.

Let the cone ABCD, and the cylinder BFKG have the same base, viz. the circle BCD, and the same altitude, viz. the perpendicular from the point A upon the plane BCD; the cone ABCD is the third part of the cylinder BFKG. If not, let the cone ABCD be the third part of another cylinder LMNO having the same altitude with the cylinder BFKG; but let the bases BCD, LIM be unequal, and first let BCD be greater than LIM. Then, because the circle BCD is greater than the circle LIM, a polygon may be inscribed in BCD that shall differ from it less than LIM does, (1. cor. 2. 6.) and which therefore will be greater than LIM. Let this be the polygon BECFD; and upon BECFD let there be constituted the pyramid ABECFD, and the prism BCFKHG. Because the polygon BECFD is greater than the circle LIM, the prism BCFKHG is greater than the cylinder LMNO, for they have the same altitude, but the prism has the greater base. But the pyramid ABECFD is the third part of the prism BCFHG (16. 8.); therefore it is greater

Of Cylinders, Cones, and the Sphere.

greater than the third part of the cylinder LMNO. Now the cone ABECFD is by hypothesis the third part of the cylinder LMNO, therefore, the pyramid ABECFD is greater than the cone ABCD, and it is also less, because it is inscribed in the cone, which is impossible. Therefore the cone ABCD is not less than the third part of the cylinder BFKG. And in the same manner, by circumscribing a polygon about the circle BCD, it may be shewn, that the cone ABCD is not greater than the third part of the cylinder BFKG; therefore, it is equal to the third part of the cylinder.

Theorem IV.

Fig. 151.

If a hemisphere and cone have equal bases and altitudes, a series of cylinders may be inscribed in the hemisphere, and another series may be circumscribed about the cone, having all the same altitudes with one another, and such that their sum shall differ from the sum of the hemisphere and the cone by a solid, less than any given solid.

Let ADB be a semicircle, of which the centre is C, and let CD be at right angles to AB; let DB and DA be squares described on DC, draw CE, and let the figure thus constructed revolve about DC: then the quadrant BCD will describe a hemisphere having C for its centre, and the triangle CDE will describe a cone having its vertex at C, and having for its base the circle described by DE, equal to that described by BC, which is the base of the hemisphere. Let W be a given solid, a series of cylinders may be described in the hemisphere ADB, and another described about the cone ECI, so that their sum shall differ from the sum of the hemisphere and cone, by a solid less than the solid W.

Upon the base of the hemisphere let a cylinder be constituted equal to W, and let its altitude be CX. Divide CD into such a number of equal parts, that each of them shall be less than CX; let these be CH, HG, GF and FD. Draw FN, GO, HP parallel to CB, meeting the circle in K, L, and M, and the straight line CE in Q, R, and S. Draw Kf, Lg, Mh, perpendicular to GO, HP, and CB; and draw Qq, Rr, Ss perpendicular to the same lines. It is evident that the figure being thus constructed, if the whole revolve about CD, the rectangles Ff, Gg, Hh will describe cylinders that will be circumscribed by the hemisphere BDA; and that the rectangles DN, Fq, Gr, Hs will also describe cylinders that will circumscribe the cone ICE. Now it may be demonstrated, as was done of the prisms inscribed in a pyramid (14. 8.), that the hemisphere exceeds the sum of all the cylinders described within it, by a solid less than the cylinder generated by the rectangle HB, that is, by a solid less than W. In the same manner it may be demonstrated, that the sum of the cylinders circumscribing the cone ICE is greater than the cone by a solid less than the cylinder generated by the rectangle DN, that is, by a solid less than W. Therefore, since the sum of the cylinders inscribed in the hemisphere together with a solid less than W, is equal to the hemisphere; and since the sum of the cylinders described about the cone is equal to the cone together with a solid less than W; adding equals to equals, the sum of all the cylinders together with a solid less than W is equal to the hemisphere and cone together with a solid less than W; therefore, the difference between the whole of the cylinders, and the sum of the hemisphere and the cone, is equal to the difference of two solids, each of which is less than W: but this difference must also be less than W; therefore the difference between the two series of cylinders, and the sum of the hemisphere and cone is less than the given solid W.

Theorem V.

Fig. 151.

The same things being supposed as in last theorem, the sum of all the cylinders inscribed in the hemisphere, and described about the cone, is equal to a cylinder having the same base and altitude with the hemisphere.

For, the same construction being supposed as in last theorem, let L be the point in which GO meets the circle ADB, then because CGL is a right angle, if CL be joined, the circles described with the radii CG and GL are equal to the circle described with the radius CL or GO (2. cor. 4. 6.). Now CG=GR, because CD=DE, therefore, the circles described by the revolution of the radii GR and GL about the point G are together equal to the circle described by the revolution of the radius GO about the same point G; therefore also the cylinders that stand upon the two first of these circles having the common altitude GH are equal to the cylinder which stands upon the remaining circle, and which has the same altitude GH. The cylinders described by the revolution of the rectangles Gg and Gr are therefore equal to the cylinder described by the rectangle GP. And as the same may be shewn of all the rest, the cylinders described by the rectangles Hh, Gg, Ff, and by the rectangles Hs, Gr, Fq, DN, are together equal to the cylinder described by DB, that is, to the cylinder having the same base and altitude with the hemisphere.

Theorem VI.

Fig. 151.

Every sphere is two thirds of the circumscribing cylinder.

Let the figure be constructed as in the two last theorems, and if the hemisphere described by the quadrant BDC be not equal to two thirds of the cylinder described by the rectangle BD, let it be greater by the solid W. Then as the cone described by CDE is one-third of the cylinder described by BD, the cone and the hemisphere together will exceed the cylinder by W. But that cylinder is equal to the sum of all the cylinders described by the rectangle Hh, Gg, Ff, Hs, Gr, Fq, DN; therefore, the hemisphere and the cone added together exceed the sum of all these cylinders by the solid W, which is absurd; for it has been shewn (4.) that the hemisphere and the cone together differ from the sum of these cylinders by a solid less than W. The hemisphere is therefore equal to two thirds of the cylinder de-

scribed

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scribed by the rectangle BD; and therefore the whole sphere is two thirds of the cylinder described by twice the rectangle BD, that is to two thirds of the circumscribing cylinder.

We here conclude the *Elements of Geometry*. Their application, constituting what is sometimes called *Practical Geometry*, will be given under the article Mensuration.

Of Cylinders, Cones, and the Sphere.

A Table shewing the Theorem of the foregoing Treatise, that corresponds to each of the most material Propositions in the first six, and in the eleventh and twelfth, books of *Euclid's Elements*.

Euclid.	Geometry.
Book I.	Theor. Sect.
Prop. 4.	5. 1.
5.	11. 1.
6.	12. 1.
8.	10. 1.
13.	1. 1.
14.	3. 1.
15.	4. 1.
16.	23. 1.
17.	24. 1.
18. 19.	13. 1.
20.	7. 1.
21.	8. 1.
24. 25.	9. 1.
26.	6. 1.
27. 28.	22. 1.
29.	21. 1.
30.	20. 1.
32.	23. 24. 25. 1.
33.	28. 1.
34.	26. 1.
35. 36.	1. 4.
37. 38.	2 cor. to 2. 4.

Euclid.	Geometry.
Book I.	Theor. Sect.
Pr. 41.	2. 4.
47.	13. 4.
48.	scholium 15. 4.
Book II.	Theor. Sect.
Pr. 4.	10. 4.
5.	12. 4.
7.	11. 4.
12.	15. 4.
13.	14. 4.
Book III.	Theor. Sect.
Pr. 3.	6. 2.
10.	cor. 7. 2.
11.	12. 2.
12.	11. 2.
14.	8. 2.
15.	2. 2. 8. 2.
16.	9. 2.
20.	14. 2.
21.	15. 2.
22.	16. 2.
26. 27.	13. 2.

Euclid.	Geometry.
Book. III.	Theor. Sect.
Pr. 28. 29.	4. 2.
31.	17. 2.
32.	18. 2.
35.	28. 4.
36	29. 4. 30. 4.
Book V.	Theor. Sect.
Pr. 4.	5. 3.
12.	8. 3.
15.	1. 3.
16.	2. 3.
17. 18. 19.	4. 3.
22.	6. 3.
23.	7. 3.
24.	8. 3.
Book VI	Theor. Sect.
Pr. 1.	cor. 5. 4. cor. 6. 4.

Euclid.	Geometry.
Book VI.	Theor. Sect.
Pr. 2.	17. 4. 18. 4.
3.	19. 4.
4.	20. 4.
5.	21. 4.
6.	22. 4.
8.	23. 4.
14. 15	cor. 24. 4.
16. 17.	8. 4.
19.	25. 4.
20.	26. 4. 27. 4.
31.	1 cor. 27. 4.
33.	31. 4.
Book XI.	Theor. Sect.
Pr. 1.	1. 7.
3.	3. 7.
4.	4. 7.
6.	1 cor. 5. 7.
8.	5. 7.

Euclid.	Geometry.
Book XI.	Theor. Sect.
9.	2 cor. 5. 7.
10.	10. 7.
13.	2 cor. 4. 7.
14.	6. 7.
15.	10. 7.
16.	7. 7.
17.	14. 7.
18.	11. 7.
19.	13. 7.
20.	20. 7.
24.	2. 8.
25.	8. 8.
28.	3. 8.
29.	4. 8.
30. 31.	5. 8.
32.	9. 8.
33.	12. 8.
Book XII.	Theor. Sect.
Pr. 1.	1. 6.
2.	4. 6.
7.	16. 8.
10.	3. 9.

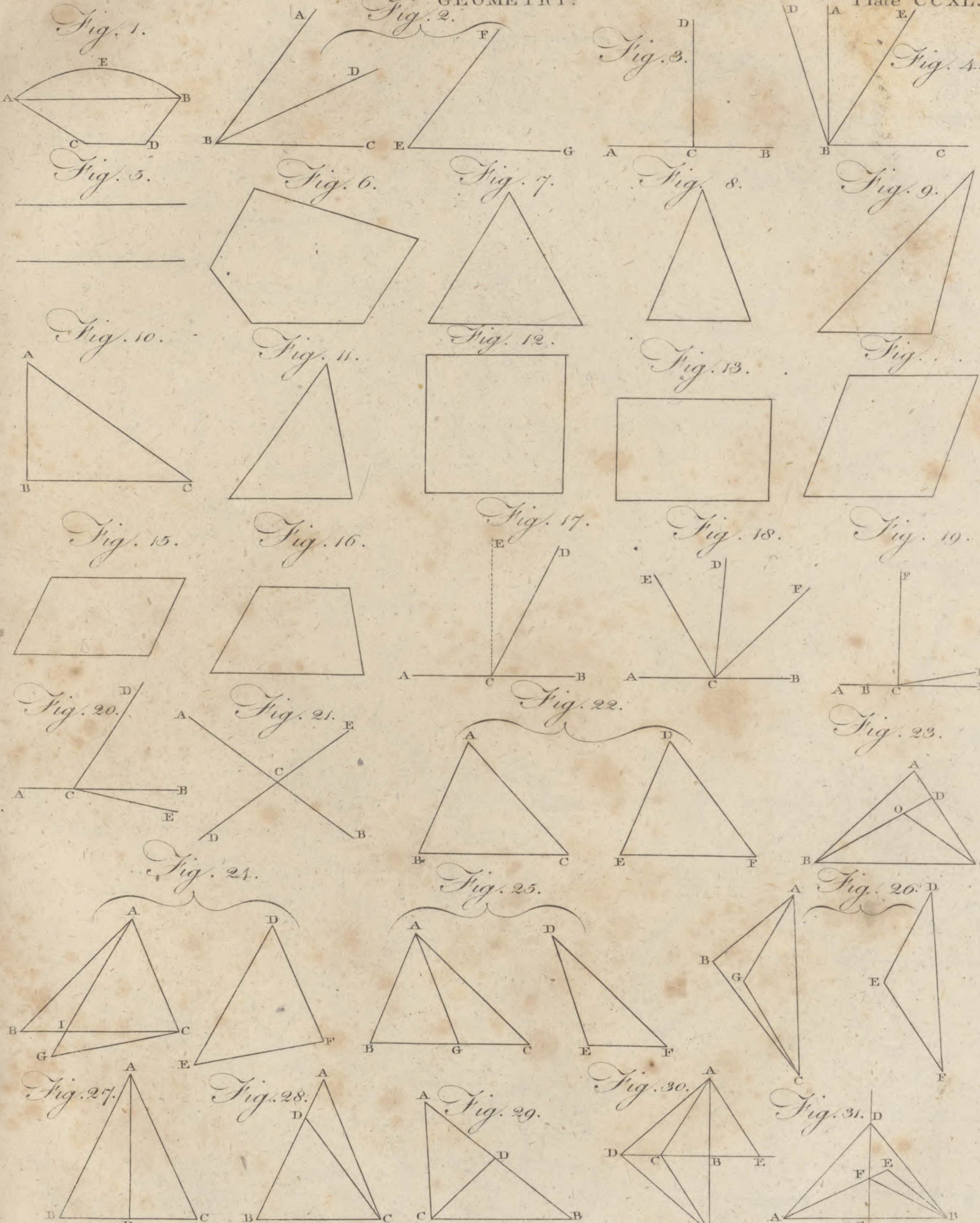
George.

GEORGE I. II. and III. kings of Great Britain.—George I. the son of Ernest Augustus, duke of Brunswick Lunenburgh, and elector of Hanover; succeeded to the throne of Great Britain in 1714, in virtue of an act of parliament, passed in the latter part of the reign of King William III. limiting the succession of the crown, after the demise of that monarch, and Queen Anne (without issue), to the princess Sophia of Hanover, and the heirs of her body, being Protestants.—George II. the only son of the former, succeeded him in 1727, and enjoyed a long reign of glory; dying amidst the most rapid and extensive conquests in the 77th year of his age. He was succeeded by his grandson George III. our present sovereign. For particulars, see Britain, N° 374—701.

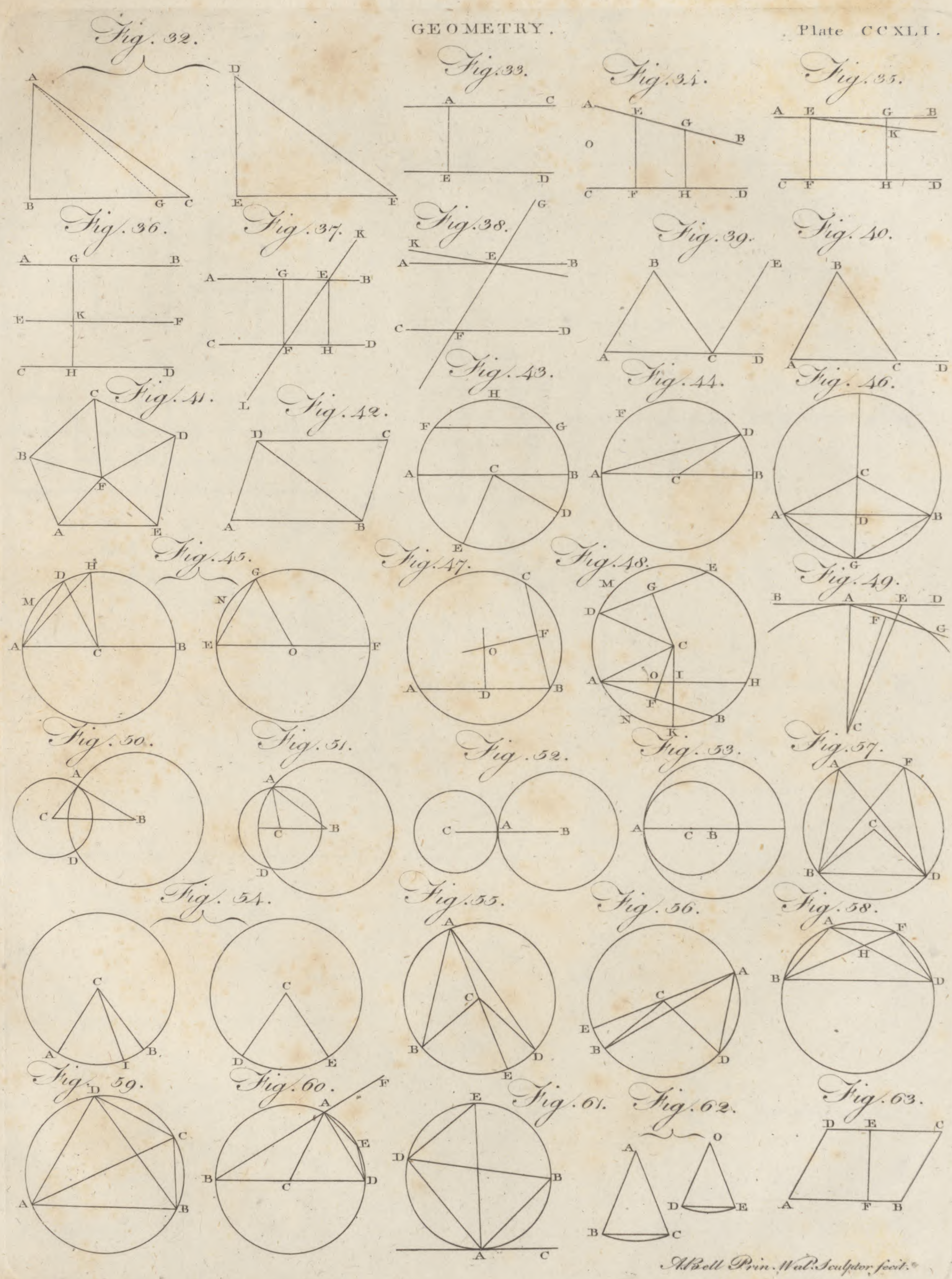
George, or *Knights of St George*, has been the denomination of several military orders, whereof that of the garter is one of the most illustrious. See Garter, and *St George*, below.

George.

King George's Islands, are two islands in the South sea, lying in W. Long. 144. 56. S. Lat. 14. 28. They were first discovered by Commodore Byron in 1765, and have since been visited by Captain Cook in 1774. Commodore Byron's people had an encounter with the inhabitants, which proved fatal to some of the natives; but Captain Cook was more fortunate. A lieutenant and two boats well-armed were sent on shore by Captain Cook; and landed without opposition. As soon as the gentlemen landed, the islanders embraced them by touching noses, a mode of civility used in New Zealand,



A. Bell Prin. Wal. Sculptor fecit.



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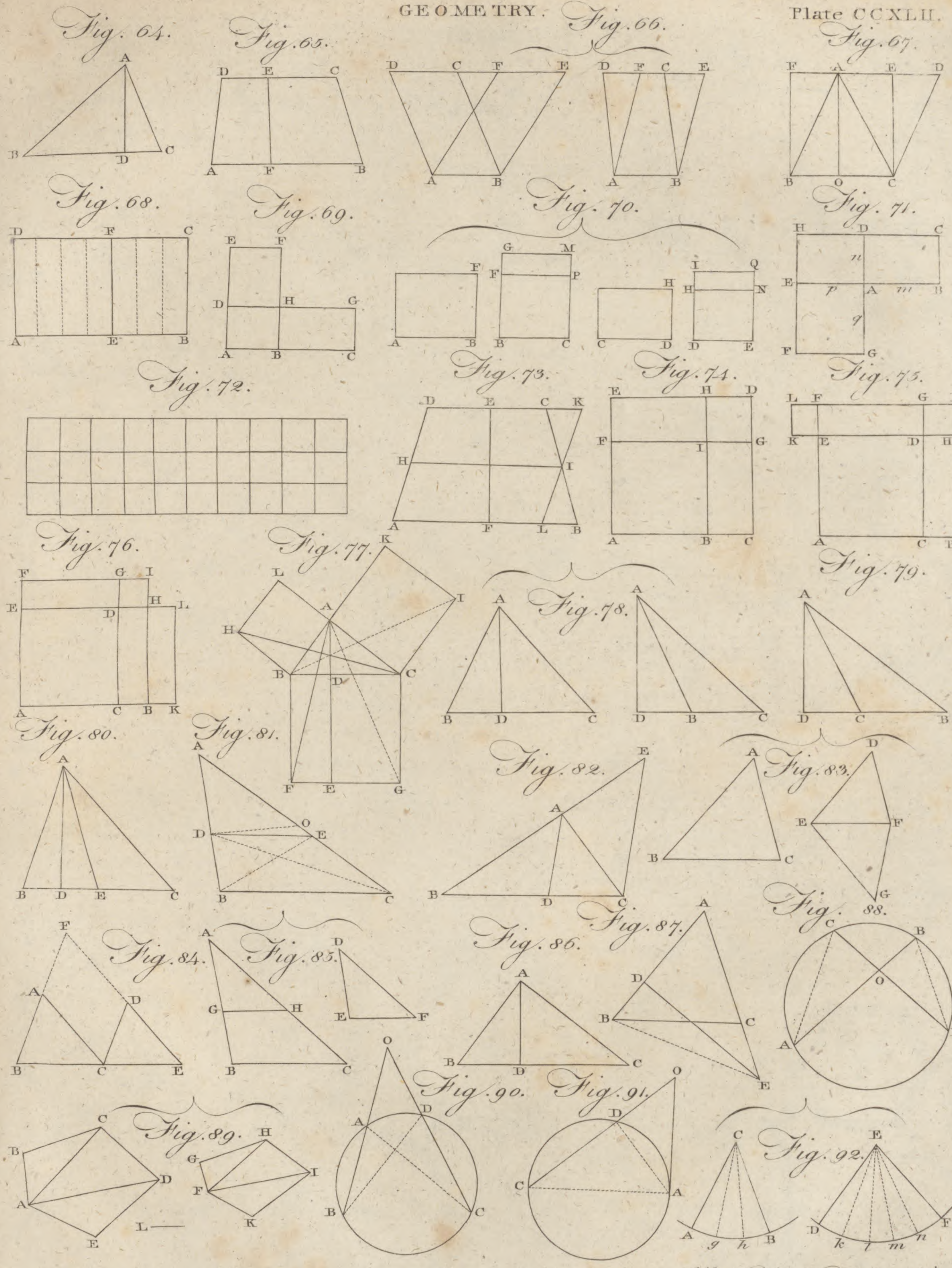

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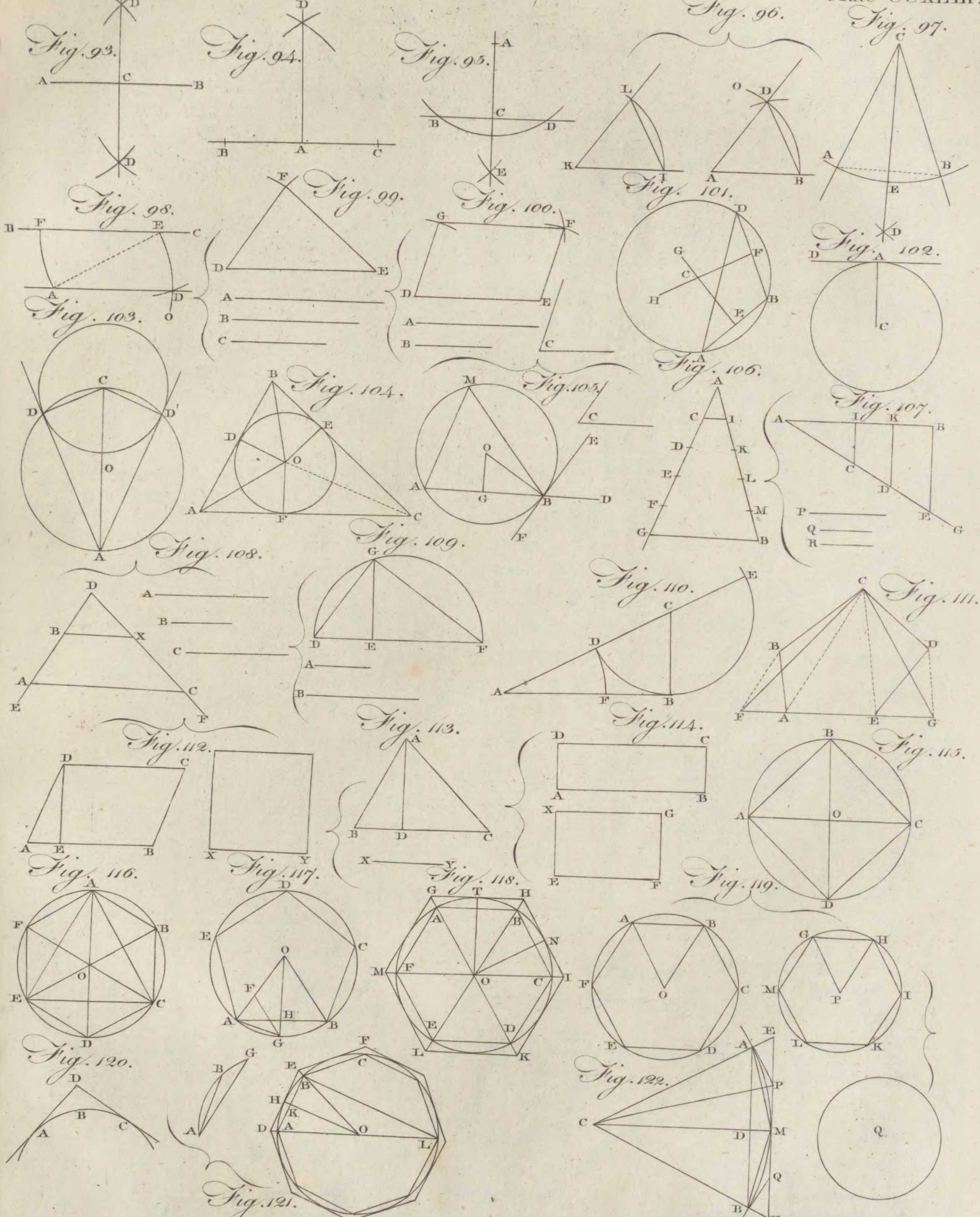

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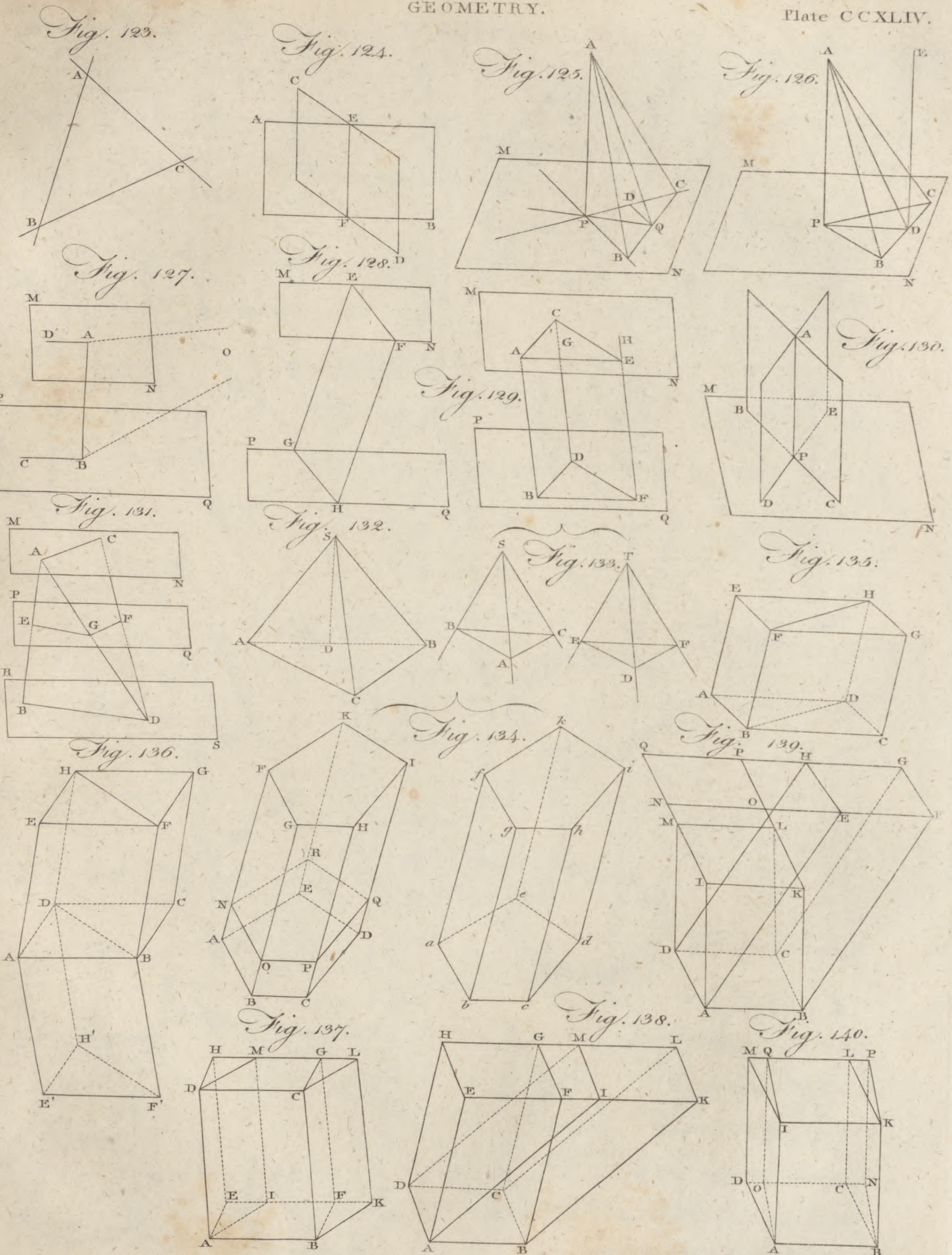

A. Bell Prin. Wal. Sculptor fecit.

George.

land, which is 900 leagues diſtant, and the only place beſides this where the cuſtom has been obſerved to prevail. Notwithſtanding this ceremony, however, very little real friendſhip ſeemed to take place on the part of the iſlanders. They crowded about the boats as the people were ſtepping into them, and ſeemed in doubt whether they ſhould detain them or let them go; at laſt, however, not thinking themſelves ſufficiently ſtrong, they ſeemed contented with their departure, and aſſiſted them in puſhing off their boats; but ſome of the moſt turbulent threw ſtones into the water, which fell very near them, and all ſeemed to glory that they had as it were driven them off. The Britiſh brought off five dogs of a white colour with fine long hair, with which the iſland ſeemed to be plentifully ſupplied. Theſe they purchaſed with ſmall nails, and ſome ripe bananas which had been brought from the Marqueſas. On this iſland Mr Forſter found a kind of ſcurvy-graſs, which the natives informed him they were wont to bruiſe and mix with ſhell fiſh; after which, they threw it into the ſea whenever they perceived a ſhoal of fiſh. This preparation intoxicates them for ſome time; and thus they are caught on the ſurface of the water without any other trouble than that of taking them out. The name of this plant among the natives is *enow*. The largeſt iſland, which they call *Tiookea*, is ſomething of an oval ſhape, and about 10 leagues in circuit; the other iſland, which lies two leagues to the weſtward of Tiookea, is four leagues long from north-eaſt to ſouth-weſt, and from three to five miles broad. The ſoil of both is extremely ſcanty; the foundation conſiſts of coral, very little elevated above the ſurface of the water.

GEORGE, ST, or *GEORGE of Cappadocia*; a name whereby ſeveral orders, both military and religious, are denominated. It took its riſe from a ſaint or hero famous throughout all the Eaſt, called by the Greeks Μεγαλομαρτυρ, q. d. *great martyr*.

On ſome medals of the emperors John and Manuel Comneni, we have the figure of St George armed, holding a ſword or javelin in one hand, and in the other a buckler, with this inſcription; an O, and therein a little

P
A, and ΓΕ—ΓΙΟC, making Ο ΑΓΙΟΣ ΓΕΟΡΓΙΟΣ, *O holy*
O

George. He is generally repreſented on horſeback, as being ſuppoſed to have frequently engaged in combats in that manner. He is highly venerated throughout Armenia, Muſcovy, and all the countries which adhere to the Greek rite: from the Greek, his worſhip has long ago been received into the Latin church; and England and Portugal have both choſen him for their patron ſaint.

Great difficulties have been raiſed about this ſaint or hero. His very exiſtence has been called in queſtion. Dr Heylin, who wrote firſt and moſt about him, concluded with giving him entirely up, and ſuppoſing him only a ſymbolical device; and Dr Pettingal has turned him into a mere Baſilidian ſymbol of victory. Mr Pegg, in a paper in the Archæologia *, has attempted to reſtore him. And, finally, Mr Gibbon † has ſunk him into an Arian biſhop in the reigns of Conſtantius and Julian.—The biſhop alluded to,

* Vol. i. p. 1.
† Hiſt. vol. ii. p. 404.

GEORGE the Cappadocian, was ſo ſurnamed, according to our author, from his parents or education; and was born at Epiphania in Cilicia, in a fuller's ſhop. "From this obſcure and ſervile origin he raiſed himſelf by the talents of a paraſite: and the patrons, whom he aſſiduouſly flattered, procured for their worthleſs dependent a lucrative commiſſion, or contract, to ſupply the army with bacon. His employment was mean: he rendered it infamous. He accumulated wealth by the baſeſt arts of fraud and corruption; but his malverſations were ſo notorious, that George was compelled to eſcape from the purſuits of juſtice. After this diſgrace, in which he appears to have ſaved his fortune at the expence of his honour, he embraced, with real or affected zeal, the profeſſion of Arianiſm. From the love, or the oſtentation, of learning, he collected a valuable library of hiſtory, rhetoric, philoſophy, and theology; and the choice of the prevailing faction promoted George of Cappadocia to the throne of Athanaſius." His conduct in this ſtation is repreſented by our hiſtorian as polluted by cruelty and avarice, and his death conſidered as a juſt puniſhment for the enormities of his life, among which Mr Gibbon ſeems to rank his "enmity to the gods."

The immediate occaſion of his death, however, as narrated by eccleſiaſtical writers, will not probably appear calculated to add any ſtain to his memory. "There was in the city of Alexandria a place in which the heathen prieſts had been uſed to offer human ſacrifices. This place, as being of no uſe, Conſtantius gave to the church of Alexandria, and George the biſhop gave orders for it to be cleared, in order to build a Chriſtian church on the ſpot. In doing this they diſcovered an immenſe ſubterraneous cavern, in which the heathen myſteries had been performed, and in it were many human ſkulls. Theſe, and other things which they found in the place, the Chriſtians brought out and expoſed to public ridicule. The heathens, provoked at this exhibition, ſuddenly took arms and ruſhing upon the Chriſtians, killed many of them with ſwords, clubs, and ſtones: ſome alſo they ſtrangled, and ſeveral they crucified. On this the Chriſtians proceeded no farther in clearing the temple; but the heathens, purſuing their advantage, ſeized the biſhop as he was in the church, and put him in priſon. The next day they deſpatched him; and then faſtening the body to a camel, he was dragged about the ſtreets all day, and in the evening they burnt him and the camel together. This fate, Sozomen ſays, the biſhop owed in part to his haughtineſs while he was in favour with Conſtantius, and ſome ſay the friends of Athanaſius were concerned in this maſſacre; but he aſcribes it chiefly to the inveteracy of the heathens, whoſe ſuperſtitions he had been very active in aboliſhing.

This George, the Arian biſhop of Alexandria, was a man of letters, and had a very valuable library, which Julian ordered to be ſeized for his own uſe; and in his orders concerning it, he ſays that many of the books were on philoſophical and rhetorical ſubjects, though many of them related to the doctrine of the impious Galileans (as in his ſneering contemptuous way he always affected to call the Chriſtians). 'Theſe books (ſays he) I could wiſh to have utterly deſtroyed; but leſt books of value ſhould be deſtroyed along with them, let theſe alſo be carefully ſought for.'

But Mr Gibbon gives a different turn to the affair of

George. of George's murder, as well as relates it with different circumstances. "The Pagans (says he) excited his devout avarice; and the rich temples of Alexandria were either pillaged or insulted by the haughty prelate, who exclaimed, in a loud and threatening tone, 'How long will these sepulchres be permitted to stand?' Under the reign of Constantius, he was expelled by the fury, or rather by the justice, of the people: and it was not without a violent struggle, that the civil and military powers of the state could restore his authority, and gratify his revenge. The messenger who proclaimed at Alexandria the accession of Julian, announced the downfal of the archbishop. George, with two of his obsequious ministers, Count Diodorus and Darcontius master of the mint, was ignominiously dragged in chains to the public prison. At the end of 24 days, the prison was forced open by the rage of a superstitious multitude, impatient of the tedious forms of judicial proceedings. The *enemies of gods* and men expired under their cruel insults; the lifeless bodies of the archbishop and his associates were carried in triumph through the streets on the back of a camel; and the inactivity of the Athanasian party was esteemed a shining example of evangelical patience. The remains of these guilty wretches were thrown into the sea; and the popular leaders of the tumult declared their resolution to disappoint the devotion of the Christians, and to intercept the future honours of these martyrs, who had been punished, like their predecessors, by the enemies of their religion. The fears of the Pagans were just, and their precautions ineffectual. The meritorious death of the archbishop obliterated the memory of his life. The rival of Athanasius was dear and sacred to the Arians, and the seeming conversion of those sectaries introduced his worship into the bosom of the Catholic church. The odious stranger, disguising every circumstance of time and place, assumed the mask of a martyr, a saint, and a Christian hero; and the infamous George of Cappadocia has been transformed into the renowned St George of England, the patron of arms, of chivalry, and of the garter."

Knights of St George. See GARTER. There have been various other orders under this denomination, most of which are now extinct; particularly one founded by the emperor Frederic III. in the year 1470, to guard the frontiers of Bohemia and Hungary against the Turks; another, called *St George of Alfama*, founded by the kings of Arragon; another in Austria and Carinthia; and another in the republic of Genoa, still subsisting, &c.

Religious of St George. Of these there are divers orders and congregations; particularly canons regular of St George in Alga, at Venice, established by authority of Pope Boniface IX. in the year 1404. The foundation of this order was laid by Bartholomew Colonna, who preached, in 1396, at Padua, and some other villages in the state of Venice. Pope Pius V. in 1570, gave these canons precedence of all other religious. Another congregation of the same institute in Sicily, &c.

St George del Mina, the capital of the Dutch settlements on the Gold coast of Guinea, situated seven or eight miles west of Cape-coast castle the capital of the British settlements there. W. Long. 5'. and N. Lat. 5.° George.

St George, a fort and town of Asia, in the peninsula on this side the Ganges, and on the coast of Coromandel, belonging to the British; it is otherwise called *Madras*, and by the natives *Chilipatam*. It fronts the sea, and has a salt water river on its back side, which hinders the fresh water springs from coming near the town, so that they have no good water within a mile of them. In the rainy seasons it is incommoded by inundations; and from April to September, it is so scorching hot, that if the sea breezes did not cool the air, there would be no living there. There are two towns, one of which is called the *White Town*, which is walled round, and has several bulwarks and bastions to defend it: it is 400 paces long and 150 broad, and is divided into regular streets. Here are two churches, one for the Protestants, and the other for the Papists; as also a good hospital, a town hall, and a prison for debtors. They are a corporation, and have a mayor and aldermen, with other proper officers. The *Black Town* is inhabited by Gentoos, Mahometans, and Portuguese and Armenian Christians, and each religion has its temples and churches. This, as well as the White Town, is ruled by the English governor and his council. The diamond mines are but a week's journey from this place, which renders them pretty plentiful, but there are no large ones since that great diamond was procured by Governor Pitt. This colony produces very little of its own growth or manufacture for foreign markets, and the trade is in the hands of the Armenians and Gentoos. The chief things the British deal in, besides diamonds, are calicoes, chintz, muslins, and the like. This colony may consist of 80,000 inhabitants in the towns and villages, and there are generally 400 or 500 Europeans. Their rice is brought by sea from Gangam and Orixa, their wheat from Surat and Bengal, and their fire wood from the islands of Diu; so that an enemy, with a superior force at sea, may easily distress them. The houses of the White Town are built with brick, and have lofty rooms and flat roofs; but the Black Town consists chiefly of thatched cottages. The military power is lodged in the governor and council, who are also the last resort in civil causes. The Company have two chaplains, who officiate by turns, and have each 100l. a-year, besides the advantages of trade. They never attempt to make proselytes, but leave that to the Popish missionaries. The salaries of the Company's writers are very small: but, if they have any fortune of their own, they may make it up by trade; which must generally be the case, for they commonly grow rich. It was taken by the French in 1746, who restored it at the peace of Aix-la-Chapelle.

St George's, the largest of the Bermuda or Summer islands. W. Long. 65. 10. N. Lat. 32. 30.

Cross of St George, a red one in a field argent, which makes part of the British standard.

GEORGE, a lake in East Florida, also denominated Great lake, about 15 miles broad, and 20 feet deep. There are some beautiful islands in it, the largest of which is about two miles broad, commanding a delightful and very extensive prospect. There are manifest traces of a large town of the Aborigines, and the

the iſland itſelf appears to have been the favourite reſidence of an Indian prince. It lies to the ſouth of Lake Champlain, and its waters lie about 100 feet higher. It abounds with ſiſhes of a ſuperior quality, ſuch as the Oſwego baſs, and ſpeckled trouts of conſiderable magnitude. The French at one period called it Lake Sacrament, as they were at the trouble to bring from it their water for ſacramental purpoſes, to the churches they had planted in Canada.

GEORGETOWN, the name of ſeveral towns in America, ſuch, for inſtance, as Georgetown in Maryland, about 65 miles S. W. of Philadelphia; Georgetown in the county of Lincoln, and diſtrict of Maine, lying on both ſides of Kennebeck river, 148 miles S. W. of Philadelphia, where the Roman Catholics have a very flouriſhing college: it is the name of a village in Fayette county, Pennſylvania, where a number of boats are annually built; and of a poſt town in the diſtrict of the ſame name, where the Epiſcopalians, Baptiſts, and Methodiſts, have each a place of worſhip, although the number of houſes in it does not much exceed 300, which are conſtructed chiefly of wood. It lies 127 miles S. W. of Wilmington, and 681 from Philadelphia.

GEORGIA, a country of Aſia, bounded on the north by Circaſſia, on the eaſt by Dagheſtan and Shirvan, on the ſouth by Armenia, and on the weſt by the Euxine or Black ſea; comprehending the greateſt part of the ancient Colchis, Iberia, and Albania. About the etymon of the name of this country, authors are not agreed. The moſt probable opinion is, that it is a corruption by ſoftening of *Kurgia*, from the river Kur; whence alſo it is ſuppoſed that the inhabitants are called by the Perſians indifferently *Gurgi* and *Kurgi;* and the country *Kurgiſtan* and *Gurgiſtan:* It is divided by a ridge of mountains into eaſtern and weſtern; the former of which is again ſubdivided into the kingdoms of Caket, Carduel or Carthuel, and Goguetia; and the latter into the provinces of Abcaſſia, Mireta or Imeretia, and Guriel. Another diviſion is into Georgia Proper, Abcaſſia, and Mingrelia. A third diviſion will be afterwards mentioned.

"Georgia (ſays Sir George Chardin) is as fertile a country as can be ſeen; the bread is as good here as in any part of the world; the fruit of an exquiſite flavour, and of different ſorts: no place in Europe yields better pears and apples, and no place in Aſia better pomegranates. The country abounds with cattle, veniſon, and wild fowl, of all ſorts; the river Kur is well ſtocked with fiſh; and the wine is ſo rich, that the king of Perſia has always ſome of it for his own table. The inhabitants are robuſt, valiant and of a jovial temper; great lovers of wine, and eſteemed very truſty and faithful; endowed with good natural parts, but, for want of education, very vicious. The women are generally ſo fair and comely, that the wives and concubines of the king of Perſia and his court are for the moſt part Georgian women. Nature has adorned them with graces nowhere elſe to be met with: it is impoſſible to ſee them without loving them; they are of a good ſize, clean limbed, and well ſhaped. Another traveller, however, of no mean character, thus expreſſes himſelf with reſpect to the women: "As to the Georgian women, they did not at all ſurpriſe us; for we expected to find them perfect beauties. They are, indeed no way diſagreeable; and may be counted beauties, if compared with the Curdes. They have an air of health that is pleaſing enough; but, after all, they are neither ſo handſome nor ſo well ſhaped as is reported. Thoſe who live in the towns have nothing extraordinary more than the others; ſo that I may, I think, venture to contradict the accounts that have been given of them by moſt travellers."

This country formerly abounded with great cities, as appears not only from its hiſtory, but from the ruins of many of them ſtill viſible, which ſhow that they muſt have been very large, opulent, and magnificently built. Theſe were all deſtroyed by the inundations of northern barbarians from Mount Caucaſus, as the Alans, Huns, Suevi, and ſome others, ſo much noted in hiſtory for their ſtrength, courage, and conqueſts.

The lateſt diviſion of this country is into nine provinces; five of which are ſubject to the famous prince Heraclius, forming what is commonly called the kingdom of Georgia; and four are under the dominion of David, compoſing the kingdom or principality of Imeretia. See IMERETIA.

This whole country is ſo extremely beautiful, that ſome fanciful travellers have imagined they had here found the ſituation of the original garden of Eden. The hills are covered with foreſts of oak, aſh, beech, cheſnuts, walnuts, and elms, encircled with vines, growing perfectly wild, but producing vaſt quantities of grapes. From theſe is annually made as much wine as is neceſſary for the yearly conſumption; the remainder is left to rot on the vines. Cotton grows ſpontaneouſly, as well as the fineſt European fruit trees. Rice, wheat, millet, hemp, and flax, are raiſed on the plains, almoſt without culture. The valleys afford the fineſt paſturage in the world; the rivers are full of fiſh; the mountains abound in minerals, and the climate is delicious; ſo that nature appears to have laviſhed on this favourite country every production that can contribute to the happineſs of its inhabitants.

On the other hand, the rivers of Georgia, being fed by mountain torrents, are at all ſeaſons either too rapid or too ſhallow for the purpoſes of navigation: the Black ſea, by which commerce and civilization might be introduced from Europe, has been till very lately in the excluſive poſſeſſion of the Turks: the trade of Georgia by land is greatly obſtructed by the high mountains of Caucaſus; and this obſtacle is ſtill increaſed by the ſwarms of predatory nations, by which thoſe mountains are inhabited.

It is ſaid, that in the 15th century, a king of Georgia divided among his five ſons the provinces of Carduel and Caket, Imeretia, Mingrelia, Guriel, and Abcaſſia. Theſe petty princes were too jealous to unite for their common defence, and too weak ſingly to reſiſt a foreign enemy, or even to check the encroachments of their great vaſſals, who ſoon became independent. By forming a party among theſe nobles, the Turks gradually gained poſſeſſion of all the weſtern provinces, while the Perſians occupied the governments of Carduel and Caket. Since that period the many unſucceſsful attempts of the Georgians to recover their liberty have repeatedly produced the devaſtation of their country. Abbas the Great is ſaid to have carried off in one expedition from the provinces of of Carduel and Caket no lefs than 80,000 families; a number which, probably, exceeds the whole actual population of thofe provinces. The moft horrible cruelties were again exercifed on the unhappy people, at the beginning of the prefent century, by the mercilefs Nadir; but thefe were trifling evils, compared with thofe arifing from the internal diffenfions of the great barons. This numerous body of men, idle, arrogant, and ferocious, poffeffed of an unlimited power over the lives and properties of their vaffals, having no employment but that of arms, and no hopes of aggrandizing themfelves but by the plunder of their rivals, were conftantly in a ftate of warfare; and as their fuccefs was various, and the peafants of the vanquifhed were conftantly carried off and fold to the Turks or Perfians, every expedition increafed the depopulation of the country. At length they invited the neighbouring mountaineers, by the hopes of plunder, to take part in their quarrels; and thefe dangerous allies, becoming acquainted with the country, and being fpectators of the weaknefs of its inhabitants, foon completed its defolation. A few fqualid wretches, half naked, half ftarved, and driven to defpair by the mercilefs exactions of their landlords, are thinly difperfed over the moft beautiful provinces of Georgia. The revolutions of Perfia, and the weaknefs of the Turks, have indeed enabled the princes of the country to recover their independence; but the fmallnefs of their revenue has hitherto difabled them from repreffing effectually the tyranny of the nobles, and relieving the burdens of the peafants.

The capital of Georgia is Teflis, where Prince Heraclius refides (See Teflis.) Of this prince, fo celebrated for his exploits and fuccefs in fhaking off the Ottoman yoke, we have the following account by the late Profeffor Guldenftaedt when he travelled into thefe parts in 1770. "Heraclius, or, as he is called, the Tzar Iracli, is above 60 years old, of a middle fize, with a long countenance, a dark complexion, large eyes, and a fmall beard. He paffed his youth at the court and in the army of the celebrated Nadir Shah, where he contracted a fondnefs for Perfian cuftoms and manners, which he has introduced into his kingdom. He has feven fons and fix daughters. He is much revered and dreaded by the Perfian khans his neighbours; and is ufually chofen to mediate between them in their difputes with each other. When they are at war, he fupports one of the parties with a few troops, who diffufe a fpirit and courage among the reft, becaufe the Georgian foldiers are efteemed the braveft of thofe parts; and Prince Heraclius himfelf is renowned for his courage and military fkill. When on horfeback he has always a pair of loaded piftols at his girdle, and, if the enemy is near, a mufket flung over his fhoulder. In all engagements he is the foremoft to give examples of perfonal bravery; and frequently charges the enemy at the head of his troops with the fabre in his hand. He loves pomp and expence; he has adopted the drefs of Perfia; and regulates his court after the manner of that country. From the example of the Ruffian troops, who were quartered in Georgia during the laft Turkifh war, he has learnt the ufe of plates, knives, and forks, difhes and houfehold furniture, &c."

The fubjects of Heraclius are eftimated at about 60,000 families; but this, notwithftanding the prefent defolated ftate of the country, is probably an under valuation. The peafants belonging to the queen, and thofe of the patriarch, pay no tax to the prince, and therefore do not appear on the books of the revenue officers. Many fimilar exemptions have likewife been granted by the prince to his fons-in-law, and his favourites. Befides, as the impoft on the peafants is not a poll-tax, but a tax on hearths, the inhabitants of a village, on the approach of the collectors, frequently carry the furniture of feveral huts into one, and deftroy the remainder, which are afterwards very eafily replaced. It is probable, therefore, that the population of Georgia does not fall fhort of 350,000 fouls. The revenues may be eftimated at about 150,000 rubles, or 26,250l. They confift of, 1. The cuftoms, farmed at 1750l.—2. Rent paid by the farmers of the mint, at Teflis, 1750l.—3. The tribute paid by the khans of Erivan and Ganfha, 7000l.—and, 4. The hearth money levied on the peafants, amounting to 15,750l. The common coins here are the abaffes, of about 15d. value, and a fmall copper coin, ftamped at the mint at Teflis. Befides thefe, a large quantity of gold and filver money is brought into the country from Perfia and Turkey, in exchange for honey, butter, cattle, and blue linens.

The government of Georgia is defpotic; but, were it not for the affiftance of the Ruffian troops, the prince would be frequently unable to carry his decrees into execution. The punifhments in criminal cafes are fhockingly cruel; fortunately they are not frequent, becaufe it is feldom difficult to efcape into fome of the neighbouring countries, and becaufe the prince is more enriched by confifcating the property of the criminal, than by putting him to torture. Judicial combats are confidered as the privilege of nobility, and take place when the caufe is extremely intricate, or when the power and intereft of two claimants are fo equal, that neither can force a decifion of the court in his favour. This mode of trial is called an appeal to the judgment of God.

The drefs of the Georgians nearly refembles that of the Coffacks; but men of rank frequently wear the habit of Perfia. They ufually dye their hair, beard, and nails with red. The Georgian women employ the fame colour to ftain the palms of their hands. On their heads they wear a cap or fillet, under which their black hair falls on their forehead: behind, it is braided into feveral treffes. Their eyebrows are painted with black, in fuch a manner as to form one entire line, and their faces are perfectly coated with white and red. Their robe is open to the girdle, fo that they are reduced to conceal their breafts with their hands. Their air and manner are extremely voluptuous. Being generally educated in convents, they can all read and write; a qualification which is very unufual among the men, even of the higheft rank. Girls are betrothed as foon as poffible, often at three or four years of age. In the ftreets the women of rank are always veiled, and then it is indecent in any man to accoft them. It is likewife uncivil in converfation to inquire after the wives of any of the company. Thefe, however, are not ancient cuftoms, but are a confequence of the violences committed by the Perfians, under Shah Nadir.

Georgia.

Travellers accuse the Georgians of drunkenness, superstition, cruelty, sloth, avarice, and cowardice; vices which are everywhere common to slaves and tyrants, and are by no means peculiar to the natives of this country. The descendants of the colonists, carried off by Shah Abbas, and settled at Peria, near Ispahan, and in Masanderan, have changed their character with their government; and the Georgian troops, employed in Persia against the Affghans, were advantageously distinguished by their docility, their discipline, and their courage.

The other inhabitants of Georgia are Tartars, Offi, and Armenians, called in the Georgian language Somakhi. These last are found all over Georgia, sometimes mixed with the natives, and sometimes in villages of their own. They speak among themselves their own language, but all understand and can talk the Georgian. Their religion is partly the Armenian, and partly the Roman Catholic. They are the most oppressed of the inhabitants, but are still distinguished by that instinctive industry which everywhere characterizes the nation.

Besides these, there are in Georgia considerable numbers of Jews, called, in the language of the country, Uria. Some have villages of their own; and others are mixed with the Georgian, Armenian, and Tartar inhabitants, but never with the Offi. They pay a small tribute above that of the natives.

Georgia, one of the United States of America, lying between South Carolina and Florida. It extends 120 miles upon the sea-coast, and 300 miles from thence to the Apalachian mountains, and its boundaries to the north and south are the rivers Savannah and Alatamaha. The whole coast is bordered with islands; the principal of which are Skidaway, Wassaw, Ossabaw, St Catherine's, Sapelo, Frederica, Jekyl, Cumberland, and Amelia.

The settlement of a colony between the rivers Savannah and Alatamaha was meditated in England in 1732, for the accommodation of poor people in Great Britain and Ireland, and for the further security of Carolina. Private compassion and public spirit conspired to promote the benevolent design. Humane and opulent men suggested a plan of transporting a number of indigent families to this part of America free of expence. For this purpose they applied to the king, George II. and obtained from him letters patent, bearing date June 9. 1732, for legally carrying into execution what they had generously projected. They called the new province *Georgia*, in honour of the king, who encouraged the plan. A corporation, consisting of 21 persons, was constituted by the name of, The Trustees for settling and establishing the colony of Georgia.

In November 1732, 116 settlers embarked for Georgia to be conveyed thither free of expence, furnished with every thing requisite for building and for cultivating the soil. Mr James Oglethorpe, one of the trustees, and an active promoter of the settlement, embarked as the head and director of these settlers. They arrived at Charlestown early in the next year. Mr Oglethorpe, accompanied by William Bull, shortly after his arrival, visited Georgia; and after surveying the country, marked the spot on which Savannah now stands, as the fittest to begin their settlement. Here they accordingly began and built a small fort, and a number of small huts for their defence and accommodation. Such of the settlers as were able to bear arms were embodied, and well appointed with officers, arms, and ammunition. A treaty of friendship was concluded between the settlers and their neighbours the Creek Indians, and every thing wore the aspect of peace and future prosperity. But the fundamental regulations established by the trustees of Georgia were ill adapted to the circumstances and situation of the poor settlers, and of pernicious consequences to the prosperity of the province. Yet although the trustees were greatly mistaken with respect to their plan of settlement, it must be acknowledged their views were generous. Like other distant legislators, who framed their regulations upon principles of speculation, they were liable to many errors and mistakes; and however good their design, their rules were found improper and impracticable. These injudicious regulations and restrictions, the wars in which they were involved with the Spaniards and Indians, and the frequent insurrections among themselves, threw the colony into a state of confusion and wretchedness too great for human nature long to endure. Their oppressed situation was represented to the trustees by repeated complaints; till at length finding that the province languished under their care, and weary with the complaints of the people, they in the year 1752 surrendered their charter to the king, and it was made a royal government. —In the year 1740, the Rev. George Whitefield founded an orphan house academy in Georgia about 12 miles from Savannah. Mr Whitefield died at Newbury port, in New England, in October 1770, in the 56th year of his age, and was buried under the Presbyterian church in that place. From the time Georgia became a royal government in 1752 till the peace of Paris in 1763, she struggled under many difficulties, arising from the want of credit and friends, and the frequent molestations of enemies. The good effects of the peace were sensibly felt in the province of Georgia. From this time it began to flourish under the fatherly care of Governor Wright. To form a judgment of the rapid growth of the colony, we need only attend to its exports. In the year 1763, they consisted of 7500 barrels of rice, 9633 pounds of indigo, 1250 bushels of Indian corn, which, together with deer and beaver skins, naval stores, provisions, timber, &c. amounted to no more than 27,021l. sterling. Ten years afterwards, in 1773, they amounted to 121,677l. sterling. The chief articles of export from this state are, rice, tobacco, indigo, sago, lumber of various kinds, naval stores, leather, deer skins, snake-root, myrtle, bees wax, corn, live stock, &c.

During the American war, Georgia was overrun by the British troops, and the inhabitants were obliged to flee to the neighbouring states for safety. Since the peace the progress of the population of this state is said to have been astonishingly rapid; though it has been a good deal checked within these few years by the hostile irruptions of the Creek Indians, who continually harass the frontiers of the state. Treaties have been held, and a cessation of hostilities agreed to, between the parties, but all have hitherto proved ineffectual to the accomplishment of a peace.

These Indians inhabit the middle parts of the state, and

Georgia.

and are the moſt numerous tribe of Indians of any within the limits of the United States. Their whole number is 17,280, of which 5860 are fighting men. Their principal towns lie in latitude 32° and longitude 11° 20′ from Philadelphia. They are ſettled in a hilly but not mountainous country. The ſoil is fruitful in a high degree, and well watered, abounding in creeks and rivulets, whence they are called the *Creek Indians*. The Seminolas, a diviſion of the Creek nation inhabit a level flat country on the Apalachicola and Flint rivers, fertile and well watered. The Chactaws or Flatheads inhabit a very fine and extenſive tract of hilly country, with large and fertile plains intervening, between the Alabama and Miſſiſſippi rivers, in the weſtern part of this ſtate. This nation have 43 towns and villages, in three diviſions, containing 12,123 ſouls, of which 4041 are fighting men. The Chicaſaws are ſettled on the head branches of the Tombeckbe, Mobile, and Yazoo rivers, in the north-weſt corner of the ſtate. Their country is an extenſive plain, tolerably well watered from ſprings, and of a pretty good ſoil. They have 7 towns, the central one of which is in latitude 34° 23′, and longitude 14° 30′ weſt. The number of ſouls in this nation, have been reckoned at 1725, of which 575 are fighting men.

That part of Georgia which has been laid out in counties is divided into the following, viz. Chatham, Effingham, Burke, Richmond, Wilkes, Liberty, Glynn, Camden, Waſhington, Greene, Franklin; and the chief towns are, Savannah, Ebenezer, Wayneſborough and Louiſville, Auguſta, Waſhington, Sunbury, Brunſwick, St Patrick's, Golphinton, Greenſburg.—Savannah was formerly the capital, and is ſtill the largeſt town (ſee Savannah). But the preſent ſeat of government in this ſtate is *Auguſta*, ſituated on the ſouth-weſt bank of Savannah river, about 134 miles from the ſea, and 117 north-weſt of Savannah. The town, which contains not far from 200 houſes, is on a fine large plain; and as it enjoys the beſt ſoil, and the advantage of a central ſituation between the upper and lower countries, is riſing faſt into importance. Louiſville, however, is deſigned as the future ſeat of government in this ſtate. It has lately been laid out on the bank of Ogeechee river, about 70 miles from its mouth, but is not yet built.

Savannah river forms a part of the diviſional line which ſeparates this ſtate from South Carolina. It is formed principally of two branches, by the names of *Tugulo* and *Keowee*, which ſpring from the mountains. Ogeechee river, about 18 miles ſouth of the Savannah, is a ſmaller river, and nearly parallel with it in its courſe. Alatamaha, about 60 miles ſouth of Savannah river, is formed by the junction of the Okonee and Okemulgee branches. It is a noble river, but of difficult entrance. Like the Nile, it diſcharges itſelf by ſeveral mouths into the ſea. Beſides theſe, there is Turtle river, Little Sitilla, Great Sitilla, Crooked river, and St Mary's, which form a part of the ſouthern boundary of the United States. The rivers in the middle and weſtern parts of this ſtate are the Apalachicola, which is formed by the Chatahouchee and Flint rivers, Mobile, Paſcagoula, and Pearl rivers. All theſe running ſouthwardly, empty into the gulf of Mexico.

In the grand convention at Philadelphia in 1787, the inhabitants of this ſtate were reckoned at 90,000, including three-fifths of 20,000 negroes. But from the number of the militia, which has been aſcertained with a conſiderable degree of accuracy, there cannot be at moſt more than half that number. No general character will apply to the inhabitants at large. Collected from different parts of the world, as intereſt, neceſſity, or inclination led them, their character and manners muſt of courſe partake of all the varieties which diſtinguiſh the ſeveral ſtates and kingdoms from whence they came. There is ſo little uniformity, that it is difficult to trace any governing principles among them. An averſion to labour is too predominant, owing in part to the relaxing heat of the climate, and partly to the want of neceſſity to excite induſtry. An open and friendly hoſpitality, particularly to ſtrangers, is an ornamental characteriſtic of a great part of this people.

In regard to religion, politics, and literature, this ſtate is yet in its infancy. In Savannah is an Epiſcopal church, a Preſbyterian church, a ſynagogue, and a German Lutheran church, ſupplied occaſionally by a German miniſter from Ebenezer, where there is a large convenient ſtone church, and a ſettlement of ſober induſtrious Germans of the Lutheran religion. In Auguſta they have an Epiſcopal church. In Midway is a ſociety of Chriſtians eſtabliſhed on the congregational plan. Their anceſtors emigrated in a colony from Dorcheſter, near Boſton, about the year 1700, and ſettled at a place named Dorcheſter, about 20 miles ſouth-weſt of Charleſtown, South Carolina. In 1752, for the ſake of a better climate and more land, almoſt the whole ſociety removed and ſettled at Midway.—They, as a people, retain in a great meaſure that ſimplicity of manners, that unaffected piety and brotherly love, which characterized their anceſtors, the firſt ſettlers of New England. The upper countries are ſupplied pretty generally by Baptiſt and Methodiſt miniſters; but the greater part of the ſtate is without miniſters of any denomination.

The numerous defects in the late conſtitution of this ſtate, induced the citizens pretty univerſally to petition for a reviſion of it. It was accordingly reviſed, or rather a new one was formed, in the courſe of the year 1789, nearly upon the plan of the conſtitution of the United States, which has lately been adopted by the ſtate.

The charter containing the preſent ſyſtem of education in this ſtate was paſſed in the year 1785. A college, with ample and liberal endowments, is inſtituted in Louiſville, a high and healthy part of the country, near the centre of the ſtate. There is alſo proviſion made for the inſtitution of an academy in each county in the ſtate, to be ſupported from the ſame funds, and conſidered as parts and members of the ſame inſtitution, under the general ſuperintendance and direction of a preſident and board of truſtees, appointed for their literary accompliſhments from the different parts of the ſtate, and inveſted with the cuſtomary powers of corporations. The inſtitution thus compoſed is denominated *the univerſity of Georgia*.—The funds for the ſupport of this inſtitution are principally in lands, amounting in the whole to about 50,000 acres, a great part of which is of the beſt quality,

lity, and at present very valuable. There are also nearly 6000l. sterling in bonds, houses, and town lots in the town of Augusta. Other public property to the amount of 1000l. in each county has been set apart for the purposes of building and furnishing their respective academies. The funds originally designed for the support of the orphan house are chiefly in rice plantations and negroes.

Georgia, a township in the county of Franklin, containing about 400 inhabitants. It is situated on Lake Champlain, opposite to the north end of South Hero island.

Georgia, a cluster of barren islands in the South sea, to the eastward of the coast of Terra del Fuego, in lat. 54° 35′ S. and long. 36° 30′ W. One of these islands is from 150 to 180 miles in length.

GEORGIC, a poetical composition upon the subject of husbandry, containing rules therein, put into a pleasing dress, and set off with all the beauties and embellishments of poetry. The word is borrowed from the Latin *georgicus*, and that of the Greek γεωργικος, of γη, *terra*, "earth," and εργαζομαι, *opero*, "I work, or labour," of εργον, *opus*, "work." Hesiod and Virgil are the two greatest masters in this kind of poetry.—The moderns have produced nothing in this kind, except Rapin's book of Gardening; and the celebrated poem entitled Cyder, by Mr Philips, who, if he had enjoyed the advantage of Virgil's language, would have been second to Virgil in a much nearer degree.

Georgium Sidus. See Astronomy *Index*.

GEPIDÆ, Gepides, or Gepidi, in *Ancient Geography*, according to Procopius, were a Gothic people, or a canton or branch of them; some of whom, in the migration of the Goths, settled in an island at the mouth of the Vistula, which they called *Gepidos* after their own name, which denotes lazy or slothful; others in Dacia, calling their settlement there *Gepidia*.

GERANIUM, crane's bill, in *Botany*, a genus of plants belonging to the monadelphia class; and in the natural method ranking under the 14th order, *Gruinales*. See Botany *Index*.

GERAR, or Gerara, in *Ancient Geography*, the south boundary of Canaan near Berseba; situated between Cades and Sur; two deserts well known, the former facing Egypt, the latter Arabia Petræa.

GERARDE, John, a surgeon in London, and the greatest botanist of his time, was many years chief gardener to Lord Burleigh; who was himself a great lover of plants, and had the best collection of any nobleman in the kingdom, among which were a great number of exotics introduced by Gerarde. In 1597 he published his *Herbal*, which was printed at the expence of J. Norton, who procured from Francfort the same blocks in wood as were used in the herbal of Tabernæmontanus. In 1663, Thomas Johnson, an apothecary, published an improved edition of Gerarde's book; which met with such approbation by the university of Oxford, that they conferred on him the degree of doctor of physic. The descriptions in the herbal are plain and familiar; and both these authors have laboured more to make their readers understand the characters of the plants, than to inform them that they themselves understood Greek and Latin. The herbal of Gerarde is now to be considered only as a literary curiosity. The figures in general express very accurately the characters of the plants they are intended to represent.

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

GERFALCON. See Falco, Ornithology *Index*.

GERGESA, in *Ancient Geography*, a Transjordan town, no otherwise known than by the *Gergeseni* of St Matthew, and *Gergesæi* of Moses; supposed to have stood in the neighbourhood of Gadara and near the sea of Tiberias. The *Gergesæi*, one of the seven ancient people of Canaan, less frequently mentioned than the rest, appear to have been less considerable and more obscure: their name is from *Girgasi*, one of Canaan's sons. See Girgashites.

GERIZIM. See Garizim.

GERM, in vegetation. See Germen.

GERMAN, in matters of genealogy, signifies whole, entire, or own. *Germani, quasi eadem stirpe geniti*; (Fest.) Hence,

Brother German, denotes a brother both by the father's and mother's side, in contradistinction to uterine brothers, &c. who are only so by the mother's side.

Cousins German, are those in the first or nearest degree, being the children of brothers or sisters.

Among the Romans we have no instance of marriage between cousins german before the time of the emperor Claudius, when they were very frequent.

Theodosius prohibited them under very severe penalties, even fine and proscription. See Consanguinity.

German, or *Germanic*, also denotes any thing belonging to Germany; as the German empire, German flute, &c.

GERMANDER. See Teucrium, Botany *Index*.

GERMANICUS Cæsar, the son of Drusus, and paternal nephew to the emperor Tiberius, who adopted him; a renowned general, but still more illustrious for his virtues. He took the title of *Germanicus* from his conquests in that country; and though he had the moderation to refuse the empire offered to him by his army, Tiberius, jealous of his success, and of the universal esteem he acquired, caused him to be poisoned, A. D. 29, aged 34. He was a protector of learning; and composed some Greek comedies and Latin poems, some of which are still extant.

GERMANTOWN, in the county of Philadelphia, Pennsylvania, in North America, about seven miles from the city of Philadelphia. It was once esteemed the second town in the country, till many inland towns in a short time rose superior to it, both for the extent of their establishments and number of inhabitants. The knitting of cotton, thread, and worsted stockings, is carried on in it to a considerable extent. The principal congregation of the people called Mennonists is in Germantown, who derive their name from one Menno Simon, a learned man of Witmars in Germany. Although inimical to the doctrine of general salvation, they will not swear, fight, bear any civil office, go to law, or take interest for money. Germantown is also memorable for a bloody battle which was fought in it on the 4th of October, 1777.

GERMANY, a very extensive empire of Europe, but which, in different ages of the world, has had very

very different limits. Its name, according to the most probable conjecture, is derived from the Celtic words *Ghar man*, signifying a warlike man, to which their other name, *Allman*, or *Aleman*, likewise alludes.

The ancient history of the Germans is altogether wrapped up in obscurity; nor do we, for many ages, know any thing more of them than what may be learned from the history of their wars with the Romans. The first time we find them mentioned by the Roman historians, is about the year 211 B. C. at which time Marcellus subdued Insubria and Liguria, and defeated the Gæsatæ, a German nation situated on the banks of the Rhine. From this time history is silent with regard to any of these northern nations, till the irruption of the Cimbri and Teutones, who inhabited the most northerly parts of Germany. The event of their enterprise is related under the articles AMBRONES, CIMBRI, and TEUTONES. We must not, however, imagine, because these people happened to invade Italy at the same time, that therefore their countries were contiguous to one another. The Cimbri and Teutones only dwelt beyond the Rhine; while the Ambrones inhabited the country between Switzerland and Provence. It is indeed very difficult to fix the limits of the country called *Germany* by the Romans. The southern Germans were intermixed with the Gauls, and the northern ones with the Scythians; and thus the ancient history of the Germans includes that of the Dacians, Huns, Goths, &c. till the destruction of the western Roman empire by them. Ancient Germany, therefore, we may reckon to have included the northern part of France, the Netherlands, Holland, *Germany* so called at present, Denmark, Prussia, Poland, Hungary, part of Turkey in Europe, and Muscovy.

1 Limits of ancient Germany.

The Romans divided Germany into two regions; Belgic or Lower Germany, which lay to the southward of the Rhine; and Germany Proper, or High Germany. The first lay between the rivers Seine and the Rhine; and in this we find a number of different nations, the most remarkable of which were the following.

2 Nations inhabiting Lower Germany.

1. The Ubii, whose territory lay between the Rhine and the Mosa or Maese, and whose capital was the city of Cologne. 2. Next to them were the Tungri, supposed to be the same whom Cæsar calls *Eburones* and *Condrusi;* and whose metropolis, then called *Attuatica*, has since been named *Tongres*. 3. Higher up from them, and on the other side of the Moselle, were the Treviri, whose capital was Augusta Trevirorum, now *Triers*. 4. Next to them were the Tribocci, Nemetes, and Vangiones. The former dwelt in Alsace, and had Argentoratum, now *Strasburg*, for their capital; the others inhabited the cities of Worms, Spire, and Mentz. 5. The Mediomatrici were situated along the Moselle, about the city of Metz in Lorrain: and above them were situated another German nation, named *Raurici*, *Rauraci*, or *Rauriaci*, and who inhabited that part of Helvetia, or Switzerland, about Basil. To the westward and southward of these were the Nervii, Suessiones, Silvanectes, Leuci, Rhemi, Lingones, &c. who inhabited Belgic Gaul.

Between the heads of the Rhine and Danube was seated the ancient kingdom of Vindelicia, whose capital was called *Augusta Vindelicorum*, now *Augsburg*. Below it on the banks of the Danube were the kingdoms of Noricum and Pannonia. The first of these was divided into Noricum *Ripense* and *Mediterraneum*. It contained a great part of the provinces of Austria, Styria, Carinthia, Tyrol, Bavaria, and some others of less note. The latter contained the kingdom of Hungary, divided into Upper and Lower; and extending from Illyricum to the Danube, and the mountains Cætii in the neighbourhood of *Vindebona*, now *Vienna*.

3 Nations inhabiting High Germany.

Upper or High Germany lay beyond the Rhine and the Danube. Between the Rhine and the Elbe were the following nations. 1. The Chauci, Upper and Lower; who were divided from each other by the river Visurges, now the *Weser*. Their country contained what is now called *Bremen*, *Lunenburg*, *Friezland*, and *Groninghen*. The Upper Chauci had the Cherusci, and the lower the Chamavi on the south-east, and the German ocean on the north-west. 2. The Frisii, Upper and Lower, were divided from the Lower Chauci by the river Amisia, now the Ems; and from one another by an arm of the Rhine. Their country still retains the name of *Friesland*, and is divided into east and west; but the latter is now dismembered from Germany, and become one of the Seven United Provinces. 3. Beyond the Isela, now the *Isel*, which bounded the country of the Frisii, were situated the Bructeri, who inhabited that tract now called *Broecmorland;* and the Marsi, about the river Luppe. On the other side of that river were the *Usipii* or *Usipetes;* but these were famed for often changing their territories, and therefore found in other places. 4. Next to these were the Juones, or inhabitants of Juliers, between the Maese and the Rhine. 5. The Catti, another ancient and warlike nation, inhabited Hesse and Thuringia, from the Hartzian mountains to the Rhine and Weser: among whom were comprehended the Mattiaci, whose capital is by some thought to be *Marpurg*, by others *Baden*. 6. Next to these were the Sedusii bordering upon Suabia; the Norisci, or the ancient inhabitants of Northgow, whose capital was Nuremberg; and the Marcomanni, whose country anciently reached from the Rhine to the head of the Danube, and to the Neckar. The Marcomanni afterwards went and settled in Bohemia and Moravia, under their general or king Maroboduus: and some of them in Gaul, whence they drove the Boii, who had seated themselves there. 7. On the other side of the Danube, and between the Rhine and it, were the Hermunduri, who possessed the country now called *Misnia* in Upper Saxony; though some make their territories to have extended much farther, and to have reached quite to, or even beyond, the kingdom of Bohemia, once the seat of the Boii, whence its name. 8. Beyond them, on the north of the Danube, was another seat of the Marcomanni along the river Albis, or Elbe. 9. Next to Bohemia were situated the Quadi, whose territories extended from the Danube to Moravia, and the northern part of Austria. These are comprehended under the ancient name of *Suevi;* part of whom at length forced their way into Spain, and settled a kingdom there. 10. Eastward of the Quadi were situated the Bastarnæ, and parted from them by the Granna, now *Gran;* a river that falls into the Danube, and by the Carpathian mountains, from them called *Alpes Basiarnicæ*. The country of the Bastarnæ indeed

Germany. indeed made part of the European Sarmatia, and so was without the limits of Germany properly so called; but we find these people so often in league with the German nations, and joining them for the destruction of the Romans, that we cannot but account them as one people.

Between those nations already taken notice of, seated also on the other side of the Danube and the Hercynian forest, were several others whose exact situation is uncertain, viz. the Martingi, Burii, Borades, Lygii or Logiones, and some others, who are placed by our geographers along the forest above mentioned, between the Danube and the Vistula.

On this side the Hercynian forest, were the famed Rhætii, now *Grisons*, seated among the Alps. Their country, which was also called *Western Illyricum*, was divided into Rhætia *Prima* or *Propria* and *Secunda*; and was then of much larger extent, spreading itself towards Suabia, Bavaria, and Austria.

On the other side of the Hercynian forest were, 1. The Suevi, who spread themselves from the Vistula to the river Elbe. 2. The Longobardi, so called according to some on account of their wearing long beards, but, according to others, on account of their consisting of two nations, viz. the Bardi and Lingones. These dwelt along the river Elbe, and bordered southward on the Chauci above mentioned. 3. The Burgundi, of whose original seat we are uncertain. 4. The Semnones; who, about the time of Tiberius, were seated on the river Elbe. 5. The Angles, Saxons, and Goths, were probably the descendants of the Cimbri; and inhabited the countries of Denmark, along the Baltic sea, and the peninsula of Scandinavia, containing Norway, Sweden, Lapland, and Finmark. 6. The Vandals were a Gothic nation, who, proceeding from Scandinavia, settled in the countries now called *Mecklenburgh* and *Brandenburgh*. 7. Of the same race were the Dacians, who settled themselves in the neighbourhood of the Palus Mæotis, and extended their territories along the banks of the Danube.

These were the names of the German nations who performed the most remarkable exploits in their wars with the Romans. Besides these, however, we find mention made of the Scordisci, a Thracian nation, who afterwards settled on the banks of the Danube. About the year 113 B. C. they ravaged Macedon, and cut off a whole Roman army sent against them; the general, M. Porcius Cato, grandson to Cato the censor, being the only person who had the good fortune to make his escape. After this, they ravaged all Thessaly; and advanced to the coasts of the Adriatic, into which, because it stopped their farther progress, they discharged a shower of darts. By another Roman general, however, they were driven back into their own country with great slaughter; and soon after, Metellus so weakened them by repeated defeats, that they were incapable, for some time, of making any more attempts on the Roman provinces. At last, in the consulship of M. Livius Drusus and L. Calpurnius Piso, the former prevailed on them to pass the Danube, which thenceforth became the boundary between the Romans and them. Notwithstanding this, in the time of the Jugurthine war, the Scordisci repassed the Danube on the ice every winter, and being joined by the Triballi a people of Lower Mæsia, and the Daci of Upper Mæsia, penetrated as far as Macedon, committing everywhere dreadful ravages. So early did these northern nations begin to be formidable to the Romans, even when they were most renowned for warlike exploits.

4 Wars of the Scordisci with the Romans.

Till the time of Julius Cæsar, however, we hear nothing more concerning the Germans. About 58 years B. C. he undertook his expedition into Gaul; during which, his assistance was implored by the Ædui, against Ariovistus, a German prince who oppressed them. Cæsar, pleased with this opportunity of increasing his power, invited Ariovistus to an interview; but this being declined, he next sent deputies, desiring him to restore the hostages he had taken from the Ædui, and to bring no more troops over the Rhine into Gaul. To this a haughty answer was returned; and a battle soon after ensued, in which Ariovistus was entirely defeated, and with great difficulty made his escape.

5 Expedition of Julius Cæsar into Germany.

In 55 B. C. Cæsar having subdued the Suessiones, Bellovaci, Ambiani, Nervii, and other nations of Belgic Gaul, hastened to oppose the Usipetes and Tenchtheri. These nations having been driven out of their own country by the Suevi, had crossed the Rhine with a design to settle in Gaul. As soon as he appeared, the Germans sent him a deputation, offering to join him, provided he would assign them lands. Cæsar replied, that there was no room in Gaul for them; but he would desire the Ubii to give them leave to settle among them. Upon this, they desired him to retreat with the Ubii; but in the mean time fell upon some Roman squadrons: which so provoked Cæsar, that he immediately marched against them, and coming unexpectedly upon them, defeated them with great slaughter. They fled in the utmost confusion; but the Romans pursued them to the conflux of the Rhine and the Maese, where the slaughter was renewed with such fury, that almost 400,000 of the Germans perished. After this, Cæsar being resolved to spread the terror of the Roman name through Germany, built a bridge over the Rhine, and entered that country. In this expedition, however, which was his last in Germany, he performed no remarkable exploit. A little before his death, indeed, he had projected the conquest of that, as well as of a great many other countries; but his assassination prevented the execution of his designs. Nor is there any thing recorded of the Germans till about 17 B. C. when the Tenchtheri made an irruption into Gaul, and defeated M. Lollius, proconsul of that province. At last, however, they were repulsed, and forced to retire with great loss beyond the Rhine.

6 Rhætii invade Italy.

Soon after this the Rhætii invaded Italy, where they committed the greatest devastations, putting all the males they met to the sword, without distinction of age: nay, we are told, that when they happened to take women with child, they consulted their augurs to know whether the child was a male or female; and if they pronounced it a male, the mother was immediately massacred. Against these barbarians was sent Drusus, the second son of Livia, a youth of extraordinary valour and great accomplishments. He found means to bring them to a battle; in which the Romans proved victorious, and cut in pieces great numbers of their enemies, with very little loss on their own

own fide. Thofe who efcaped the general flaughter, being joined by the Vindelici, took their route towards Gaul, with a defign to invade that province. But Auguftus, upon the firft notice of their march, defpatched againft them Tiberius with feveral chofen legions. He was no lefs fuccefsful than Drufus had been; for having tranfported his troops over the lake Brigantium, now Conftance, he fell unexpectedly on the enemy, gave them a total overthrow, took moft of their ftrong holds, and obliged the whole nation to fubmit to fuch terms as he chofe to impofe upon them.

7 They are fubdued, together with the Vindelici and Norici,

Thus were the Vindelici, the Rhætii, and Norici, three of the moft barbarous nations in Germany fubdued. Tiberius, to keep the conquered countries in awe, planted two colonies in Vindelicia, and opened from thence a road into Rhætia and Noricum. One of the cities which he built for the defence of his colonies, he called, from his father Drufus, *Drufomagus;* the other by the name of Auguftus, *Augufta Vindelicorum;* which cities are now known by the names of *Mimminghen* and *Augsburg*. He next encountered the Pannonians, who had been fubdued by Agrippa, but revolted on hearing the news of that great commander's death, which happened 11 years B. C. Tiberius, however, with the affiftance of their neighbours the Scordifci, foon forced them to fubmit. They delivered up their arms, gave hoftages, and put the Romans in poffeffion of all their towns and ftrong holds. Tiberius fpared their lives; but laid wafte their fields, plundered their cities, and fent the beft part of their youth into other countries.

8 and the Pannonians.

In the mean time, Drufus having prevented the Gauls from revolting, which they were ready to do, prepared to oppofe the Germans who dwelt beyond the Rhine. They had collected the moft numerous and formidable army that had ever been feen in thofe parts; with which they were advancing towards the Rhine, in order to invade Gaul. Drufus defeated them as they attempted to crofs that river; and, purfuing the advantage he had gained, entered the country of the Ufipetes, now *Relinchufen*, and from thence advanced againft the Sicambri in the neighbourhood of the Lyppe and Yffel. Them he overthrew in a great battle, laid wafte their country, burnt moft of their cities, and following the courfe of the Rhine, approached the German ocean, reducing the Frifii and the Chauci between the Ems and the Elbe. In thefe marches the troops fuffered extremely for want of provifions; and Drufus himfelf was often in great danger of being drowned, as the Romans who attended him were at that time quite unacquainted with the flux and reflux of the ocean.

9 Exploits of Drufus in Germany.

The Roman forces went into Eaft Friefland for their winter quarters; and next year (10 B. C.) Drufus marched againft the Tenchtheri, whom he eafily fubdued. Afterwards, paffing the Lupias, now the Lyppe, he reduced the Catti and Cherufci, extending his conquefts to the banks of the Vifurgis or Wefer; which he would have paffed, had he not been in want of provifions, the enemy having laid wafte the country to a confiderable diftance. As he was retiring, the Germans unexpectedly fell upon him in a narrow paffage; and having furrounded the Roman army, cut a great many of them in pieces. But Drufus having animated his men by his example, after a bloody conflict, which lafted the whole day, the Germans were defeated with fuch flaughter, that the ground was ftrewed for feveral miles with dead bodies. Drufus found in their camp a great quantity of iron chains which they had brought for the Romans; and fo great was their confidence, that they had agreed beforehand about the divifion of the booty. The Tenchtheri were to have the horfes, the Cherufci and Sicambri the baggage, and the Ufipetes and Catti the captives. After this victory, Drufus built two forts to keep the conquered countries in awe; the one at the confluence of the Lyppe and the Alme, the other in the country of the Catti on the Rhine. On this occafion alfo he made a famous canal, long after called in honour of him *Foffa Drufiana*, to convey the waters of the Rhine into the Sala or Sale. It extended eight miles; and was very convenient for conveying the Roman troops by water to the countries of the Frifii and Chauci, which was the defign of the undertaking.

The following year (9 B. C.) Auguftus, bent on fubduing the whole of Germany, advanced to the banks of the Rhine, attended by his two fons-in-law Tiberius and Drufus. The former he fent againft the Daci, who lived up to the fouth of the Danube; and the latter to complete the conqueft he had fo fuccefsfully begun in the weftern parts of Germany. The former eafily overcame the Daci, and tranfplanted 40,000 of them into Gaul. The latter, having paffed the Rhine, fubdued all the nations from that river to the Elbe; but having attempted in vain to crofs this laft, he fet out for Rome: an end, however, was put to his conquefts and his life by a violent fever, with which he was feized on his return.

After the death of Drufus, Tiberius again overran all thofe countries in which Drufus had fpent the preceding fummer; and ftruck fome of the northern nations with fuch terror, that they fent deputies to fue for peace. This, however, they could not obtain upon any terms; the emperor declaring that he would not conclude a peace with one, unlefs they all defired it. But the Catti, or according to fome the Sicambri, could not by any means be prevailed upon to fubmit; fo that the war was ftill carried on, though in a languid manner, for about 18 years. During this period, fome of the German nations had quitted their forefts, and begun to live in a civilized manner under the protection of the Romans; but one Quinctilius Varus being fent to command the Roman forces in that country, fo provoked the inhabitants by his extortions, that not only thofe who ftill held out refufed to fubmit, but even the nations that had fubmitted were feized with an eager defire of throwing off the yoke. Among them was a young nobleman of extraordinary parts and valour, named *Arminius*. He was the fon of Sigimer, one of the moft powerful lords among the Catti, had ferved with great reputation in the Roman armies, and been honoured by Auguftus with the privileges of a Roman citizen and the title of knight. But the love of his country prevailing over his gratitude, he refolved to improve the general difcontent which reigned among his countrymen, to deliver them from the bondage of a foreign dominion. With this view he engaged, underhand, the leading men of all the nations between the Rhine and the Elbe, in a confpiracy againft the Romans. In order to put Varus off

10 Arminius heads the Germans againft the Romans.

Germany.

off his guard, he at the ſame time adviſed him to ſhow himſelf to the inhabitants of the more diſtant provinces, adminiſter juſtice among them, and accuſtom them, by his example, to live after the Roman manner, which he ſaid would more effectually ſubdue them than the Roman ſword. As Varus was a man of a peaceable temper, and averſe from military toils, he readily conſented to this inſidious propoſal, and, leaving the neighbourhood of the Rhine, marched into the country of the Cheruſci. Having there ſpent ſome time in hearing cauſes and deciding civil controverſies, Arminius perſuaded him to weaken his army, by ſending out detachments to clear the country of robbers. When this was done, ſome diſtant nations of Germany roſe up in arms by Arminius's directions; while thoſe through which Varus was to paſs in marching againſt them, pretended to be in a ſtate of profound tranquillity, and ready to join the Romans againſt their enemies.

11 Cuts off Varus with his army.

On the firſt news of the revolt, Varus marched againſt the enemy with three legions and ſix cohorts; but being attacked by the Germans as he paſſed through a wood, his army was almoſt totally cut off, while he himſelf and moſt of his officers fell by their own hands. Such a terrible overthrow, though it raiſed a general conſternation in Rome, did not, however, diſhearten Auguſtus, or cauſe him to abandon his enterpriſe. About two years after (A. D. 12.), Tiberius and Germanicus were appointed to command in Germany. The death of Auguſtus, however, which happened ſoon after, prevented Tiberius from going on his expedition; and Germanicus was for ſome time hindered from proceeding in his, by a revolt of the legions, firſt in Pannonia, and then in Germany. About the year 15, Germanicus having brought over the ſoldiers to their duty, laid a bridge acroſs the Rhine, over which he marched 12,000 legionaries, 26 cohorts of the allies, and eight alæ (ſquadrons of 300 each) of horſe. With theſe he firſt traverſed the Cœſian foreſt (part of the Hercynian, and thought to lie partly in the duchy of Cleves, and partly in Weſtphalia), and ſome other woods. On his march he was informed that the Marſi were celebrating a feſtival with great mirth and jollity. Upon this he advanced with ſuch expedition, that he ſurpriſed them in the midſt of their debauch; and giving his army full liberty to make what havock they pleaſed, a terrible maſſacre enſued, and the country was deſtroyed with fire and ſword for 50 miles round, without the loſs of a ſingle man on the part of the Romans.—This general maſſacre rouſed the Bructeri, the Tubantes, and the Uſipetes; who, beſetting the paſſes through which the Roman army was to return, fell upon their rear, and put them into ſome diſorder; but the Romans ſoon recovered themſelves, and defeated the Germans with conſiderable loſs.

12 Exploits of Germanicus.

The following year (A. D. 16.), Germanicus taking advantage of ſome inteſtine broils which happened among the Catti, entered their country, where he put great numbers to the ſword. Moſt of their youth, however, eſcaped by ſwimming over the Adrana, now the Oder, and attempted to prevent the Romans from laying a bridge over that river: but being diſappointed in this, ſome of them ſubmitted to Germanicus, while the greater part, abandoning their villages, took refuge in the woods; ſo that the Romans, without oppoſition, ſet fire to all their villages, towns, &c. and having laid their capital in aſhes, began their march back to the Rhine.

Germanicus had ſcarce reached his camp, when he received a meſſage from Segeſtes, a German prince, in the intereſt of the Romans, acquainting him that he was beſieged in his camp by Arminius. On this advice, he inſtantly marched againſt the beſiegers; entirely defeated them; and took a great number of priſoners, among whom was Thuſneldis, the wife of Arminius, and daughter of Segeſtes, whom the former had carried off, and married againſt her father's will. Arminius then, more enraged than ever, for the loſs of his wife, whom he tenderly loved, ſtirred up all the neighbouring nations againſt the Romans. Germanicus, however, without being diſmayed by ſuch a formidable confederacy, prepared himſelf to oppoſe the enemy with vigour: but, that he might not be obliged to engage ſuch numerous forces at once, detached his lieutenant Cæcina, at the head of 40 cohorts, into the territories of the Bructeri; while his cavalry, under the command of Pedo, entered the country of the Friſii. As for Germanicus himſelf, he embarked the remainder of his army, conſiſting of four legions, on a neighbouring lake; and tranſported them by rivers and canals to the place appointed on the river Ems, where the three bodies met. In their march they found the ſad remains of the legions conducted by Varus, which they buried with all the ceremony their circumſtances could admit. After this they advanced againſt Arminius, who retired and poſted himſelf advantageouſly cloſe to a wood. The Roman general followed him; and coming up with him, ordered his cavalry to advance and attack the enemy. Arminius, at their firſt approach, pretended to fly; but ſuddenly wheeled about, and giving the ſignal to a body of troops, whom he had concealed in the wood, to ruſh out, obliged the cavalry to give ground. The cohorts then advanced to their relief; but they too were put into diſorder, and would have been puſhed into a moraſs, had not Germanicus himſelf advanced with the reſt of the cavalry to their relief. Arminius did not think it prudent to engage theſe freſh troops, but retired in good order; upon which Germanicus alſo retired towards the Ems. Here he embarked with four legions, ordered Cæcina to reconduct the other four by land, and ſent the cavalry to the ſea ſide, with orders to march along the ſhore to the Rhine. Though Cæcina was to return by roads well known, yet Germanicus adviſed him to paſs, with all poſſible ſpeed, a cauſeway, called the *long bridges*, which led acroſs vaſt marſhes, ſurrounded on all ſides with woods and hills that gently roſe from the plain.

Arminius, however, having got notice of Cæcina's march, arrived at the long bridges before Cæcina, and filled the woods with his men, who, on the approach of the Romans, ruſhed out, and attacked them with great fury. The legions, not able to manage their arms in the deep waters and ſlippery ground, were obliged to yield; and would in all probability have been entirely defeated, had not night put an end to the combat. The Germans, encouraged by their ſucceſs, inſtead of refreſhing themſelves with ſleep, ſpent the whole night in diverting the courſes of the ſprings

which

Germany. which rose in the neighbouring mountains; so that, before day, the camp which the Romans had begun was laid under water, and their works were overturned. Cæcina was for some time at a loss what to do; but at last resolved to attack the enemy by daybreak, and, having driven them to their woods, to keep them there in a manner besieged, till the baggage and wounded men should pass the causeway, and get out of the enemy's reach. But when his army was drawn up, the legions posted on the wings, seized with a sudden panic, deserted their stations, and occupied a field beyond the marshes. Cæcina thought it advisable to follow them; but the baggage stuck in the mire, as he attempted to cross the marshes, which greatly embarrassed the soldiers. Arminius perceiving this, laid hold of the opportunity to begin the attack; and crying out, "This is a second Varus, the same fate attends him and his legions," fell on the Romans with inexpressible fury. As he had ordered his men to aim chiefly at the horses, great numbers of them were killed; and the ground becoming slippery with their blood and the slime of the marsh, the rest either fell or threw their riders, and, galloping through the ranks, put them in disorder. Cæcina distinguished himself in a very eminent manner; but his horse being killed, he would have been taken prisoner, had not the first legion rescued him. The greediness of the enemy, however, saved the Romans from utter destruction; for just as the legions were quite spent, and on the point of yielding, the barbarians on a sudden abandoned them in order to seize their baggage. During this respite, the Romans struggled out of the marsh, and having gained the dry fields, formed a camp with all possible speed, and fortified it in the best manner they could.

The Germans having lost the opportunity of destroying the Romans, contrary to the advice of Arminius, attacked their camp next morning, but were repulsed with great slaughter; after which they gave Cæcina no more molestation till he reached the banks of the Rhine. Germanicus, in the mean time, having conveyed the legions he had with him down the river Ems into the ocean, in order to return by sea to the river Rhine, and finding that his vessels were overloaded, delivered the second and 14th legions to Publius Vitellius, desiring him to conduct them by land. But this march proved fatal to great numbers of them; who were either buried in the quicksands, or swallowed up by the overflowing of the tide, to which they were as yet utter strangers. Those who escaped, lost their arms, utensils, and provisions; and passed a melancholy night upon an eminence, which they had gained by wading up to the chin. The next morning the land returned with the tide of ebb; when Vitellius, by a hasty march, reached the river Usingis, by some thought to be the Hoerenster, on which the city of Groningen stands. There Germanicus, who had reached that river with his fleet, took the legions again on board, and conveyed them to the mouth of the Rhine, whence they all returned to Cologne, at a time when it was reported they were totally lost.

This expedition, however, cost the Romans very dear, and procured very few advantages. Great numbers of men had perished; and by far the greatest part of those who had escaped so many dangers returned without arms, utensils, horses, &c. half naked, lamed, and unfit for service. The next year, however, Germanicus, bent on the entire reduction of Germany, made vast preparations for another expedition. Having considered the various accidents that had befallen him during the war, he found that the Germans were chiefly indebted for their safety to their woods and marshes, their short summers and long winters; and that his troops suffered more from their long and tedious marches than from the enemy. For this reason he resolved to enter the country by sea, hoping by that means to begin the campaign earlier, and surprise the enemy. Having therefore built with great despatch, during the winter, 1000 vessels of different sorts, he ordered them early in the spring (A. D. 16.) to fall down the Rhine, and appointed the island of the Batavians for the general rendezvous of his forces. When the fleet was sailing, he detached Silius one of his lieutenants, with orders to make a sudden irruption into the country of the Catti; and, in the mean time, he himself, upon receiving intelligence that a Roman fort on the Luppias was besieged, hastened with six legions to its relief. Silius was prevented, by sudden rains, from doing more than taking some small booty, with the wife and daughter of Arpen king of the Catti; neither did those who besieged the fort wait the arrival of Germanicus. In the mean time, the fleet arriving at the island of the Batavians, the provisions and warlike engines were put on board and sent forward; ships were assigned to the legions and allies; and the whole army being embarked, the fleet entered the canal formerly cut by Drusus, and from his name called *Fossa Drusiana*. Hence he sailed prosperously to the mouth of the Ems; where, having landed his troops, he marched directly to the Weser, where he found Arminius encamped on the opposite bank, and determined to dispute his passage. The next day Arminius drew out his troops in order of battle; but Germanicus, not thinking it advisable to attack them, ordered the horse to ford over under the command of his lieutenants Stertinius and Emilius; who, to divide the enemy's forces, crossed the river in two different places. At the same time Cariovalda, the leader of the Batavian auxiliaries, crossed the river where it is most rapid: but being drawn into an ambuscade, he was killed, together with most of the Batavian nobility; and the rest would have been totally cut off, had not Stertinius and Emilius hastened to their assistance. Germanicus in the mean time passed the river without molestation. A battle soon after ensued; in which the Germans were defeated with so great a slaughter that the ground was covered with arms and dead bodies for more than 10 miles round: and among the spoils taken on this occasion, were found, as formerly, the chains with which the Germans had hoped to bind their captives.

13 His second expedition.

In memory of this signal victory Germanicus raised a mount, upon which he placed as trophies the arms of the enemy, and inscribed underneath the names of the conquered nations. This so provoked the Germans, though already vanquished and determined to abandon their country, that they attacked the Roman army unexpectedly on its march, and put them into some disorder. Being repulsed, they encamped between a river and a large forest surrounded by a marsh except on on one side, where it was enclosed by a broad rampart formerly raised by the Angrivarii as a barrier between them and the Cherusci. Here another battle ensued; in which the Germans behaved with great bravery, but in the end were defeated with great slaughter.

After this second defeat, the Angrivarii submitted, and were taken under the protection of the Romans, and Germanicus put an end to the campaign. Some of the legions he sent to their winter quarters by land, while he himself embarked with the rest on the river Ems, in order to return by sea. The ocean proved at first very calm, and the wind favourable: but all of a sudden a storm arising, the fleet, consisting of 1000 vessels, was dispersed: some of them were swallowed up by the waves; others were dashed in pieces against the rocks, or driven upon remote and inhospitable islands, where the men either perished by famine, or lived upon the flesh of the dead horses with which the shores soon appeared strewed; for, in order to lighten their vessels, and disengage them from the shoals, they had been obliged to throw overboard their horses and beasts of burden, nay, even their arms and baggage. Most of the men, however, were saved, and even great part of the fleet recovered. Some of them were driven upon the coast of Britain; but the petty kings who reigned there generously sent them back.

14 His fleet dispersed by a storm.

On the news of this misfortune, the Catti, taking new courage, ran to arms; but Caius Silius being detached against them with 30,000 foot and 3000 horse, kept them in awe. Germanicus himself, at the head of a numerous body, made a sudden irruption into the territories of the Marsi, where he recovered one of Varus's eagles, and having laid waste the country, he returned to the frontiers of Germany, and put his troops into winter quarters; whence he was soon recalled by Tiberius, and never suffered to return into Germany again.

After the departure of Germanicus, the more northern nations of Germany were no more molested by the Romans. Arminius carried on a long and successful war with Maroboduus king of the Marcomanni, whom he at last expelled, and forced to apply to the Romans for assistance; but, excepting Germanicus, it seems they had at this time no other general capable of opposing Arminius, so that Maroboduus was never restored. After the final departure of the Romans, however, Arminius having attempted to enslave his country, fell by the treachery of his own kindred. The Germans held his memory in great veneration; and Tacitus informs us, that in his time they still celebrated him in their songs.

15 Death of Arminius.

Nothing remarkable occurs in the history of Germany from this time till the reign of the emperor Claudius. A war indeed is said to have been carried on by Lucius Domitius, father to the emperor Nero. But of his exploits we know nothing more than that he penetrated beyond the river Elbe, and led his army farther into the country than any of the Romans had ever done. In the reign of Claudius, however, the German territories were invaded by Cn. Domitius Corbulo, one of the greatest generals of his age. But when he was on the point of forcing them to submit to the Roman yoke, he was recalled by Claudius, who was jealous of the reputation he had acquired.

In the reign of Vespasian, a terrible revolt happened among the Batavians and those German nations who had submitted to the Romans; a particular account of which is given under the article ROME. The revolters were with difficulty subdued; but, in the reign of Domitian, the Dacians invaded the empire, and proved a more terrible enemy than any of the other German nations had been. After several defeats, the emperor was at last obliged to consent to pay an annual tribute to Decebalus king of the Dacians; which continued to the time of Trajan. But that warlike prince refused to pay tribute; alleging, when it was demanded of him, that "he had never been conquered by Decebalus." Upon this the Dacians passed the Danube, and began to commit hostilities in the Roman territories. Trajan, glad of this opportunity to humble an enemy whom he began to fear, drew together a mighty army, and marched with the utmost expedition to the banks of the Danube. As Decebalus was not apprised of his arrival, the emperor passed the river without opposition, and entering Dacia, laid waste the country with fire and sword. At last he was met by Decebalus with a numerous army. A bloody engagement ensued, in which the Dacians were defeated; though the victory cost the Romans dear: the wounded were so numerous, that they wanted linen to bind up their wounds; and to supply the defect, the emperor generously devoted his own wardrobe. After the victory, he pursued Decebalus from place to place, and at last obliged him to consent to a peace on the following terms: 1. That he should surrender the territories which he had unjustly taken from the neighbouring nations. 2. That he should deliver up his arms, his warlike engines, with the artificers who made them, and all the Roman deserters. 3. That for the future he should entertain no deserters, nor take into his service the natives of any country subject to Rome. 4. That he should dismantle all his fortresses, castles, and strong holds. And, lastly, That he should have the same friends and foes with the people of Rome.

16 The Dacians invade the Roman empire.

With these hard terms Decebalus was obliged to comply, though sore against his will; and being introduced to Trajan, threw himself on the ground before him, acknowledging himself his vassal; after which the latter, having commanded him to send deputies to the senate for the ratification of the peace, returned to Rome.

This peace was of no long duration. Four years after (A. D. 105.), Decebalus, unable to live in servitude as he called it, began, contrary to the late treaty, to raise men, provide arms, entertain deserters, fortify his castles, and invite the neighbouring nations to join him against the Romans as a common enemy. The Scythians hearkened to his solicitations; but the Jazyges, a neighbouring nation, refusing to bear arms against Rome, Decebalus invaded their country. Hereupon Trajan marched against him; but the Dacian, finding himself unable to withstand him by open force, had recourse to treachery, and attempted to get the emperor murdered. His design, however, proved abortive, and Trajan pursued his march into Dacia. That his troops might the more readily pass and repass the Danube, he built a bridge over that river; which by the ancients is styled the most magnificent and wonderful of all his works *. To guard the bridge, he

* See *Architecture*, N° 133.

Germany.

he orderd two caftles to be built; one on this fide the Danube, and the other on the oppofite fide; and all this was accomplifhed in the fpace of one fummer. Trajan, however, as the feafon was now far advanced, did not think it advifable to enter Dacia this year, but contented himfelf with making the neceffary preparations.

17
They are fubdued by Trajan.

In the year 106, early in the fpring, Trajan fet out for Dacia; and having paffed the Danube on the bridge he had built, reduced the whole country, and would have taken Decebalus himfelf, had he not put an end to his own life, in order to avoid falling into the hands of his enemies. After his death the kingdom of Dacia was reduced to a Roman province; and feveral caftles were built in it, and garrifons placed in them, to keep the country in awe.

After the death of Trajan, the Roman empire began to decline, and the northern nations to be daily more and more formidable. The province of Dacia indeed was held by the Romans till the reign of Gallienus; but Adrian, who fucceeded Trajan, caufed the arches of the bridge over the Danube to be broken down, left the barbarians fhould make themfelves mafters of it, and invade the Roman territories. In the time of Marcus Aurelius, the Marcomanni and Quadi invaded the empire, and gave the emperor a terrible overthrow. He continued the war, however, with better fuccefs afterwards, and invaded their country in his turn. It was during the courfe of this war that the Roman army is faid to have been faved from deftruction by that miraculous event related under the article CHRISTIANS, p. 70. col. 2.

18
Marcomanni and Quadi formidable to the empire.

In the end, the Marcomanni and Quadi were, by repeated defeats, brought to the verge of deftruction; infomuch that their country would probably have been reduced to a Roman province, had not Marcus Aurelius been diverted from purfuing his conquefts by the revolt of one of his generals. After the death of Marcus Aurelius, the Germanic nations became every day more and more formidable to the Romans. Far from being able to invade and attempt the conqueft of thefe northern countries, the Romans had the greateft difficulty to reprefs the incurfions of their inhabitants. But for a particular account of their various invafions of the Roman empire, and its total deftruction by them at laft, fee the article ROME.

19
Roman empire deftroyed by the Heruli.

The immediate deftroyers of the Roman empire were the Heruli; who, under their leader Odoacer, dethroned Auguftulus the laft Roman emperor, and proclaimed Odoacer king of Italy. The Heruli were foon expelled by the Oftrogoths; and thefe in their turn were fubdued by Juftinian, who reannexed Italy to the eaftern empire. But the popes found means to obtain the temporal as well as fpiritual jurifdiction over a confiderable part of the country, while the Lombards fubdued the reft. Thefe laft proved very troublefome to the popes, and at length befieged Adrian I. in his capital. In this diftrefs he applied to Charles the Great, king of France; who conquered both Italy and Germany, and was crowned emperor of the weft in 800.

20
Hiftory of Germany fince the time of Charlemagne.

The pofterity of Charlemagne inherited the empire of Germany until the year 880; at which time the different princes affumed their original independence, rejected the Carlovingian line, and placed Arnulph king of Bohemia on the throne. Since this time Germany has ever been confidered as an elective monarchy. Princes of different families, according to the prevalence of their intereft and arms, have mounted the throne. Of thefe the moft confiderable, until the Auftrian line acquired the imperial power, were the houfes of Saxony, Franconia, and Suabia. The reigns of thefe emperors contain nothing more remarkable than the contefts between them and the popes; for an account of which fee the article ITALY. From hence, in the beginning of the 13th century, arofe the factions of the Guelphs and Gibellines, of which the former was attached to the popes, and the latter to the emperor; and both, by their virulence and inveteracy, tended to difquiet the empire for feveral ages. The emperors too were often at war with the infidels; and fometimes, as happens in all elective kingdoms, with one another, about the fucceffion.

But what more deferves our attention is the progrefs of government in Germany, which was in fome meafure oppofite to that of the other kingdoms of Europe. When the empire raifed by Charlemagne fell afunder, all the different independent princes affumed the right of election; and thofe now diftinguifhed by the name of *electors* had no peculiar or legal influence in appointing a fucceffor to the imperial throne; they were only the officers of the king's houfehold, his fecretary, his fteward, chaplain, marfhal, or mafter of his horfe, &c. By degrees, however, as they lived near the king's perfon, and had, like all other princes, independent territories belonging to them, they increafed their influence and authority; and in the reign of Otho III. 984, acquired the fole right of electing the emperor. Thus, while in the other kingdoms of Europe, the dignity of the great lords, who were all originally allodial or independent barons, was diminifhed by the power of the king, as in France, and by the influence of the people, as in Great Britain; in Germany, on the other hand, the power of the electors was raifed upon the ruins of the emperor's fupremacy, and of the people's jurifdiction. In 1440, Frederic III. duke of Auftria was elected emperor, and the imperial dignity continued in the male line of that family for 300 years. His fucceffor Maximilian married the heirefs of Charles duke of Burgundy; whereby Burgundy and the 17 provinces of the Netherlands were annexed to the houfe of Auftria. Charles V. grandfon of Maximilian, and heir to the kingdom of Spain, was elected emperor in the year 1519. Under him MEXICO and PERU were conquered by the Spaniards; and in his reign happened the REFORMATION in feveral parts of Germany; which, however, was not confirmed by public authority till the year 1648, by the treaty of Weftphalia, and in the reign of Ferdinand III. The reign of Charles V. was continually difturbed by his wars with the German princes and the French king Francis I. Though fuccefsful in the beginning of his reign, his good fortune towards the conclufion of it began to forfake him; which, with other reafons, occafioned his abdication of the crown. See CHARLES V.

His brother Ferdinand I. who in 1558 fucceeded to the throne, proved a moderate prince with regard to religion. He had the addrefs to get his fon Maximilian declared king of the Romans in his own lifetime, Germany. time, and died in 1564. By his last will he ordered, that if either his own male issue, or that of his brother Charles, should fail, his Austrian estates should revert to his second daughter Anne, wife to the elector of Bavaria, and her issue. We mention this destination, as it gave rise to the late opposition made by the house of Bavaria to the pragmatic sanction, in favour of the empress queen of Hungary, on the death of her father Charles VI. The reign of Maximilian II. was disturbed with internal commotions, and an invasion from the Turks: but he died in peace in 1576. He was succeeded by his son Rodolph; who was involved in wars with the Hungarians, and in differences with his brother Matthias, to whom he ceded Hungary and Austria in his lifetime. He was succeeded in the empire by Matthias; under whom the reformers, who went under the names of *Lutherans* and *Calvinists*, were so much divided among themselves, as to threaten the empire with a civil war. The ambition of Matthias at last tended to reconcile them; but the Bohemians revolted, and threw the imperial commissaries out of a window at Prague. This gave rise to a ruinous war, which lasted 30 years. Matthias thought to have exterminated both parties; but they formed a confederacy, called the *Evangelic League*, which was counterbalanced by a Catholic league.

Matthias dying in 1618, was succeeded by his cousin Ferdinand II.; but the Bohemians offered their crown to Frederic the elector Palatine, the most powerful Protestant prince in Germany, and son-in-law to his Britannic majesty James I. That prince was incautious enough to accept of the crown: but he lost it, by being entirely defeated by the duke of Bavaria and the imperial generals at the battle of Prague; and he was even deprived of his electorate, the best part of which was given to the duke of Bavaria. The Protestant princes of Germany, however, had among them at this time many able commanders, who were at the head of armies, and continued the war with wonderful obstinacy: among them were the margrave of Baden Durlach, Christian duke of Brunswick, and count Mansfeld; the last was one of the best generals of the age. Christiern IV. king of Denmark declared for them; and Richelieu, the French minister, was not fond of seeing the house of Austria aggrandized. The emperor, on the other hand, had excellent generals; and Christiern, having put himself at the head of the evangelic league, was defeated by Tilly, an Imperialist of great reputation in war. Ferdinand made so moderate a use of his advantages obtained over the Protestants, that they formed a fresh conspiracy at Leipsic, of which the celebrated Gustavus Adolphus king of Sweden was the head. An account of his glorious victories is given under the article SWEDEN. At last he was killed at the battle of Lutzen in 1632. But the Protestant cause did not die with him. He had brought up a set of heroes, such as the duke of Saxe Weimer, Torstenson, Banier, and others, who shook the Austrian power; till under the mediation of Sweden, a general peace was concluded among all the belligerent powers, at Munster, in the year 1648: which forms the basis of the present political system of Europe.

Ferdinand II. was succeeded by his son Ferdinand III. This prince died in 1657; and was succeeded by the emperor Leopold, a severe, unamiable, and not very fortunate prince. He had two great powers to contend with, France on the one side, and the Turks on the other; and was a loser in his war with both. Louis XIV. at that time king of France, was happy in having the two celebrated generals Condé and Turenne in his service. The latter had already distinguished himself by great exploits against the Spaniards; and, on the accession of Leopold, the court of France had taken the opportunity of confirming the treaty of Munster, and attaching to her interest several of the independent princes of Germany. The tranquillity which now took place, however, was not established upon any permanent basis. War with Spain was resumed in the year 1668; and the great successes of Turenne in the Netherlands stimulated the ambition of the prince of Condé to attempt the conquest of Franche Compte, at that time under the protection of the house of Austria. This was accomplished in three weeks: but the rapid success of Louis had awakened the jealousy of his neighbours to such a degree, that a league was formed against him by England, Holland, and Sweden; and the French monarch, dreading to enter the lists with such formidable enemies, consented to the treaty of Aix-la-Chapelle, by which, among other articles, Franche Compte was restored. The flames of war, however, were renewed by the insatiable ambition of the French monarch; who, having entered into an alliance with Charles II. of England, aimed at nothing less than the total overthrow of the Dutch republic. The events of that war are related under the article UNITED PROVINCES; here it is sufficient to observe, that the misfortunes of the Dutch excited the compassion of the emperor and court of Spain, who now openly declared themselves their allies. Turenne was opposed by the prince of Orange in conjunction with the celebrated Imperial general Montecuculi, whose artful conduct eluded even the penetration of Turenne, and he sat down suddenly before the city of Bonne. Here he was joined by the prince of Orange, who had likewise found means to elude the vigilance of the French generals. Bonne surrendered in a short time, and several other places in Cologne fell into the hands of the allies; who likewise cut off the communication betwixt France and the United Provinces; so that Louis was soon obliged to recal his armies, and abandon all his conquests with greater rapidity than they had been made. In 1674 he was abandoned by his ally Charles II. of England, and the bishop of Munster and elector of Cologne were compelled to renounce their allegiance to him; but notwithstanding these misfortunes, he continued everywhere to make head against his enemies, and even meditated new conquests. With a powerful army he again invaded Franche Compte in person, and in six weeks reduced the whole province to his obedience. In Alsace, Turenne defeated the Imperial general at Sintzheim, and ravaged the palatinate. Seventy thousand Germans were surprised; a considerable detachment was cut in pieces at Mulhausen; the elector of Brandenburg, who had been intrusted with the chief command, was routed by Turenne near Colmar; a third body met with a similar fate at Turkheim; and the whole German forces were obliged at last to evacuate the province and repass the Rhine.

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In consequence of these disasters the Imperial general Montecuculi was recalled to act against Turenne. The military skill of the two commanders seemed to be nearly equal; but before the superiority could be adjudged to either, Turenne was killed by a cannon ball as he was reconnoitring a situation for erecting a battery. By his death the Imperialists obtained a decided superiority. Montecuculi penetrated into Alsace; and the French, under De Lorges nephew to the deceased general, were happy in being able to escape a defeat.

Part of the German army now sat down before Treves, where they were opposed by Mareschal Crequi; but the negligence of that general exposed him to such a dreadful defeat, that he was obliged to fly into the city with only four attendants. Here he endeavoured in vain to animate the people to a vigorous defence. The garrison mutinied against his authority; and, when he refused to sign the capitulation they made, delivered him up prisoner to the enemy. Louis in the mean time had taken the field in person against the prince of Orange; but the disastrous state of affairs in Germany induced him to recal the prince of Condè to make head against Montecuculi. In this campaign the prince seemed to have the advantage. He compelled the Germans to raise the sieges of Hagenau and Saverne; and at last to repass the Rhine without having been able to force him to a battle.

This was the last campaign made by these celebrated commanders; both of them now, contented with the fame they had acquired, retiring from the field to spend the remainder of their days in peace. The excellent discipline, however, which the two great French generals had introduced into their armies, still continued to make them very formidable, though it did not always ensure them of victory. In Germany, the duke of Lorrain, who had recovered Philipsburgh, was repeatedly defeated by Mareschal Crequi, who had been ransomed from his captivity, and become more prudent by his defeat. In Flanders, the prince of Orange was overmatched by the duke of Orleans and Marshal Luxemburg. A peace was at length concluded at Nimeguen in 1679, by which the king of France secured himself Franche Compté with a great many cities in the Netherlands; while the king of Sweden was reinstated in those places of which he had been stripped by the Danes and Germans. This tranquillity, however, was of no long duration. Louis employed every moment in preparations for new conquests; possessed himself of the imperial city of Strasburg by treachery; and dispossessed the elector Palatine and the elector of Treves of the lordships of Falkemburg, Germansheim, and Valdentz. On the most frivolous pretences he had demanded Alost from the Spaniards; and on their refusal, seized upon Luxemburg. His conduct, in short, was so intolerable, that the prince of Orange, his inveterate enemy, found means to unite the whole empire in a league against him. Spain and Holland became parties in the same cause; and Sweden and Denmark seemed also inclined to accede to the general confederacy. Notwithstanding this formidable combination, however, Louis seemed still to have the advantage. He made himself master of the cities of Philipsburgh, Manheim, Frankendal, Spires, Worms, and Oppenheim: the fruitful country of the palatinate was ravaged in a dreadful manner; the towns were reduced to ashes; and the people, driven from their habitations, were everywhere left to perish through the inclemency of the weather and want of provisions. By this cruelty his enemies were rather exasperated than vanquished: the Imperialists, under the conduct of the duke of Lorrain, resumed their courage, and put a stop to the French conquests. At length all parties, weary of a destructive war, consented to the treaty of Ryswick in 1697. By this treaty Louis gave up to the empire, Fribourg, Brisac, Kheil, and Philipsburg; he consented also to destroy the fortifications of Strasburg. Fort Louis and Traerbach, the works of which had exhausted the skill of the great Vauban, with Lorrain, Treves, and the Palatinate, were resigned to their respective princes; insomuch that the terms to which the French monarch now consented, after so many victories, were such as could scarce have been expected under the pressure of the greatest misfortunes. The views of Louis, however, in consenting to this apparently humiliating treaty, were beyond the views of ordinary politicians. The health of the king of Spain was in such a declining way, that his death appeared to be at hand; and Louis now resolved to renew his pretensions to that kingdom, which he had formerly by treaty solemnly renounced. His designs in this respect could not be concealed from the vigilance of William III. of Britain; of which Louis being sensible, and knowing that the emperor had claims of the same nature on Spain, he thought proper to enter into a very extraordinary treaty with William. This was no less than the partition of the whole Spanish dominions, which were now to be distributed in the following manner. To the young prince of Bavaria were to be assigned Spain and the East Indies; the dauphin, son to Louis, was to have Naples, Sicily, and the province of Guipuscoa; while the archduke Charles, son to the emperor Leopold, was to have only the duchy of Milan. By this scandalous treaty the indignation of Charles was roused, so that he bequeathed the whole of his dominions to the prince of Bavaria. This scheme, however, was disconcerted by the sudden death of the prince; upon which a new treaty of partition was concluded between Louis and William. By this the kingdom of Spain, together with the East India territories, were to be bestowed on the archduke Charles, and the duchy of Milan upon the duke of Lorrain. The last moments of the Spanish monarch were disturbed by the intrigues of the rival houses of Austria and Bourbon; but the haughtiness of the Austrian ministers so disgusted those of Spain, that they prevailed upon their dying monarch to make a new will. By this the whole of his dominions were bequeathed to Philip duke of Anjou, grandson to the king of France; and Louis, prompted by his natural ambition, accepted the kingdom bequeathed to his grandson, excusing himself to his allies in the best manner he could for departing from his engagements with them. For this, however, he was made to pay dear. His insatiable ambition and his former successes had alarmed all Europe. The emperor, the Dutch, and the king of England, entered into a new confederacy against him; and a bloody war ensued, which threatened

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to overthrow the French monarchy entirely. While this war (of which an account is given under the article BRITAIN) was carried on with ſuch ſucceſs, the emperor Leopold died in the year 1705.

He was ſucceeded by his ſon Joſeph, who put the electors of Cologne and Bavaria to the ban of the empire; but being ill ſerved by Prince Louis of Baden general of the empire, the French partly recovered their affairs, notwithſtanding their repeated defeats. The duke of Marlborough had not all the ſucceſs he expected or deſerved. Joſeph himſelf was ſuſpected of a deſign to ſubvert the Germanic liberties; and it was plain by his conduct, that he expected England ſhould take the labouring oar in the war, which was to be entirely carried on for his benefit. The Engliſh were diſguſted at his ſlowneſs and ſelfiſhneſs: but he died in 1711, before he had reduced the Hungarians; and leaving no male iſſue, he was ſucceeded in the empire by his brother Charles VI. whom the allies were endeavouring to place on the throne of Spain, in oppoſition to Philip duke of Anjou, grandſon to Louis XIV.

When the peace of Utrecht took place in 1713, Charles at firſt made a ſhow as if he would continue the war; but found himſelf unable, now that he was forſaken by the Engliſh. He therefore was obliged to conclude a peace with France at Baden in 1714, that he might attend the progreſs of the Turks in Hungary; where they received a total defeat from Prince Eugene at the battle of Peterwaradin. They received another of equal importance from the ſame general in 1717, before Belgrade, which fell into the hands of the Imperialiſts; and next year the peace of Paſſarowitz, between them and the Turks was concluded. Charles employed every minute of his leiſure in making arrangements for increaſing and preſerving his hereditary dominions in Italy and the Mediterranean. Happily for him, the crown of Britain devolved to the houſe of Hanover; an event which gave him a very deciſive weight in Europe, by the connexions between George I. and II. and the empire. Charles was ſenſible of this; and carried matters with ſo high a hand, that, about the years 1724 and 1725, a breach enſued between him and George I. and ſo unſteady was the ſyſtem of affairs all over Europe at that time, that the capital powers often changed their old alliances, and concluded new ones contradictory to their intereſt. Without entering into particulars, it is ſufficient to obſerve, that the ſafety of Hanover, and its aggrandizement, was the main object of the Britiſh court; as that of the emperor was the eſtabliſhment of the pragmatic ſanction in favour of his daughter the (late empreſs queen), he having no male iſſue. Mutual conceſſions upon thoſe great points reſtored a good underſtanding between George II. and the emperor Charles: and the elector of Saxony, flattered with the view of gaining the throne of Poland, relinquiſhed the great claims he had upon the Auſtrian ſucceſſion.

The emperor, after this, had very bad ſucceſs in a war he entered into with the Turks, which he had undertaken chiefly to indemnify himſelf for the great ſacrifices he had made in Italy to the princes of the houſe of Bourbon. Prince Eugene was then dead, and he had no general to ſupply his place. The ſyſtem of France, however, under Cardinal Fleury, happened at that time to be pacific; and ſhe obtained for him, from the Turks, a better peace than he had reaſon to expect. Charles, to keep the German and other powers eaſy, had, before his death, given his eldeſt daughter, the late empreſs queen, in marriage to the duke of Lorrain, a prince who could bring no acceſſion of power to the Auſtrian family.

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Charles died in 1740; and was no ſooner in the grave, than all he had ſo long laboured for muſt have been overthrown, had it not been for the firmneſs of George II. The young king of Pruſſia entered and conquered Sileſia, which he ſaid had been wrongfully diſmembered from his family. The king of Spain and the elector of Bavaria ſet up claims directly incompatible with the pragmatic ſanction, and in this they were joined by France; though all thoſe powers had ſolemnly guaranteed it. The imperial throne, after a conſiderable vacancy, was filled up by the elector of Bavaria, who took the title of *Charles VII.* in January 1742. The French poured their armies into Bohemia, where they took Prague; and the queen of Hungary, to take off the weight of Pruſſia, was forced to cede to that prince the moſt valuable part of the duchy of Sileſia by a formal treaty.

Her youth, her beauty, and ſufferings, and the noble fortitude with which ſhe bore them, touched the hearts of the Hungarians, into whoſe arms ſhe threw herſelf and her little ſon; and though they had been always remarkable for their diſaffection to the houſe of Auſtria, they declared unanimouſly in her favour. Her generals drove the French out of Bohemia; and George II. at the head of an Engliſh and Hanoverian army, gained the battle of Dettingen, in 1743. Charles VII. was at this time miſerable on the imperial throne, and would have given the queen of Hungary almoſt her own terms; but ſhe haughtily and impolitically rejected all accommodation, though adviſed to it by his Britannic majeſty, her beſt and indeed only friend. This obſtinacy gave a colour for the king of Pruſſia to invade Bohemia, under pretence of ſupporting the imperial dignity; but though he took Prague, and ſubdued the greateſt part of the kingdom, he was not ſupported by the French; upon which he abandoned all his conqueſts, and retired into Sileſia. This event confirmed the obſtinacy of the queen of Hungary: who came to an accommodation with the emperor, that ſhe might recover Sileſia. Soon after, his Imperial majeſty, in the beginning of the year 1745, died; and the duke of Lorrain, then grand duke of Tuſcany, conſort to the queen of Hungary, after ſurmounting ſome difficulties, was choſen emperor.

The bad ſucceſs of the allies againſt the French and Bavarians in the Low Countries, and the loſs of the battle of Fontenoy, retarded the operations of the empreſs queen againſt his Pruſſian majeſty. The latter beat the emperor's brother, Prince Charles of Lorrain, who had before driven the Pruſſians out of Bohemia; and the conduct of the empreſs queen was ſuch, that his Britannic majeſty thought proper to guarantee to him the poſſeſſion of Sileſia, as ceded by treaty. Soon after, his Pruſſian majeſty pretended that he had diſcovered a ſecret convention which had been entered into between the empreſs queen, the empreſs of Ruſſia, and the king of Poland as elector of Saxony, to ſtrip him of his dominions, and to divide

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them among themſelves. Upon this his Pruſſian majeſty, very ſuddenly, drove the king of Poland out of Saxony, defeated his troops, and took poſſeſſion of Dreſden; which he held till a treaty was made under the mediation of his Britannic majeſty, by which the king of Pruſſia acknowledged the duke of Lorrain, great duke of Tuſcany, for emperor. The war, however, continued in the Low Countries, not only to the diſadvantage, but to the diſcredit of the Auſtrians and Dutch, till it was finiſhed by the treaty of Aix-la-Chapelle, in April 1748. By that treaty Sileſia was once more guaranteed to the king of Pruſſia. It was not long before that monarch's jealouſies were renewed and verified; and the empreſs of Ruſſia's views falling in with thoſe of the empreſs queen and the king of Poland, who were unnaturally ſupported by France in their new ſchemes, a freſh war was kindled in the empire. The king of Pruſſia declared againſt the admiſſion of the Ruſſians into Germany, and his Britannic majeſty againſt that of the French. Upon thoſe two principles all former differences between theſe monarchs were forgotten, and the Britiſh parliament agreed to pay an annual ſubſidy of 670,000l. to his Pruſſian majeſty during the continuance of the war.

The flames of war now broke out in Germany with greater fury and more deſtructive violence than ever. The armies of his Pruſſian majeſty, like an irreſiſtible torrent, burſt in Saxony; totally defeated the imperial general Brown at the battle of Lowoſitz; forced the Saxons to lay down their arms, though almoſt impregnably fortified at Pirna; and the elector of Saxony fled to his regal dominions in Poland. After this, his Pruſſian majeſty was put to the ban of the empire; and the French poured, by one quarter, their armies, as the Ruſſians did by another, into the empire. The conduct of his Pruſſian majeſty on this occaſion is the moſt amazing that is to be met with in hiſtory; for a particular account of which, ſee the article Prussia.

At laſt, however, the taking of Colberg by the Ruſſians, and of Schweidnitz by the Auſtrians, was on the point of completing his ruin, when his moſt formidable enemy, the empreſs of Ruſſia, died, January 5. 1762; George II. his only ally, had died on the 25th of October 1760.

The deaths of thoſe illuſtrious perſonages were followed by great conſequences. The Britiſh miniſtry of George III. ſought to finiſh the war with honour, and the new emperor of Ruſſia recalled his armies. His Pruſſian majeſty was, notwithſtanding, ſo very much reduced by his loſſes, that the empreſs queen, probably, would have completed his deſtruction, had it not been for the wiſe backwardneſs of other German princes, not to annihilate the houſe of Brandenburg. At firſt the empreſs queen rejected all terms propoſed to her, and ordered 30,000 men to be added to her armies. The viſible backwardneſs of her generals to execute her orders, and new ſucceſſes obtained by his Pruſſian majeſty, at laſt prevailed on her to agree to an armiſtice, which was ſoon followed by the treaty of Hubertſburgh, which ſecured to his Pruſſian majeſty the poſſeſſion of Sileſia. Upon the death of the emperor her huſband, in 1765, her ſon Joſeph, who had been crowned king of the Romans in 1764, ſucceeded him in the empire.

This prince ſhowed an active and reſtleſs diſpoſition, much inclined to extend his territories by conqueſt, and to make reformations in the internal policy of his dominions, yet without taking any proper methods for accompliſhing his purpoſes. Hence he was almoſt always diſappointed; inſomuch that he wrote for himſelf the following epitaph: "Here lies Joſeph, unfortunate in all his undertakings." In the year 1788, a war commenced betwixt him and the king of Pruſſia; in which, notwithſtanding the impetuous valour of that monarch, Joſeph acted with ſuch caution that his adverſary could gain no advantage over him; and an accommodation took place without any remarkable exploit on either ſide. In 1781 he took the opportunity of the quarrel betwixt Britain and the United Provinces, to deprive the latter of the barrier towns which had been ſecured to them by the treaty of Utrecht. Theſe indeed had frequently been of great uſe to the houſe of Auſtria in its ſtate of weakneſs; but Joſeph, conſcious of his own ſtrength, looked upon it as derogatory to his honour to allow ſo many of his cities to remain in the hands of foreigners, and to be garriſoned at his expence. As at that time the Dutch were unable to reſiſt, the imperial orders for evacuating the barrier towns were inſtantly complied with; nor did the court of France, though then in friendſhip with Holland, make any offer to interpoſe. Encouraged by this ſucceſs, Joſeph next demanded the free navigation of the Scheldt; but as this would evidently have been very detrimental to the commercial intereſts of Holland, a flat refuſal was given to his requiſitions. In this the emperor was much diſappointed; having flattered himſelf that the Hollanders, intimidated by his power, would yield the navigation of the river as eaſily as they had done the barrier. Great preparations were made by the emperor, which the Dutch, on their part, ſeemed determined to reſiſt. But while the emperor appeared ſo much ſet upon this acquiſition, he ſuddenly abandoned the project entirely, and entered into a new ſcheme of exchanging the Netherlands for the duchy of Bavaria. This was oppoſed by the king of Pruſſia; and by the interference of the court of France, the emperor found himſelf at laſt obliged alſo to abandon his other ſcheme of obtaining the navigation of the Scheldt. A treaty of peace was concluded, under the guarantee of his moſt Chriſtian majeſty. The principal articles were, that the ſtates acknowledged the emperor's ſovereignty over the Scheldt from Antwerp to the limits of Seftingen; they agreed to demoliſh certain forts, and to pay a conſiderable ſum of money in lieu of ſome claims which the emperor had on Maeſtricht, and by way of indemnification for laying part of his territories under water.

The treaty with the Dutch was no ſooner concluded than a quarrel with the Turks took place, which terminated in an open war. It does not appear that the emperor had at this time any real provocation, but ſeems to have acted merely in conſequence of his engagements with Ruſſia to reduce the dominions of the Grand Signior. All theſe foreign engagements, however, did not in the leaſt retard the progreſs of reformation which the emperor carried on throughout his dominions with a rapidity ſcarcely to be matched, and which at laſt produced the revolt of the Auſtrian Netherlands. In the courſe of his labours in this way, a complete

Germany. complete code of laws was compiled. These were at first greatly commended for their humanity, as excluding almost entirely every species of capital punishment; yet, when narrowly considered, the commutations were found to be so exceedingly severe, that the most cruel death would, comparatively speaking, have been an act of mercy. Even for smaller crimes the punishments were severe beyond measure; but the greatest fault of all was, that the modes of trial were very defective, and the punishments so arbitrary, that the most perfect and innocent character lay at the mercy of a tyrannical judge. The innovations in ecclesiastical matters were, however, most offensive to his subjects in the Netherlands. Among the many changes introduced into this department, the following were some of the most remarkable. 1. An abridgment of divine service. 2. A total suppression of vocal performers in choirs. 3. The introduction of the vernacular language instead of the Latin in administering the sacraments. 4. The prohibition of chanting hymns in private houses. 5. The suppression of a great number of religious houses, and the reduction of the number of the clergy. 6. The total abolition of the papal supremacy throughout the imperial dominions. The same spirit of innovation displayed itself even in the most minute matters. Many favours were bestowed upon the Jews; and in 1786 the emperor wrote with his own hand to the different handicraft and trading corporations in Vienna, requesting that their youths might be received as apprentices in that city. Severe laws against gaming were enacted and put in execution with equal rigour. Heavy restrictions were also laid on all the societies of free masons in Germany, while those in the Netherlands were totally suppressed.

The great number of innovations in religious matters were highly resented by the inhabitants of the Netherlands, who have always been remarkable for their attachment to the Romish religion in its most superstitious form. Indeed the alterations in the civil constitution were so great, that even those who were least bigotted in this respect began to fear that their liberties were in danger, and an universal dissatisfaction was excited. The emperor behaved at first in a very haughty manner, and refused to yield the smallest point to the solicitations of his subjects. Finding, however, that a general revolt was about to take place, and being unable at that time, on account of the Turkish war, to spare such a force as would be necessary to reduce the provinces to obedience, he thought proper, in the autumn of 1787, to promise a restoration of their ancient constitution and privileges. His promises, however, were found to be so delusive, and his conduct was so arbitrary and capricious, that in the end of the year 1789 the states of all the provinces in the Austrian Netherlands came to a resolution of entirely throwing off the yoke. Articles of a federal union were drawn up, and a new republic was formed under the title of the *Belgic Provinces*. The situation of the emperor's affairs at that time did not allow him to take the measures necessary for preventing this revolt; to which perhaps his his ill state of health also contributed. About the beginning of February 1790 his distemper increased to such a degree as to be thought dangerous; and continuing daily to grow worse, he sunk under it on the 20th of the same month, in the 40th year of his age, and 26th of his reign. Germany.

The leaders of the Austrian revolution, however, soon became so disagreeable to their countrymen, that they were obliged to fly; and the congress, which had been established as the supreme legislative body, behaved with such tyranny, that they became generally detested. Meantime, the late emperor was succeeded by his brother Peter Leopold Joseph, grand duke of Tuscany; under whose administration matters have taken a more favourable turn. By his wisdom, moderation, and humanity, he has already in a great measure retrieved the bad consequences of his predecessor's conduct, having made peace with the Ottomans, and regained the allegiance of the Netherlands; and upon the whole seems to be actuated not more by a sense of his own rights, than by a regard to the rights and happiness of his subjects.

At present, Germany is bounded on the north by the Baltic sea, Denmark, and the German ocean; on the east, by Prussia, Hungary, and Poland; and on the west, by the Low Countries, Lorrain, and Franche Compte: so that it now comprehends the Palatinate of Cologne, Triers, and Liege, which formerly belonged to the Gauls; and is dismembered of Friesland, Groningen, and Overyssel, which are now incorporated with the Low Countries.

21 Situation, extent, &c. of Germany.

Since the time of Charles the Great, this country has been divided into High and Low Germany. The first comprehends the Palatinate of the Rhine, Franconia, Suabia, Bavaria, Bohemia, Moravia, Austria, Carinthia, Carniola, Stiria, the Swiss, and the Grisons. The provinces of Low Germany are, the Low Country of the Rhine, Triers, Cologne, Mentz, Westphalia, Hesse, Brunswick, Misnia, Lusatia, High Saxony upon the Elbe, Low Saxony upon the Elbe, Mecklenburg, Lunenburg, Brandenburg, and Pomerania.

22 Constitution of the empire.

Monarchy was first established in Germany by Clodovick: after him Charlemagne extended his power and his dominions; and so great had the empire become, that during his reign, and that of his son, government was administered in the provinces by persons vested with power for that purpose under the title of *Dukes*. In the districts of these provinces, justice was distributed by a *comes* or count, which officer was in Germany called *Graf*. But from their courts lay an appeal to that of the emperor, before a president styled *Comes Palatinus*, that is, "Count Palatine, or of the palace," in German denominated *Pfalzgraf*. The frontiers or marches were governed by a marquis, styled by the Germans *Markgraf*, similar to our lord warden. Generally the centre of the empire was ruled by an officer who possessed a similar power, but a greater extent of dominion, than the Grave, under the title of *Landgrave*. Towns and castles, which were occasionally honoured with the residence of the emperor, were governed by a Burggraf. It may be remarked, that the signification of the above-mentioned titles, and the extent of power which they conferred upon the persons honoured with them, differ according to the successive ages and the gradual developement of the German constitution.

By reason of family broils in the imperial house, and civil wars in their dominions, the dignity of the sovereign

Germany.

reign was depreffed, and a new form in the government raifed up. The dukes exalted themfelves above the power of the emperor, and fecured for their fons a fucceffion to their greatnefs; while the intereft of the fovereign, in order to ftrengthen the bond of perfonal attachment, ratified to others and their defcendants that fway which had been formerly delegated and dependant on his will. Hence arofe the modern conftitution of diftinct principalities, acknowledging one head in the perfon of an emperor. But fhortly after the election of Conrade duke of Franconia to the throne, this new-gained authority of the princes became doubtful. However, after moft violent difturbances and confufions, the regulations yielded to by Albert II. and his fucceffors, particularly by Frederick III. laid the foundation of the German conftitution; but the power and form of which were afterwards improved by Maximilian. Before Charles V. mounted the throne, on the death of Maximilian, the electors formed a bulwark againft the Imperial power, by an inftrument called the *capitulation;* to which articles of government he and all emperors elected fince have fworn, previous to their inveftiture with the Imperial dignity.

23
Of the electors.

When the German monarchy received an elective form, the right of election was not limited to the great officers of ftate, for other princes participated of this privilege. But the empire being governed by four dukes, the princes under their authority, in order to court their favour, gave to them the difpofal of their votes, and of thofe of their vaffals. The three archbifhops alfo, who were neceffarily prefent at the coronation, obtained the electoral dignity. However, befide this origin of the modern electors, the high ftations about court procured their poffeffors an influence over other members, and their general refidence there gave them a folid advantage in their conftant and early prefence at the diet of election. For in times of turbulence feveral emperors were elected, when the princes had not an opportunity to attend. And hence fprung up a fanction to that right, which the high officers of the houfehold had affumed, of electing without any confultation of the other members of the empire. Pope Gregory X. too, either conceiving that they did poffefs, or willing that they fhould acquire, this right, exhorted them in a bull to terminate the troubles of Germany by electing an emperor. And fince that period they have been held as the fole electors. But the poffeffion of this high power was ftrengthened by a league amongft themfelves, called the *electoral union,* which received additional confirmation from the emperor Louis of Bavaria, and was formally and fully ratified by that famous conftitution of Charles IV. termed the *golden bull;* according to which, the territories and the high officers by which the electoral dignity is conveyed, muft defcend according to the right of primogeniture, and are indivifible.

The golden bull declares the following number and titles of the electors: The archbifhop of Mentz as great chancellor of the German empire; the elector of Cologne as great chancellor of the empire in Italy; the elector of Triers as great chancellor of the empire in Gaul and Arles; the king of Bohemia as cupbearer; the count Palatine as high fteward; the duke of Saxony as grand marfhal; the margrave of Brandenburg as grand chamberlain. The number originally was feven, but the emperor Leopold created the duke of Lunenburg, anceftor to our prefent Britifh fovereign, an elector; to whom the poft of arch-treafurer was afterwards given; and thus Hanover forms the eighth electorate. But this number cannot be increafed by the emperor without a previous election by the electors themfelves; who, thus capable of electing and of being elected, may ftyle themfelves *Coimperantes;* and they exercife part of the imperial authority, if a vacancy of the throne happen. But when or before this occurs, the election of the emperor is proceeded to after the following manner: The elector of Mentz, before the lapfe of a month after the death of the emperor, fummons, as great chancellor of the empire, the reft of the electors to attend on fome fixed day within the fpace of three months from the date of the fummons. The electors generally fend their ambaffadors to the place of election, which is held at Frankfort on the Mayne; but faving the right of the city of Frankfort, it may be held elfewhere.

24
Election of the emperor.

When the diet of electors is affembled, they proceed to compofe the capitulation, to which the emperor when elected is to fwear. The capitulation being adjufted, the elector of Mentz appoints a day for the election. When this day arrives, the gates of the city are fhut, and the keys delivered to the elector of Mentz. The electors or their ambaffadors, Proteftants excepted, repair in great pomp to mafs; and after its celebration they take a folemn oath to choofe, unbiaffed and uninfluenced, the perfon that appears moft proper for the imperial dignity. After this they repair to the facrifty, where the elector of Mentz firft afks, if there be any impediment known againft their proceeding at prefent to an election; and next he obtains a promife, that the perfon elected by the majority fhall be received as emperor. The declarations of the electoral ambaffadors, in refpect to thofe two points, are recorded by two notaries of the empire. Then all witneffes withdraw; and the elector of Mentz collecting the fuffrages, which are *viva voce,* and giving his own laft, the witneffes are recalled, and he declares the perfon whom the electors have chofen. But the election is not complete, nor is the new emperor proclaimed, until the capitulation be fworn to either by himfelf or by his ambaffadors if he be abfent. From this time he is ftyled king of the Romans until the coronation takes place; which ceremony confers the title of emperor. According to the golden bull, it fhould be celebrated at Aix-la-Chapelle, out of refpect to Charlemagne, who refided there; but faving the right to Aix-la-Chaplle, it may take place elfewhere. The coronation is performed by the archbifhop of Mentz or elector of Cologne. And, when he is feated on his throne, the duke of Saxony delivers into his hand the fword of Charles the Great, with which he makes fome knights of the holy Roman empire, and is alfo obliged to confer that honour upon fuch others as are nominated by the refpective electors. When he proceeds to dinner in the great hall, he is feated at a table elevated two fteps higher than that of the electors, and is ferved by counts of the empire. The electors, each of whom has alfo his table, are attended by the gentlemen of their refpective courts. Thefe electors, who affift perfonally at the ceremony

Germany. remony, ſit and eat at their own tables; but thoſe who are repreſented by ambaſſadors have only their tables covered out of form with plates, at which the ambaſſadors do not ſit.

For the benefit of the empire during the reign of an emperor, his preſumptive ſucceſſor may be elected king of the Romans. But this election confers at firſt a mere title; for by an expreſs article in his capitulation, the king of the Romans ſwears not to interfere with the government during the life of the emperor; but on his deceaſe, the coronation confirms him emperor without a ſecond election.

Should there not be a king of the Romans, and the throne become vacant, the government is adminiſtered by vicars of the empire, who are the electors Palatine and of Saxony, as count palatine and arch-marſhal of the empire. Each has his diſtrict and tribunal of the vicariate; and by the golden bull it is eſtabliſhed, that all acts of the vicars are valid; but they are all fully confirmed by the emperor; which confirmation, by an article of his capitulation, he is bound to give.

There are alſo vicars of the emperor. Theſe officers are conſtituted by a delegation of the imperial power from the emperor to any prince of the empire, when he is unable to execute his authority himſelf. But theſe vicars ſtand accountable to the emperor; their acts may be annulled and their offices revoked, all dependent on the will of the emperor, and determinable at his pleaſure.

When the race of Charlemagne ceaſed to govern in Germany, the princes and ſtates aſſociated to continue the empire; and that its majeſty might be viſible, and its laws enforced, they agreed to chooſe an emperor. From this emperor all electors and princes except thoſe before 1582 receive inveſtiture of their dominions; counts and free cities from the Aulic council. But this inveſtiture is no more than a ſign of ſubmiſſion to the majeſty of the empire, which is depoſited in the emperor. For as the conſtituted members of the empire are dependent on that collective union from which they derive protection, they therefore ſhow this dependence on the emperor, becauſe he repreſents the majeſty of that union or of that empire; but in all other reſpects they are independent and free.

Theſe princes or ſovereigns may even wage war with the prince wearing the imperial crown, as poſſeſſed of other titles and dominions unconnected with his imperial ſtation. Nor can the ſovereignty of any member be affected ſo long as he remains loyal to the empire; which loyalty conſtitutes his duty, and ſecures him its protection. But ſhould he be guilty of any violation againſt the emperor, as head of the empire, ſuch a crime would commit him to the puniſhment of its laws, and he would be put under the ban. For this crime would be againſt that collective body of ſovereigns whoſe union conſtitutes the empire; and therefore any violation of that union is juſtly puniſhed with deprivation of theſe territories which render ſuch ſovereigns members of the empire. Nor can this puniſhment of the ban derogate from the dignity of thoſe princes who derive their ſovereignty from this conſtitution, and whoſe ſubjection is an act of their own conſent. However, no member of the empire can at preſent be put under the ban without being firſt heard, and without the concurrence of the electors, princes, and ſtates, being previouſly obtained. Germany.

25 Powers of the emperor.

The emperor is endowed with many privileges, and his power partly appears in the exerciſe of his reſerved rights, or the peculiar prerogatives annexed to the imperial dignity. He grants to princes the inveſtiture of their dominions; but to this he is bound as the laws direct. He confers titles, but promiſes that they ſhall be beſtowed only on ſuch perſons as will maintain their dignity, and can ſupport their rank. Beſide, he can give merely the title; for the power or privilege of prince or count can be obtained only from their reſpective bodies. But in ſome inſtances, even titles are of high importance. For the deſcendants of a prince are incapable of ſucceſſion, if their mother be of inferior rank to their father; but the conferring of a title ennobles her and removes the bar, if the collateral line conſents.

The emperor can alſo make cities, found univerſities, grant the privilege of fairs, &c. He can alſo diſpenſe with the tedious terms of minority, and empower princes to aſſume at an earlier age the government of their own dominions. He decides all rank and precedency, and has a power of *primæ preces*, that is, of granting for once in every chapter of the empire a vacant ſeat. But he is not above the law; for electors have not only choſen but depoſed emperors. However, the influence of the capitulation is to prevent ſuch rigorous proceedings: but ſhould the capitulation be violated, the college of electors might proceed to remonſtrance; and if theſe remonſtrances ſhould be without effect, in conjunction with the diet, they might reſort to more forcible remedies.

26 Diet of the empire.

The diet is that aſſembly of the ſtates in which the legiſlative power of the empire reſides; and is compoſed of the electors, princes, prelates, counts, and free cities of the empire. It has ſat ſince 1663, and is held uſually at Ratiſbon. The emperor, when preſent, preſides in perſon; when abſent, by his commiſſary, whoſe communication of propoſals from the emperor to the aſſembly is called the *commiſſorial decree*. The elector of Mentz, as chancellor of the empire, is director of the diet; and to his chancery are all things addreſſed that are to be ſubmitted to the empire; the reading of which by his ſecretary to the ſecretaries of the other miniſters at the diet is denominated *per dictaturam*, and conſtitutes the form of tranſmitting papers or memorials to the dictature of the empire.—The diet is compoſed of three diſtinct colleges, each of which has its particular director. The firſt college is that of electors; of which the archbiſhop of Mentz is director as firſt elector. The ſecond college is that of princes. It conſiſts of princes, archbiſhops, and biſhops; and of prelates, abbots, and counts, who are not conſidered as princes. Each prince ſpiritual and temporal has a vote, but prelates and counts vote by benches. The prelates are divided into two benches, the counts into four; and each bench has only one vote. The archduke of Auſtria and the archbiſhop of Saltzburg are alternately directors of the college of princes. The third college is that of the free cities of the empire; the director of which is the miniſter of the city in which the diet happens to ſit.

In

Germany.

In all these colleges, the sentiments of the majority are conclusive, except in respect of fundamental laws, which affect the whole empire, or such matters as relate to religion. In these they must be unanimous.

Where religion is interested, the proceedings are also different. The colleges are then considered as consisting of two bodies, the evangelic and the catholic; and if any religious point be proposed, it must meet not only the unanimous concurrence of the proposing body, but must have the majority of the other to establish it. This distinction arose from a conjunction called the *evangelic body;* which was formed by the Protestant states and princes to guard the Protestant interest in Germany, by watching over the laws for the security of their religion, and, in case of violation, by obtaining redress from the imperial throne. For in any part of the empire, as in the palatinate, where the count is a Papist and the subjects are Protestants, should oppressions arise, application would be made to the evangelic body through the director. The elector of Saxony is director of the evangelic body, though he is a Papist: but therefore his representations in favour of the Protestants have more force; and beside, should he abuse an office which invests him with considerable weight and influence, he could be instantly deprived of it.

The first two colleges are styled superior, and in effect constitute the diet: for all points that come before the diet, are generally first deliberated in the college of electors, and pass from that to the college of princes; in which, if any objection arise, a free conference takes place between the directors of each college. And should they, in consequence of this free conference, concur, they invite the third college to accede to their joint opinion; which invitation is generally complied with: but should this college return a refusal, the opinion of the other two colleges is in some few cases engrossed in the chancery, and delivered to the emperor's commissary as the opinion of the empire. The opinion of the third college is merely mentioned at the close. However, though the superior colleges do in effect constitute the diet; yet the received maxim is, that no two colleges constitute a majority, that is, the majority of voices at the diet; nor can the emperor confirm the opinion of two colleges as an opinion of the diet. By the peace of Westphalia, a decisive vote was recognized as a right of the imperial cities, which the two superior colleges should not infringe upon; their vote being, by the fundamental law, of equal weight with that of the electors and princes.

After a measure is approved of by the colleges, it is submitted to his Imperial majesty to receive his negative or confirmation. Should he approve the point, it is published in his name as the resolution of the empire, which states are exhorted to obey, and tribunals desired to consider as such.

The diet not only makes and explains laws, but decides ambiguous cases. It must also be consulted before war is made; appoints the field marshal who is to command the army, and assigns him his council of war. The diet also enters into and makes alliances, but usually empowers the emperor to negotiate them; and foreign states have their ambassadors at the diet, but the diet sends no ministers to foreign courts.

27 Administration of justice, &c.

In the origin of the empire, justice was administered in the districts of the provinces by counts, and appeals lay from their courts to that of the emperor before the count palatine. But as civil broils shook the power of the emperor, they interrupted also the course of justice. The consequent inconveniences caused several solicitations to be preferred from the states to different emperors for the establishment of a court of justice, which should take cognizance of great as well as small causes. And at length such a court was erected by Maximilian I. under the title of the *Imperial Chamber at Worms*, in the year 1495; but was removed to Spires in 1533, and to Wetzlar in 1696, where it is now held. The members of this court are a judge of the chamber and 25 assessors, partly Protestants partly Papists. The president is appointed by the emperor, the assessors by the states. The court receives appeals from inferior jurisdictions, and decides dubious titles; and all causes before it between prince and prince, or princes and private persons, are adjudged according to the laws of the respective parties, or according to the Imperial law. The tribunal is under the inspection of visitors appointed by the states; and, during their visitation, the sentences of the court are subject to revision. Appeals lie afterwards also from the judgment of the visitors to that of the diet.

28 Aulic council.

The emperors finding themselves deprived of many of their powers, wished to raise their prerogatives by forming a tribunal, of which they should name the judge, and before whom causes in the last resort should come. But Maximilian foresaw, in respect to the new tribunal, that though a consciousness of its importance made the states struggle for its erection, the expences of its establishment would make them neglect its support; and the event bore witness to his sagacity. But when, through the omissions and negligence of the states, there happened to be a cessation in the distribution of justice by the Imperial chamber, he revived his court of the count Palatine, or Aulic council. And in order to gain the quiet acquiescence of the states, under the mask of a partition of power, and of generous moderation, he desired them to add eight to the number of assessors, and the salaries of all should be discharged by him. The states swallowed the bait, but soon perceived that they had lost part of their liberty.

The emperor, by keeping the tribunal always open, by filling its seats with men of first-rate talents, and by having its sentences duly and speedily executed, drew all causes before it. The states remonstrated, declaring, that the Imperial chamber ought to be not only the supreme, but sole tribunal of that kind. The emperor answered, that he had erected the Imperial chamber in consequence of their solicitations; but as they had not supplied the tribunal with judges, he provided for that deficiency by a constant administration of justice in the establishment of another.

The Aulic council now subsists with equal authority, each receiving appeals from inferior jurisdictions; but neither appealing to the other, as the *dernier resort* from both must be had to the diet. However, to the Aulic council belong the reserved rights of the emperor; and to the Imperial chamber also are annexed peculiar powers. The Imperial chamber subsists during a vacancy

Germany. cancy of the throne under the authority of the vicars of the empire; whereas the Aulic council does not exist until appointed by the succeeding emperor.

The Aulic council consists of a president, vice president, and 17 assessors, of whom six are Protestants. The vice chancellor of the empire is also entitled to a seat; and all decrees issuing from the council pass through his hands to those who are to execute them. This tribunal obtains for the emperor, through the appeals from the courts of other princes, a new authority beside that which he possesses from his reserved rights; but electors and some princes, as those of Hanover, Austria, Brunswick, Swedish Pomerania, Hesse, are free from this dependence on the emperor, to whose Aulic council their subjects cannot appeal; nor can it take cognizance of ecclesiastical or criminal causes, both of which appertain to territorial justice; which we shall presently consider when we have surveyed the executive instrument of Imperial justice.

The division of the empire into circles is a regulation coeval with the establishment of the Imperial chamber by Maximilian, in order to strengthen the arm of justice with vigour to enforce its decrees. The original division was into six circles, which are called the *ancient circles*; and are, Bavaria, Franconia, Suabia, Lower Saxony, the Upper Rhine, and Westphalia; but the powerful princes, who at first declined bringing their dominions under the form of circles, were led by a political finesse of the emperors to adopt the regulation, and increase the number to ten, by forming the four new circles of Austria, Burgundy, the Electorate circle, and Upper Saxony.

Over these circles preside directors, to whom the tribunals of justice commit the execution of their decrees. The six old circles have two directors each, the four new have one each. The office of director is permanent and hereditary, as it belongs always to the first prince in the circle, upon whom it confers high authority; for all the decrees of the Imperial chamber and Aulic council are of no avail unless the director will execute them.

The directors of the circles are not only instruments of war but of peace: for in case of an Imperial war, they are to collect the troops of the circle; and if any state or prince of their respective circles suffers violation from others, they are to yield protection and enforce the peace; or should there be any tumultuous uprisings of the people, the suppression of such belongs to them.

The emperor is the executive instrument of the whole empire; the directors are such of the constitutive parts called circles. The prosperity and security of which being at stake, the directors, as presidents, must hold frequent diets in their respective circles, in order to consult on and adopt salutary measures for their safety and welfare: but as the interests of those near to us are generally so intimately blended with our own, that the good of either cannot be pursued without the mutual concurrence of both, there arise negotiations on particular points between the diets of different circles, which are therefore styled *confederate circles*; and these negotiations being more frequent amongst the circles of the Upper and Lower Rhine, or Westphalia, they are denominated the *corresponding circles*.

Every prince is sovereign in his own country; and may enter into alliances, and pursue by all political measures his own private interest, as other sovereigns do; for if even an imperial war be declared, he may remain neuter if the safety of the empire be not at stake.

29 Powers of the German princes.

Each state or sovereign appoints in general three colleges for its government. The first is the *geheimderath*, or privy council; the second is the *regierung*, or regency; the third the *renthcammer*, or chamber of finances. Each of these has a president; and a member of the first college is always president of the second.—The geheimderath represents the prince, and superintends the other two. The regierung regulates limits of territories, holds conferences with other princes, and is in most countries a court of justice: however, in some states there is also a court of justice called *justitz department*. And besides the right of conferences assigned to the regierung by the sovereign, when there are disputes between princes, there is also an *austrage*, or arbitration appointed in order to decide them. Attention must be paid to this privilege of princes, who must be called on to appoint an austrage before resort be had to the Imperial tribunal, but to which there still lies an appeal from the judgment of the austrage. The renthcammer attends to the regulation of domains and estates, to the territorial revenues, and management of the taxes.

Every sovereign or prince is arbitrary in laws of policy, but not of revenue; for no new tax or impost can be laid on his country without the consent of the nobles and subjects. For this purpose, on the *land tag*, or day on which his subjects are to be convened, which is once in the period of four or five years, and at no other time can he assemble them, he calls together the nobles and commissaries or deputies of the towns of his dominions. The nobles usually attend in person, but may send representatives. To this assembly the prince proposes the taxes, &c. and a majority of voices disposes of the measures.

Villages, though considerable, send no deputies to this assembly; because they are either already represented by their respective lords, or because they rank too low, being in a state of vassalage when compared to towns: for their inhabitants must mend highways, and can be impressed as soldiers; from both of which inhabitants of towns are exempt.

On the land tag, the respective quotas also of each place are fixed, in order to discharge the prince's contingent in case of an Imperial war.

There is no fixed standing army of the empire; but the various states furnish their quotas pursuant to the agreement of 1681, when called upon by the diet in case of war, viz.

30 Military force and annual revenue.

	Foot.	Horse.
Upper Saxony	2707	1321
Lower Saxony	2707	1321
Westphalia	2707	1321
Upper Rhine	2853	491
Lower Rhine	2707	600
Burgundy	2707	1321
Franconia	1902	980
Austria	5507	2521
Bavaria	1494	800
Suabia	2707	1321
Total	27,998	11,997

The

The whole number of forces in the ſervice of the ſeveral German princes has been ſtated at half a million; others calculate, that the eccleſiaſtical princes can furniſh 74,500 men, the temporal princes 379,000, and the emperor 90,000, as head of the houſe of Auſtria. Total 543,500.

The revenue accruing to the emperor as ſuch in time of peace, is very trifling, only about 20,000 crowns, being the contributions of a few imperial towns; but in caſe of war, extraordinary aids, called *Roman Months*, laid on by the diet, are contributed by the different circles at the following rate for raiſing $1\frac{1}{2}$ millions of florins, viz.

	Florins.	*Xtr.*
Upper Saxony	156,360	15
Lower Saxony	156,360	15
Weſtphalia	156,360	15
Upper Rhine	101,411	30
Lower Rhine	105,654	5
Burgundy	156,360	15
Franconia	113,481	25
Auſtria	306,390	20
Bavaria	91,261	5
Suabia	156,360	15
Total	1,499,997	40

The actual revenue of all Germany has been calculated at nearly 18,000,000l. ſterling, or 100 millions of dollars.

31 Productions and commerce.

From the great extent of the empire, every variety of ſoil is to be met with; but it is upon the whole more fertile than otherwiſe. The middle parts are moſt productive in corn and cattle; the ſouthern abound with excellent wines and fruits. The northern parts, from their coldneſs, are rather unfavourable to vegetation; however, agriculture throughout improves exceedingly. Their mines, though early explored, ſtill continue great ſources of wealth. They produce, excepting tin, almoſt every mineral. Of quickſilver, one mine alone is computed to yield 50,000 pounds weight a-year. They furniſh the fineſt ſort of clay for porcelain, and have excellent and extenſive ſalt works.

From the central ſituation of Germany, its commerce with the reſt of Europe is very extenſive. Its minerals are decidedly the firſt native articles for trade; after which its medicinal waters, ſalt, hemp, flax, linen, ſilk, wines, fruits, corn, cattle, ſtuffs, cloths, timber, porcelain, wrought iron and ſteel, drugs, oil, and colours, are the principal. The artizans furniſhed by the revocation of the edict of Nantz, enable Germany no longer to ſtand in need of the wrought ſilks of other countries. Great commercial fairs ſtill exiſt in Germany, and it is conſidered upon the whole that the balance of trade is in its favour.

32 Character of the ancient Germans.

With regard to the character of the ancient Germans, they are deſcribed to us by the Greek and Roman writers as reſembling the Gauls; and differing from other nations by the largeneſs of their ſtature, ruddy complexion, blue eyes, and yellow buſhy hair, haughty and threatening looks, ſtrong conſtitutions, and being proof againſt hunger, cold, and all kinds of hardſhip.

Their native diſpoſition diſplayed itſelf chiefly in their martial genius, and in their ſingular fidelity. The former of theſe they did indeed carry to ſuch an exceſs as came little ſhort of downright ferocity; but, as to the latter, they not only valued themſelves highly upon it, but were greatly eſteemed by other nations for it; inſomuch that Auguſtus, and ſeveral of his ſucceſſors, committed the guard of their perſons to them, and almoſt all other nations either courted their friendſhip and alliance, or hired them as auxiliaries; though it muſt be owned, at the ſame time, that their extreme love of liberty, and their hatred of tyranny and oppreſſion, have often hurried them to treachery and murder, eſpecially when they have thought themſelves ill uſed by thoſe who hired them; for in all ſuch caſes they were eaſily ſtirred up, and extremely vindictive. In other caſes, Tacitus tells us, they were noble, magnanimous, and beneficent, without ambition to aggrandize their dominions, or invading thoſe from whom they received no injury; rather chooſing to employ their ſtrength and valour defenſively than offenſively; to preſerve their own, than to ravage their neighbours.

Their friendſhip and intercourſe was rather a compound of honeſt bluntneſs and hoſpitality, than of wit, humour, or gallantry. All ſtrangers were ſure to meet with a kind reception from them to the utmoſt of their ability: even thoſe who were not in a capacity to entertain them, made it a piece of duty to introduce them to thoſe who could; and nothing was looked upon as more ſcandalous and deteſtable, than to refuſe them either the one or the other. They do not ſeem, indeed, to have had a taſte for grand and elegant entertainments; they affected in every thing, in their houſes, furniture, diet, &c. rather plainneſs and ſimplicity, than ſumptuouſneſs and luxury. If they learned of the Romans and Gauls the uſe of money, it was rather becauſe they found it more convenient than their ancient way of bartering one commodity for another; and then they preferred theſe ancient coins which had been ſtamped during the times of the Roman liberty, eſpecially ſuch as were either milled or cut in the rims, becauſe they could not be ſo eaſily cheated in them as in ſome others, which were frequently nothing but copper or iron plated over with ſilver. This laſt metal they likewiſe preferred before gold, not becauſe it made a greater ſhow, but becauſe it was more convenient for buying and ſelling: And as they became in time more feared by, or more uſeful to, the Romans; ſo they learned how to draw enough of it from them to ſupply their whole country, beſides what flowed to them from other nations.

As they deſpiſed ſuperfluities in other caſes, ſo they did alſo in the connubial way: every man was contented with one wife, except ſome few of their nobles, who allowed themſelves a plurality, more for ſhow than pleaſure; and both were ſo faithful to each other, and chaſte, true, and diſintereſted, in their conjugal affection, that Tacitus prefers their manners in this reſpect to thoſe of the Romans. The men ſought not dowries from their wives, but beſtowed them upon them. Their youth, in thoſe cold climes, did not begin ſo ſoon to feel the warmth of love as they do in hotter ones: it was a common rule with them not to marry young; and thoſe were moſt eſteemed who continued longeſt in celibacy, becauſe they looked upon it as an effectual means to make them

Germany. them grow tall and strong; and to marry, or be concerned with a woman, before they were full 20 years old, was accounted shameful wantonness. The women shared with their husbands not only the care of the family, and the education of their children, but even the hardships of war. They attended them in the field, cooked the victuals for them, dressed their wounds, stirred them up to fight manfully against their enemies, and sometimes have, by their courage and bravery, recovered a victory when it was upon the point of being snatched from them. In a word, they looked upon such constant attendance on them, not as a servitude, like the Roman dames, but as a duty and an honour. But what appears to have been still a harder fate upon the ancient German dames was, that their great Odin excluded all those from his *valhalla* or paradise, who did not, by some violent death, follow their deceased husbands thither. Yet notwithstanding their having been anciently in such high repute for their wisdom and supposed spirit of prophecy, and their continuing such faithful and tender helpmates to their husbands, they sunk in time so low in their esteem, that, according to the old Saxon law, he that hurt or killed a woman was to pay but half the fine that he should have done, if he had hurt or killed a man.

33
Their funerals.

There is scarcely any one thing in which the Germans, though so nearly allied in most of their other customs to the Gauls, were yet more opposite to them than in their funerals. Those of the latter were performed with great pomp and profusion; those of the former were done with the same plainness and simplicity which they observed in all other things; the only grandeur they affected in them was, to burn the bodies of their great men with some peculiar kinds of wood; but then the funeral pile was neither adorned with the clothes and other fine furniture of the deceased, nor perfumed with fragrant herbs and gums: each man's armour, that is, his sword, shield, and spear, were flung into it, and sometimes his riding horse. The Danes, indeed, flung into the funeral pile of a prince, gold, silver, and other precious things, which the chief mourners, who walked in a gloomy guise round the fire, exhorted the bystanders to fling liberally into it in honour of the deceased. They afterwards deposited their ashes in urns, like the Gauls, Romans, and other nations; as it plainly appears, from the vast numbers which have been dug up all over the country, as well as from the sundry dissertations which have been written upon them by several learned moderns of that nation. One thing we may observe, in general, that whatever sacrifices they offered for their dead, whatever presents they made to them at their funerals, and whatever other superstitious rites they might perform at them, all was done in consequence of those excellent notions which their ancient religion had taught them, the immortality of the soul, and the bliss or misery of a future life.

34
Their belief of a future state.

It is impossible, indeed, as they did not commit any thing to writing till very lately, and as none of the ancient writers have given us any account of it, to guess how soon the belief of their great Odin, and his paradise, was received among them. It may, for aught we know, have been older than the times of Tacitus, and he have known nothing of it, by reason of their scrupulous care in concealing their religion from strangers: but as they conveyed their doctrines to posterity by songs and poems, and most of the northern poets tell us that they have drawn their intelligence from those very poems which were still preserved among them; we may rightly enough suppose, that whatever doctrines are contained in them, were formerly professed by the generality of the nation, especially since we find their ancient practice so exactly conformable to it. Thus, since the surest road to this paradise was, to excel in martial deeds, and to die intrepidly in the field of battle; and since none were excluded from it but base cowards, and betrayers of their country; it is natural to think, that the signal and excessive bravery of the Germans flowed from this ancient belief of theirs: and, if their females were so brave and faithful as not only to share with their husbands all the dangers and fatigues of war, but at length to follow them by a voluntary death, into the other world; it can hardly be attributed to any thing else but a strong persuasion of their being admitted to live with them in that place of bliss. This belief, therefore, whether received originally from the old Celtes, or afterwards taught them by the since deified Odin, seems, from their general practice, to have been universally received by all the Germans, though they might differ one from another in their notions of that future life.

The notion of a future happiness obtained by martial exploits, especially by dying sword in hand, made them bewail the fate of those who lived to an old age, as dishonourable here, and hopeless hereafter: upon which account, they had a barbarous way of sending them into the other world, willing or not willing. And this custom lasted several ages after their receiving Christianity, especially among the Prussians and Venidi; the former of whom, it seems, despatched by a quick death, not only their children, the sick, servants, &c. but even their parents, and sometimes themselves: and among the latter we have instances of this horrid parricide being practised even in the beginning of the 14th century. All that need be added is, that, if those persons, thus supposed to have lived long enough, either desired to be put to death, or at least seemed cheerfully to submit to what they knew they could not avoid, their exit was commonly preceded with a fast, and their funeral with a feast; but if they endeavoured to shun it, as it sometimes happened, both ceremonies were performed with the deepest mourning. In the former, they rejoiced at their deliverance, and being admitted into bliss; in the latter, they bewailed their cowardly excluding themselves from it. Much the same thing was done towards those wives who betrayed a backwardness to follow their dead husbands.

35
Remarkable for drinking to excess.

We must likewise observe, that, in these funerals, as well as in all their other feasts, they were famed for drinking to excess; and one may say of them, above all the other descendants of the ancient Celtes, that their hospitality, banquets, &c. consisted much more in the quantity of strong liquors, than in the elegance of eating. Beer and strong mead, which were their natural drink, were looked upon as the chief promoters of health, strength, fertility, and bravery; upon which account, they made no scruple to indulge themselves to the

Germany. the utmoſt in them, not only in their feaſts, and eſpecially before an engagement, but even in their common meals.

36 Character of the modern Germans. The modern Germans in their perſons are tall and ſtrong built. The ladies have generally fine complexions; and ſome of them, eſpecially in Saxony, have all the delicacy of features and ſhape that are ſo bewitching in a certain iſland of Europe.

Both men and women affect rich dreſſes, which in faſhion are the ſame as in France and England; but the better ſort of men are exceſſively fond of gold and ſilver lace, eſpecially if they are in the army. The ladies at the principal courts differ not much in their dreſs from the French and Engliſh, only they are not ſo exceſſively fond of paint as the former. At ſome courts they appear in rich furs; and all of them are loaded with jewels, if they can obtain them. The female part of the burghers families, in many German towns, dreſs in a very different manner, and ſome of them inconceivably fantaſtic, as may be ſeen in many prints publiſhed in books of travels; but in this reſpect they are gradually reforming, and many of them make quite a different appearance in their dreſs from what they did 30 or 40 years ago. As to the peaſantry and labourers, they dreſs as in other parts of Europe, according to their employments, conveniency, and opulence. In Weſtphalia, and moſt other parts of Germany, they ſleep between two feather beds, or rather the upper one of down, with ſheets ſtretched to them, which by uſe becomes a very comfortable practice. The moſt unhappy part of the Germans are the tenants of little needy princes, who ſqueeze them to keep up their own grandeur; but, in general, the circumſtances of the common people are far preferable to thoſe of the French.

The Germans are naturally a frank, honeſt, hoſpitable people, free from artifice and diſguiſe. The higher orders are ridiculouſly proud of titles, anceſtry, and ſhow. The Germans, in general, are thought to want animation, as their perſons promiſe more vigour and activity than they commonly exert even in the field of battle. But when commanded by able generals, eſpecially the Italians, ſuch as Montecuculi and Prince Eugene, they have done great things, both againſt the Turks and the French. The Imperial arms have ſeldom made any remarkable figure againſt either of thoſe two nations, or againſt the Swedes or Spaniards, when commanded by German generals. This poſſibly might be owing to the arbitrary obſtinacy of the court of Vienna; for in many wars the Auſtrians have exhibited prodigies of military valour and genius.

Induſtry, application, and perſeverance, are the great characteriſtics of the German nation, eſpecially the mechanical part of it. Their works of art would be incredible were they not viſible, eſpecially in watch and clockmaking, jewellery, turnery, ſculpture, drawing, painting, and certain kinds of architecture. The Germans have been charged with intemperance in eating and drinking; and perhaps not unjuſtly, owing to the vaſt plenty of their country in wine and proviſions of every kind. But thoſe practices ſeem now to be wearing out. At the greateſt tables, though the gueſts drink pretty freely during dinner, yet the repaſt is commonly finiſhed by coffee after three or four public toaſts have been drank. But no people have more feaſting at marriages, funerals, and birth-days. Germany.

The German nobility are generally men of ſo much honour, that a ſharper in other countries, eſpecially in England, meets with more credit if he pretends to be a German, than of any other nation.

The merchants and tradeſmen are very civil and obliging. All the ſons of noblemen inherit their father's titles, which greatly perplexes the heralds and genealogiſts of that country. This perhaps is one of the reaſons why the German huſbands are not quite ſo complaiſant as they ought otherwiſe to be to their ladies, who are not entitled to any pre-eminence at the table; nor indeed do they ſeem to affect it, being far from either ambition or loquacity, though they are ſaid to be ſomewhat too fond of gaming. From what has been premiſed, it may eaſily be conceived, that many of the German nobility, having no other hereditary eſtate than a high ſounding title, eaſily enter into their armies, and thoſe of other ſovereigns. Their fondneſs for title is attended with many other inconveniences. Their princes think that the cultivation of their lands, though it may treble their revenue, is below their attention; and that, as they are a ſpecies of beings ſuperior to labourers of every kind, they would demean themſelves in being concerned in the improvement of their grounds.

The domeſtic diverſions of the Germans are the ſame as in England; billiards, cards, dice, fencing, dancing, and the like. In ſummer, people of faſhion repair to places of public reſort, and drink the waters. As to their field diverſions, beſides their favourite one of hunting, they have bull and bear baiting, and the like. The inhabitants of Vienna live luxuriouſly, a great part of their time being ſpent in feaſting and carouſing; and in winter, when the ſeveral branches of the Danube are frozen over, and the ground covered with ſnow, the ladies take their recreation in ſledges of different ſhapes, ſuch as griffins, tygers, ſwans, ſcollop-ſhells, &c. Here the lady ſits, dreſſed in velvet, lined with rich furs, and adorned with laces and jewels, having on her head a velvet cap; and the ſledge is drawn by one horſe, ſtag, or other creature, ſet off with plumes of feathers, ribands, and bells. As this diverſion is taken chiefly in the night-time, ſervants ride before the ſledge with torches, and a gentleman ſitting on the ſledge behind guides the horſe. 37 Amuſements.

The Reformation firſt ſpread in Germany to moſt advantage; and ſince the religious peace of 1555, there have been eſtabliſhed the Roman Catholic, prevailing moſtly in the ſouth; the Lutheran in the north; and the Calviniſt, called alſo the *Reformed*, near the Rhine. Civil wars conſiderably deranged this ſettlement: it was, however, eſtabliſhed by the celebrated peace of Weſtphalia, that the religion of the Seven States ſhould remain as in 1624. The Romiſh ſuperior clergy conſiſt of 8 archbiſhops, 40 biſhops, and many abbots. The Proteſtant clergy are governed by conſiſtories under the ſovereign of each ſtate. The *Corpus Catholicorum* is under the direction of the archbiſhop, elector of Mentz; and the *Corpus Evangelicorum*, or Proteſtants, under the elector of Saxony; who have the care of the public concerns of their reſpective bodies. 38 Religion and learning.

Literature

A. Bell Prin. Wal. Sculptor fecit.

Literature is in a very advanced ſtate throughout almoſt all Germany, but particularly in the Proteſtant ſtates. It is but about half a century ſince the German language has been purified and cultivated; ſince which various works of taſte and elegance, as well as ſuperior productions in the different walks of ſcience, have appeared in it. There are 38 univerſities in Germany; 19 Proteſtant, 17 Catholic, and two which partake of both; beſides a number of literary ſocieties and academic inſtitutions: and education in general is particularly attended to even in the very loweſt ranks.

We have ſaid nothing of the part which the ſtates of Germany, either individually or as a body, naturally took in the late revolution in France. It would indeed be only an unneceſſary repetition of the hiſtory of tranſactions already detailed under France and Britain. Of the changes in the government of particular ſtates, or rather in the names of the rulers, we ſhall ſay nothing. Theſe changes, made at the inſtigation of France, will probably not ſatisfy the inordinate ambition and growing power of her preſent ruler, and therefore will not be permanent.

GERMEN, the ſeed bud; defined by Linnæus to be the baſe of the piſtillum, which contains the rudiments of the ſeed; and, in progreſs of vegetation, ſwells and becomes the ſeed veſſel.

In aſſimilating the vegetable and animal kingdoms, Linnæus denominates the ſeed bud the *ovarium* or *uterus* of plants; and affirms its exiſtence to be chiefly at the time of the diſperſion of the male duſt by the antheræ; as, after its impregnation, it becomes a ſeed veſſel. See BOTANY.

GERMEN, by Pliny and the ancient botaniſts, is uſed to ſignify a bud containing the rudiments of the leaves. See GEMMA.

GERMINATION, among botaniſts, comprehends the preciſe time which the ſeeds take to riſe after they have been committed to the ſoil.—The different ſpecies of ſeeds are longer or ſhorter in riſing according to the degree of heat which is proper to each. Millet, wheat, and ſeveral of the graſſes, riſe in one day; blite, ſpinach, beans, muſtard, kidney beans, turnips, and rocket, in three days; lettuce and dill, in four; cucumber, gourd, melon, and creſs, in five; radiſh and beet, in ſix; barley, in ſeven; orach, in eight; purſlain, in nine; cabbage, in ten; hyſſop, in thirty; parſley, in forty or fifty days; peach, almond, walnut, cheſnut, peony, horned poppy, hypecoum, and ranunculus falcatus, in one year; roſe buſh, cornel tree, hawthorn, medlar, and hazel nut, in two. The ſeeds of ſome ſpecies of orchis, and of ſome liliaceous plants, never riſe at all. Of ſeeds, ſome require to be ſowed almoſt as ſoon as they are ripe, otherwiſe they will not ſprout or germinate. Of this kind are the ſeeds of coffee and fraxinella. Others, particularly thoſe of the pea-bloom flowers, preſerve their germinating faculty for a ſeries of years. Mr Adanſon aſſerts, that the ſenſitive plant retains that virtue for 30 or 40 years.

Air and water are the agents of germination. The humidity of the air alone makes ſeveral ſeeds to riſe that are expoſed to it. Seeds too are obſerved to riſe in water, without the intervention of earth; but water without air is inſufficient. Mr Homberg's experiments on this head are deciſive. He put ſeveral ſeeds under the exhauſted receiver of an air pump, with a view to eſtabliſh ſomething certain on the cauſes of germination. Some of them did not riſe at all; and the greateſt part of thoſe which did, made very weak and feeble productions. Thus it is for want of air that ſeeds which are buried at a very great depth in the earth, either thrive but indifferently, or do not riſe at all. They frequently preſerve, however, their germinating virtue for many years within the bowels of the earth; and it is not unuſual, upon a piece of ground being newly dug to a conſiderable depth, to obſerve it ſoon after covered with ſeveral plants, which had not been ſeen there in the memory of man. Were this precaution frequently repeated, it would doubtleſs be the means of recovering certain ſpecies of plants which are regarded as loſt; or which perhaps, never coming to the knowledge of botaniſts, might hence appear the reſult of a new creation. Some ſeeds require a greater quantity of air than others. Thus purſlain which does not riſe till after lettuce in the free air, riſes before it *in vacuo;* and both proſper but little, or periſh altogether, while creſſes vegetate as freely as in the open air.

GERONTES, in antiquity, a kind of judges, or magiſtrates, in ancient Sparta, anſwering to what the Areopagites were at Athens. See AREOPAGUS.

The word is formed of the Greek γεϱων, which ſignifies "old man." Whence alſo the words *gerontic*, ſomething belonging to an old man; and *Geronicon*, a famous book among the modern Greeks, containing the lives of the ancient monks. The ſenate of gerontes was called *geruſia*, that is, aſſembly or council of old men.

The gerontes were originally inſtituted by Lycurgus: their number, according to ſome, was 28; and, according to others, 32. They governed in conjunction with the king, whoſe authority they were intended to balance, and to watch over the intereſts of the people. Polybius defines their office in few words when he ſays, *per ipſos, et cum ipſis, omnia adminiſtrari*. None were to be admitted into this office under 60 years of age, and they held it for life. They were ſucceeded by the ephori.

GEROPOGON, a genus of plants belonging to the ſyngeneſia claſs, and in the natural method ranking under the 49th order, *Compoſitæ*. See BOTANY *Index*.

GERRETZ. See REMBRANDT.

GERVAISE, or GERVASE, of Tilbury, a famous Engliſh writer of the 13th century; thus named from his being born at Tilbury on the Thames. He was nephew to Henry II. king of England; and was in great credit with Otho IV. emperor of Germany, to whom he dedicated a Deſcription of the World, and a Chronicle. He alſo compoſed a Hiſtory of England, that of the Holy Land, and other works.

GERUND, in *Grammar*, a verbal noun of the neuter gender, partaking of the nature of a participle, declinable only in the ſingular number, through all the caſes except the vocative; as nom. *amandum*, gen. *amandi*, dat. *amando*, accuſ. *amandum*, abl. *amando*. The word is formed of the Latin *gerundivus*, and that from the verb *gerere*, "to bear."

The *gerund* expreſſes not only the *time*, but alſo the *manner*, of an action; as, "he fell in running poſt."—It differs from the participle, in that it expreſſes the *time*, which

which the participle does not; and from the tense properly so called, in that it expresses the *manner*, which the tense does not. See GRAMMAR.

GERUNDA, in *Ancient Geography*, a town of the Ausetani, in the Hither Spain, on the south or right side of the river Sambroca. *Gerundenses*, the people, Now *Gironne* in Catalonia, on the Ter. E. Long. 2. 35. N. Lat. 42.

GESNER, CONRAD, a celebrated physician and naturalist, was born at Zurich in 1516. Having finished his studies in France, he travelled into Italy, and taught medicine and philosophy in his own country with extraordinary reputation. He was acquainted with the languages; and excelled so much in natural history, that he was surnamed the *Pliny of Germany*. He died in 1564, leaving many works behind him; the principal of which are, 1. A history of animals, plants, and fossils; 2. *Bibliotheca Universalis*. A Greek and Latin lexicon. This author is by Boerhaave emphatically styled *Monstrum Eruditionis*, "a prodigy of learning." These indeed (as Mr Coxe observes in his Letters on Switzerland) "who are conversant with the works of this great scholar and naturalist, cannot repress their wonder, and admiration at the amplitude of his knowledge in every species of erudition, and the variety of his discoveries in natural history, which was his peculiar delight. Their wonder and admiration is still further augmented, when they consider the gross ignorance of the age which he helped to enlighten, and the scanty succours he possessed to aid him in thus extending the bounds of knowledge; that he composed his works, and made those discoveries which would have done honour to the most enlightened period, under the complicated evils of poverty, sickness, and domestic uneasiness."

GESNER, *Solomon*, the celebrated author of the Death of Abel and many other admired works in the German language, was born at Zurich in the year 1730. In his early years he showed very few signs of superior abilities; and his progress in the rudiments of education was so slow, that his master gave him up as incapable of any greater attainments than writing and the four first rules of arithmetic. Upon this he was placed under a clergyman in the neighbourhood, a relation of his father's, and who showed himself better acquainted with the art of discovering the natural inclinations of his pupils. This gentleman often carried young Gesner with him into the fields, where he made him observe the beauties of nature; and finding that he took greater pleasure in such lessons, and seemed to listen to them with peculiar attention, he occasionally repeated some of the most striking passages of the ancient authors, who have written on these subjects, in the most agreeable and pleasing manner. By this ingenious artifice, the mind of young Gesner began to open, and its powers to expand; and it is, perhaps, owing to this circumstance, that he became so fond of the language of Virgil and Theocritus. When he arrived at a proper age to think of pursuing some line of business, Mr Gesner made choice of that of a bookseller, which was the profession of his father, and in some measure of his family. Of five houses at Zurich in the printing and bookselling business, two were occupied by Gesners: one belonged to two brothers of that name; and the other, that in which our poet had a share, was known by the firm of *Orel, Gesner, and Company*. It was known also by the extent of its correspondence, and by the choice and elegance of the works which it gave to the public.

Though Mr Gesner was a bookseller, he did not, however, damp his genius, by submitting to the drudgery of business. He indulged himself freely in pursuing his favourite object, and his partners never envied him that time which he devoted to meditation and to study. In 1752, he made a tour through Germany, not so much for the purpose of extending his commerce, as to see and be acquainted with those authors who have done honour to their country. The following circumstance, which occurred during this tour, deserves to be mentioned, as it is strikingly characteristic of that timidity which often accompanies true genius. When Mr Gesner was at Berlin, he was admitted into a literary society, of which Gleim and Lessing were members. Each of the authors who composed it used to read in turn some pieces of their own composition, and Mr Gesner was very desirous of submitting to these able critics a small work, which was his first attempt; but was far from resembling those poets, whom Horace and other satirists have ridiculed, and who stun every one they meet by reciting their verses before them. As each of the members had done reading, Gesner was observed to move his hand with a kind of tremor towards his pocket, and to draw it back again without the manuscript which he ought to have produced. Having not as yet published any thing, none of the company could guess the cause of a motion which his modesty prevented him from explaining. The work which he had not the courage to show, was his small poem, entitled *Night*, which he published on his return to Zurich in 1753. It was considered as an original, of which no model is to be found among the moderns; but in the opinion of the author, it was only a piece of imaginary painting, or, to use an expression of his own, in one of his letters to Mr Huber who has translated his works, "A caricature composed in the moments of folly or intoxication." In this little poem he has introduced a short episode on the origin of the glow-worm, containing a poetical explanation of this natural phosphorus, which has all the beauty of Ovid's Metamorphoses without their prolixity. The success of this essay emboldened the too timid muse of our young bookseller, and he published a pastoral romance, called *Daphnis*, in three cantos. The applause that was deservedly bestowed upon this performance induced the author to publish, some time after, his Idylls and some other rural poems in imitation of those of Theocritus. Pastoral poetry, which at this time was little known in Germany but by translations from foreign poets, began to find many partizans, and to be preferred to every other kind. Desirous, therefore, of tracing out a new path for himself, our poet thought that he could not do a more acceptable service to his countrymen, than to paint the felicity of innocence and rural life, and the tender emotions of love and gratitude. The only author worthy of notice who had preceded Mr Gesner in this career, was Mr Rost of Leipsick, whose pastoral poems appeared for the first time in 1744. This writer polished the language of the German shepherds; he had address enough to unite spirit and simplicity in a kind of writing which appears infipid without the former, and which becomes unnatural and difgufting if it is too abundant. He fometimes throws a delicate veil over thofe images which are deficient in decency, but it is to be regretted that it is often too light. Such was the antagonift againft whom Gefner had to contend. Our poet, however, purfued a different courfe. Inftead of placing, like Roft, his fcenes in modern times, he goes back with Theocritus to the golden age, that happy age which we are fond of reviewing when our paffions are calm, and when freed from thofe anxious cares which hurry us beyond ourfelves, we contemplate amidft tranquillity the beauties and fertility of the country. The characters of Gefner's Idylls, therefore, are taken from thofe focieties which exift no longer but in the remembrance, or rather the imagination. His fhepherds are fathers, children, and hufbands, who blufh not at thefe titles fo dear to nature, and to whom generofity, beneficence, and refpect for the Deity are fentiments no lefs familiar than love. Thefe Idylls were the principal and favourite object of his purfuit, and that part of his work which acquired him the greateft reputation, efpecially among his countrymen. His death of Abel, which is well known, was publifhed for the firft time in 1758. It is written, like the reft of his pieces, in poetical profe; and was fo much fought after, that it went through no lefs than three editions in the fpace of a year, without fpeaking of the fpurious ones which appeared in Holland, at Berlin, and in France. The French edition was followed by feveral others. One came out in Italian; another in the Dutch language; a fourth in the Danifh: and laftly, two in Englifh, one of them in profe and the other in verfe. Among the pieces which Mr Gefner publifhed after the Death of Abel was his Firft Navigator, a poem in three cantos, which many people in Germany confider as his mafterpiece. He made an attempt alfo in the paftoral drama, but not with the fame fuccefs as in other kinds of rural poetry. He produced likewife, in the fame ftyle, Evander and Alcimne, in three acts; and Eraftus, a fmall piece of one act, which was reprefented with fome applaufe in feveral focieties, both at Leipfick and Vienna.

But though poetry was Gefner's darling purfuit, and though he enriched the literature of his country with works which will render his name immortal, he did not confine himfelf to one manner of imitating nature; he in turns took up the pencil and the pen, and his active genius equally directed them both. In his infancy he had received a few leffons in drawing, and he had afterwards purfued this ftudy, but without any intention of becoming an artift. At the age of thirty he felt that violent defire, which may be confidered as the voice of genius; and this was in fome meafure excited by the fight of a beautiful collection formed by Mr Heidegger, whofe daughter he had married. To pleafe his father-in-law, he ftudied this treafure, compofed principally of the beft pieces of the Flemifh fchool; and to this new tafte he had almoft facrificed every other. Mr Gefner at firft ventured only to delineate fome decorations for the frontifpieces of curious books printed in his office; but by little and little he had the courage to make other attempts. In 1765, he publifhed 10 landfcapes etched and engraved by himfelf, and dedicated them to his friend Mr Watlet. Mr Gefner owed him this mark of refpect for the care which he took to ornament with beautiful vignettes Mr Huber's tranflation of his Idylls. Twelve other pieces appeared in 1769; and after thefe attempts, Mr Gefner executed ornaments for many works which came from his preffes, among which were his own works, a German tranflation of Swift, and feveral others.

Were we to judge from Mr Gefner's enthufiafm for his favourite purfuits, and from the time and attention which he beftowed upon them, we fhould be apt to conclude, that he found little leifure for difcharging his duty as a citizen. The contrary however, was the cafe, for he paffed almoft the half of his life in the firft employments of the ftate. In 1765 he was called to the grand council, in 1767 to the leffer. In 1768 he was appointed bailiff of Elibach, that of the four guards in 1776, and in 1781 fuperintendant of waters, which office in 1787 was continued to him for fix years. In all thefe ftations Mr Gefner difcharged his duty with the moft fcrupulous fidelity; and died of a paralytical diforder, lamented by his countrymen and by thofe who had the pleafure of his acquaintance, on the 2d of March 1788, at the age of 56.

As a paftoral poet, Gefner undoubtedly is entitled to a very diftinguifhed rank: and we may juftly fay, that if he has been equalled by any, he has been excelled by none. It is commonly believed, that paftoral poetry is very limited and confined; but thofe who read the works of Gefner will be convinced, that it is fufceptible of much variety when treated of by the hand of a mafter. His paftoral romance of Daphnis is not inferior in natural fimplicity to the celebrated work of Longus; but it furpaffes it far in variety of images and incident. Eraftus and Evander are inftructive and interefting poems, on account of the contraft between the world and nature which reigns throughout them; and his Firft Navigator unites the mildeft philofophy to all the fplendour and imagery of Fairy Land. If we analyze his dramatic poems, we fhall find in them interefting fictions, characters well delineated, and fituations replete with novelty. His language is that of the Graces, and the chafteft ears might liften to the love which he has created. If he has fometimes the humour of Sterne and Fontaine, it is without their licentioufnefs. The fevereft tafte can find in his writings, no lacuna to fupply, no phrafe deferving reprehenfion, nor could a more ingenious choice of expreffions be fubftituted in the room of thofe which he has adopted.—Gefner's character as a man, appears to be no lefs amiable. In whatever point of view we confider him, whether as a hufband, a father, a friend, a magiftrate, or a citizen, his virtues are equally confpicuous. He was naturally of a melancholy turn, but he was no enemy to rational and well-timed mirth; while the mildnefs and affability of his temper rendered his company always engaging, and endeared him to thofe who had the pleafure of his acquaintance. Poffeffed of that noblenefs of fentiment, united with great modefty, which is the ufual attendant of true genius, he was fimple in his external appearance, as well as in his converfation. His language was lively and animated; but his referve before ftrangers refembled timidity, and it was only in the prefence of thofe with whom he was acquainted, that his real character appeared in its full luftre.

Mr Gefner's reputation and virtues were known even to the remoteft parts of Europe. The emprefs of Ruffia Catharine II. prefented him with a gold medal as a mark of her efteem. Strangers of all nations gave him no lefs flattering teftimonies of their admiration; and travellers thought they had feen only the half of Switzerland, if they had not been in the company of Gefner, or procured fome of his landfcapes or drawings. In this laft way he had acquired fo much reputation, that he was ranked among the beft artifts of Germany; and Mr Fuefslin, his countryman, who was himfelf a painter, in the preface to the third volume of the new edition which he publifhed of his 'Hiftorical effay on the painters, engravers, architects, and fculptors, who have done honour to Switzerland,' gives a diftinguifhed place to Mr Gefner, though then living.

GESNERIA, a genus of plants belonging to the didynamia clafs, and in the natural method ranking under the 40th order, *Perfonatæ*. See BOTANY *Index*.

GESSORIACUM, in *Ancient Geography*, a port and ftation for fhips of the Morini in Belgica. In Cæfar's time, according to Dio, there was no town; but Florus fpeaks of it as one: and the Gefforiacenfes Muri are mentioned by Eumenius in his panegyric. The author of Tabula Theodofiana, commonly called *Peutinger's map*, fays exprefsly, that Gefforiacum was in his time called *Bononia*. Now *Boulogne* in Picardy. E. Long. 1. 30. N. Lat. 50. 40.

GESTATION, among phyficians. See PREGNANCY.

GESTRICIA, a province of Sweden, bounded by Helfingia on the north, by the Bothnic gulf on the eaft, by Upland on the fouth, and by Dalecarlia on the weft.

GESTURE, a motion of the body, intended to fignify fome idea or paffion of the mind. It confifts principally in the action of the hands and face; and may be defined, a fuitable conformity of the motions of the countenance, and of feveral parts of the body, in fpeaking, to the fubject matter of the difcourfe. See DECLAMATION and ORATORY.

GETA, SEPTIMIUS, a fon of the emperor Severus, brother to Caracalla. In the eighth year of his age, he was moved with compaffion at the fate of fome of the partizans of Niger and Albinus who were to be executed, and his father ftruck with his humanity retracted the fentence. After Severus's death he reigned at Rome conjointly with his brother; but Caracalla, who envied his virtues and was jealous of his popularity, ordered him to be poifoned; and when this could not be effected, he murdered him in the arms of his mother Julia, who in the attempt of defending the fatal blows from his body received a wound in her arm, from the hand of her fon, A. D. 212. Geta had not yet reached the 23d year of his age, and the Romans had reafon to lament the death of fo virtuous a prince, while they groaned under the cruelties and oppreffion of Caracalla.

GETHIN, Lady GRACE, an Englifh lady of uncommon parts, was the daughter of Sir George Norton of Abbots-Leigh in Somerfetfhire, and born in the year 1676. She had all the advantages of a liberal education; and became the wife of Sir Richard Gethin, of Gethin Grott in Ireland. She was miftrefs of great accomplifhments, natural and acquired, but did not live long enough to difplay them to the world; for fhe died in the 21ft year of her age. She was buried in Weftminfter abbey, where a beautiful monument with an infcription is erected over her; and, for perpetuating her memory, provifion was made for a fermon to be preached in Weftminfter abbey yearly, on Afh Wednefday for ever. She wrote, and left behind her, in loofe papers, a work which, foon after her death, was methodized, and publifhed under the title of "*Reliquiæ Gethinionæ*; or, Some remains of the moft ingenious and excellent lady, Grace, lady Gethin, lately deceafed. Being a collection of choice difcourfes, pleafant apophthegms, and witty fentences. Written by her, for the moft part, by way of effay, and at fpare hours." Lond. 1700, 4to; with her picture before it.

GETHSEMANE, in *Ancient Geography*, a village in the mount of Olives, whither Jefus Chrift fometimes retreated in the night time. It was in a garden belonging to this village that he fuffered the agony in which he fweated drops of blood; and here he was arrefted by Judas and the reft who were conducted by this traitor. The place is by Maundrel defcribed as an even plot of ground, not above 57 yards fquare, lying between the foot of Mount Olivet and the brook Cedron.

GETHYLLIS, a genus of plants belonging to the dodecandria clafs, and in the natural method ranking under the ninth order *Spathaceæ*. See BOTANY *Index*.

GEUM, AVENS, or *Herb Bennet*, a genus of plants belonging to the icofandria clafs, and in the natural method ranking under the 35th order, *Senticofæ*. See BOTANY *Index*.

GHENT, a city of the Auftrian Netherlands, capital of the province of Flanders. It is feated on four navigable rivers, the Scheldt, the Lys, the Lieve, and the Moere, which run through it, and divide it into canals. Thefe form 26 little ifles, over which there are 300 bridges: among which there is one remarkable for a ftatue of brafs of a young man who was obliged to cut off his father's head; but as he was going to ftrike, the blade flew into the air, and the hilt remained in his hand, upon which they were both pardoned. There is a picture of the whole tranfaction in the townhoufe. Ghent is furrounded with walls and other fortifications, and is tolerably ftrong for a place of its circumference. But all the ground within the walls is not built upon. The ftreets are large and well paved, the market places fpacious, and the houfes built with brick. But the Friday's market place is the largeft, and is remarkable for the ftatue of Charles V. which ftands upon a pedeftal in the imperial habit. That of Cortere is remarkable for a fine walk under feveral rows of trees. In 1737 a fine opera houfe was built here, and a guard houfe for the garrifon. Near the town is a very high tower, with a handfome clock and chimes. The great bell weighs 11,000 pounds.

This town is famous for the pacification figned here, in 1526, for fettling the tranquillity of the Seventeen Provinces, which was afterwards confirmed by the king of Spain. It was taken by Louis XIV. in 1678, who

Ghost.

who afterwards restored it. The French took possession of it again after the death of Charles II. of Spain. In 1706, it was taken by the duke of Marlborough; and by the French in 1708; but it was retaken the same year. Last of all, the French took it by surprise after the battle of Fontenoy; but at the peace of Aix-la-Chapelle, it was rendered back. It was also taken by the French in 1794. This is the birth-place of John of Gaunt. It is very well seated for trade, on account of its rivers and canals. It carries on a great commerce in corn; and has linen, woollen, and silk manufactures. The number of inhabitants is about 70,000. E. Long. 4. 0. N. Lat. 51. 24.

GHOST, an apparition, or spirit of a person deceased.

The ancients supposed every man to be possessed of three different ghosts, which after the dissolution of the human body were differently disposed of. These three ghosts are distinguished by the names of *Manes*, *Spiritus*, *Umbra*. The *manes*, they fancied, went down into the infernal region; the *spiritus* ascended to the skies; and the *umbra* hovered about the tomb, as being unwilling to quit its old connexions. Thus Dido (Virg. Æn. iv. 384.) threatens Æneas after death that she will haunt him with her umbra, whilst her manes rejoices in his torments below. This idea of a threefold soul is very clearly expressed in these lines, which have been attributed to Ovid.

Bis duo sunt homini: MANES, CARO, SPIRITUS, UMBRA:
Quatuor ista loci bis duo suscipiunt.
Terra tegit CARNEM, *tumulum circumvolat* UMBRA,
Orcus habet MANES, SPIRITUS *astra petit.*

The most striking outlines of the popular superstitions respecting ghosts among us, are thus humorously collected by Captain Grose in his Provincial Glossary: "A ghost is supposed to be the spirit of a person deceased, who is either commissioned to return for some special errand, such as the discovery of a murder, to procure restitution of lands or money unjustly withheld from an orphan or widow—or, having committed some injustice whilst living, cannot rest till that is redressed. Sometimes the occasion of spirits revisiting this world, is to inform their heir in what secret place, or private drawer in an old trunk, they had hidden the title deeds of the estate; or where, in troublesome times, they buried their money or plate. Some ghosts of murdered persons, whose bodies have been secretly buried, cannot be at ease till their bones have been taken up, and deposited in consecrated ground with all the rites of Christian burial.

"Sometimes ghosts appear in consequence of an agreement made, whilst living, with some particular friend, that he who first died should appear to the survivor.

"Glanvil tells us of the ghost of a person who had lived but a disorderly kind of life, for which it was condemned to wander up and down the earth, in the company of evil spirits, till the day of judgment.

"In most of the relations of ghosts, they are supposed to be mere aerial beings, without substance, and that they can pass through walls and other solid bodies at pleasure. A particular instance of this is given, in relation the 27th, in Glanvil's collection, where one David Hunter, neat-herd to the bishop of Down and Connor, was for a long time haunted by the apparition of an old woman, whom he was by a secret impulse obliged to follow whenever she appeared, which he says he did for a considerable time, even if in bed with his wife: and because his wife could not hold him in his bed, she would go too, and walk after him till day, though she saw nothing; but his little dog was so well acquainted with the apparition, that he would follow it as well as his master. If a tree stood in her walk, he observed her always to go through it. Notwithstanding this seeming immateriality, this very ghost was not without some substance; for, having performed her errand, she desired Hunter to lift her from the ground; in the doing of which, he says, she felt just like a bag of feathers. We sometimes also read of ghosts striking violent blows; and that, if not made way for, they overturn all impediments, like a furious whirlwind. Glanvil mentions an instance of this, in relation 17th, of a Dutch lieutenant who had the faculty of seeing ghosts; and who, being prevented making way for one which he mentioned to some friends as coming towards them, was, with his companions, violently thrown down, and sorely bruised. We further learn, by relation 16th, that the hand of a ghost is 'as cold as a clod.'

"The usual time at which ghosts make their appearance is midnight, and seldom before it is dark: though some audacious spirits have been said to appear even by day light: but of this there are few instances, and those mostly ghosts who have been laid, perhaps in the Red sea (of which more hereafter), and whose times of confinement were expired: these, like felons confined to the lighters, are said to return more troublesome and daring than before. No ghosts can appear on Christmas eve; this Shakespeare has put into the mouth of one of his characters in Hamlet.

"Ghosts commonly appear in the same dress they usually wore whilst living, though they are sometimes clothed all in white; but that is chiefly the churchyard ghosts, who have no particular business, but seem to appear *pro bono publico*, or to scare drunken rustics from tumbling over their graves.

"I cannot learn that ghosts carry tapers in their hands, as they are sometimes depicted, though the room in which they appear, if without fire or candle, is frequently said to be as light as day. Dragging chains is not the fashion of English ghosts; chains and black vestments being chiefly the accoutrements of foreign spectres seen in arbitrary governments: dead or alive, English spirits are free. One instance, however, of an English ghost dressed in black is found in the celebrated ballad of William and Margaret, in the following lines:

And clay cold was her lily hand
That held her *sable shroud.*

This, however, may be considered as a poetical license, used, in all likelihood, for the sake of the opposition of *lily* to *sable*.

"If, during the time of an apparition, there is a lighted candle in the room, it will burn extremely blue: this is so universally acknowledged, that many eminent philosophers have busied themselves in accounting for it, without once doubting the truth of the fact. Dogs, too, have the faculty of seeing spirits, as is instanced in David

David Hunter's relation above quoted; but in that caſe they uſually ſhow ſigns of terror, by whining and creeping to their maſter for protection; and it is generally ſuppoſed that they often ſee things of this nature when their owner cannot; there being ſome perſons, particularly thoſe born on a Chriſtmas eve, who cannot ſee ſpirits.

"The coming of a ſpirit is announced ſome time before its appearance, by a variety of loud and dreadful noiſes; ſometimes rattling in the old hall like a coach and ſix, and rumbling up and down the ſtaircaſe like the trundling of bowls or cannon balls. At length the door flies open, and the ſpectre ſtalks ſlowly up to the bed's foot, and opening the curtains, looks ſtedfaſtly at the perſon in bed by whom it is ſeen; a ghoſt being very rarely viſible to more than one perſon, although there are ſeveral in company. It is here neceſſary to obſerve, that it has been univerſally found by experience, as well as affirmed by diverſe apparitions themſelves, that a ghoſt has not the power to ſpeak till it has been firſt ſpoken to; ſo that, notwithſtanding the urgency of the buſineſs on which it may come, every thing muſt ſtand ſtill till the perſon viſited can find ſufficient courage to ſpeak to it: an event that ſometimes does not take place for many years. It has not been found that female ghoſts are more loquacious than thoſe of the male ſex, both being equally reſtrained by this law.

"The mode of addreſſing a ghoſt is by commanding it, in the name of the Three Perſons of the Trinity, to tell you who it is, and what is its buſineſs; this it may be neceſſary to repeat three times; after which it will, in a low and hollow voice, declare its ſatisfaction at being ſpoken to, and deſire the party addreſſing it not to be afraid, for it will do him no harm. This being premiſed, it commonly enters into its narrative; which being completed, and its requeſt or commands given, with injunctions that they be immediately executed, it vaniſhes away, frequently in a flaſh of light; in which caſe, ſome ghoſts have been ſo conſiderate as to deſire the party to whom they appeared to ſhut their eyes: ſometimes its departure is attended with delightful muſic. During the narration of its buſineſs, a ghoſt muſt by no means be interrupted by queſtions of any kind; ſo doing is extremely dangerous: if any doubts ariſe, they muſt be ſtated after the ſpirit has done its tale. Queſtions reſpecting its ſtate, or the ſtate of any of their former acquaintance, are offenſive, and not often anſwered; ſpirits perhaps being reſtrained from divulging the ſecrets of their priſon houſe. Occaſionally ſpirits will even condeſcend to talk on common occurrences, as is inſtanced by Glanvil in the apparition of Major George Sydenham to Captain William Dyke, relation 10th, wherein the major reproved the captain for ſuffering a ſword he had given him to grow ruſty: ſaying, 'Captain, captain, this ſword did not uſe to be kept after this manner when it was mine.' This attention to the ſtate of arms, was a remnant of the major's profeſſional duty when living.

"It is ſomewhat remarkable that ghoſts do not go about their buſineſs like the perſons of this world. In caſes of murder, a ghoſt, inſtead of going to the next juſtice of the peace, and laying its information, or to the neareſt relation of the perſon murdered, appears to ſome poor labourer who knows none of the parties, draws the curtains of ſome decrepit nurſe or alms woman, or hovers about the place where his body is depoſited. The ſame circuitous mode is purſued with reſpect to redreſſing injured orphans or widows; when it ſeems as if the ſhorteſt and moſt certain way would be, to go to the perſon guilty of the injuſtice, and haunt him continually till he be terrified into a reſtitution. Nor is the pointing out loſt writings generally managed in a more ſummary way; the ghoſt commonly applying to a third perſon ignorant of the whole affair, and a ſtranger to all concerned. But it is preſumptuous to ſcrutinize too far into theſe matters: ghoſts have undoubtedly forms and cuſtoms peculiar to themſelves.

"If, after the firſt appearance, the perſons employed neglect, or are prevented from, performing the meſſage or buſineſs committed to their management, the ghoſt appears continually to them, at firſt with a diſcontented, next an angry, and at length with a furious, countenance, threatening to tear them in pieces if the matter is not forthwith executed; ſometimes terrifying them, as in Glanvil's relation 26th, by appearing in many formidable ſhapes, and ſometimes even ſtriking them a violent blow. Of blows given by ghoſts there are many inſtances, and ſome wherein they have been followed with an incurable lameneſs.

"It ſhould have been obſerved, that ghoſts, in delivering their commiſſions, in order to enſure belief, communicate to the perſons employed ſome ſecret, known only to the parties concerned and themſelves, the relation of which always produces the effect intended. The buſineſs being completed, ghoſts appear with a cheerful countenance, ſaying they ſhall now be at reſt, and will never more diſturb any one; and, thanking their agents, by way of reward communicate to them ſomething relative to themſelves, which they will never reveal.

"Sometimes ghoſts appear, and diſturb a houſe, without deigning to give any reaſon for ſo doing: with theſe, the ſhorteſt and only way is to exorciſe, and eject them; or, as the vulgar term is, lay them. For this purpoſe there muſt be two or three clergymen, and the ceremony muſt be performed in Latin; a language that ſtrikes the moſt audacious ghoſt with terror. A ghoſt may be laid for any term leſs than 100 years, and in any place or body, full or empty; as, a ſolid oak—the pommel of a ſword—a barrel of beer, if a yeoman or ſimple gentleman—or a pipe of wine, if an eſquire or a juſtice. But of all places the moſt common, and what a ghoſt leaſt likes, is the Red ſea; it being related, in many inſtances, that ghoſts have moſt earneſtly beſought the exorciſts not to confine them in that place. It is nevertheleſs conſidered as an indiſputable fact, that there are an infinite number laid there, perhaps from its being a ſafer priſon than any other nearer at hand; though neither hiſtory nor tradition gives us any inſtance of ghoſts eſcaping or returning from this kind of tranſportation before their time.

"Another ſpecies of human apparition may be here noticed, though it does not come under the ſtrict deſcription of a ghoſt. Theſe are the exact figures and reſemblances of perſons then living, often ſeen not only by their friends at a diſtance, but many times by themſelves;

ſelves; of which there are ſeveral inſtances in Aubery's Miſcellanies: one of Sir Richard Napier, a phyſician of London, who being on the road from Bedfordſhire to viſit a friend in Berkſhire, ſaw at an inn his own apparition lying on his bed as a dead corpſe; he nevertheleſs went forward, and died in a ſhort time: another of Lady Diana Rich, daughter of the earl of Holland, who met her own apparition walking in a garden at Kenſington, and died a month after of the ſmallpox. Theſe apparitions are called *fetches;* in Cumberland, *ſwarths;* and in Scotland, *wraiths:* they moſt commonly appear to diſtant friends and relations, at the very inſtant preceding the death of the perſon whoſe figure they put on. Sometimes, as in the inſtances above mentioned, there is a greater interval between the appearance and death." For a philoſophical inquiry into the ſubject of apparitions in general, ſee the article SPECTRE.

GIAGH, in *Chronology*, a cycle of 12 years; in uſe among the Turks and Cathayans.

Each year of the giagh bears a name of ſome animal: the firſt that of a mouſe; the ſecond that of a bullock; the third of a lynx or leopard; the fourth of a hare; the fifth of a crocodile; the ſixth of a ſerpent; the ſeventh of a horſe; the eighth of a ſheep; the ninth of a monkey; the tenth of a hen; the eleventh of a dog; and the twelfth of a hog.

They alſo divide the day into 12 parts, which they call *giaghs*, and diſtinguiſh them by the name of ſome animals. Each giagh contains two of our hours, and is divided into eight kehs, as many as there are quarters in our hours.

GIALLOLINO, in *Natural Hiſtory*, a fine yellow pigment, much uſed under the name of NAPLES YELLOW.

GIANT, a perſon of extraordinary bulk and ſtature.

The romances of all ages have furniſhed us with ſo many extravagant accounts of giants of incredible bulk and ſtrength, that the exiſtence of ſuch people is now generally diſbelieved. It is commonly thought, that the ſtature of men hath been the ſame in all ages; and ſome have even pretended to *demonſtrate* the impoſſibility of the exiſtence of giants mathematically. Of theſe our countryman M'Laurin hath been the moſt explicit. "In general (ſays he) it will eaſily appear, that the efforts tending to deſtroy the coheſion of beams ariſing from their own gravity only, increaſe in the quadruplicate ratio of their lengths: but that the oppoſite efforts tending to preſerve their coheſion, increaſe only in the triplicate proportion of the ſame lengths. From which it follows, that the greater beams muſt be in greater danger of breaking than the leſſer ſimilar ones; and that though a leſſer beam may be firm and ſecure, yet a greater ſimilar one may be made ſo long, that it will neceſſarily break by its own weight. Hence Galileo juſtly concludes, that what appears very firm, and ſucceeds very well in models, may be very weak and infirm, or even fall to pieces by its own weight, when it comes to be executed in large dimenſions according to the model. From the ſame principle he argues, that there are neceſſary limits in the operations of nature and art, which they cannot ſurpaſs in magnitude. Were trees of a very enormous ſize, their branches would fall by their own weight. Large animals have not ſtrength in proportion to their ſize; and if there were any land animals much larger than thoſe we know, they could hardly move, and would be perpetually ſubject to the moſt dangerous accidents. As to the animals of the ſea, indeed, the caſe is different; for the gravity of the water in a great meaſure ſuſtains thoſe animals; and in fact theſe are known ſometimes to be vaſtly larger than the greateſt land animals. Nor does it avail againſt this doctrine to tell us, that bones have ſometimes been found which were ſuppoſed to have belonged to giants of immenſe ſize; ſuch as the ſkeletons mentioned by Strabo and Pliny, the former of which was 60 cubits high, and the latter 46: for naturaliſts have concluded on juſt grounds, that in ſome caſes theſe bones had belonged to elephants; and that the larger ones were bones of whales, which had been brought to the places where they were found by the revolutions of nature that have happened in paſt times. Though it muſt be owned, that there appears no reaſon why there may not have been men who have exceeded by ſome feet in height the talleſt we have ſeen."

It will eaſily be ſeen, that arguments of this kind can never be concluſive; becauſe, along with an increaſe of ſtature in any animal, we muſt always ſuppoſe a proportional increaſe in the coheſion of the parts of its body. Large works ſometimes fail when conſtructed on the plan of models, becauſe the coheſion of the materials whereof the model is made, and of the large work, are the ſame; but a difference in this reſpect will produce a very remarkable difference in the ultimate reſult. Thus, ſuppoſe a model is made of firwood, the model may be ſtrong and firm enough; but a large work made alſo of fir, when executed according to the plan of the model, may be ſo weak that it will fall to pieces by its own weight. If, however, we make uſe of iron for the large work inſtead of fir, the whole will be ſufficiently ſtrong, even though made exactly according to the plan of the model. The like may be ſaid with regard to large and ſmall animals. If we could find an animal whoſe bones exceeded in hardneſs and ſtrength the bones of other animals as much as iron exceeds fir, ſuch an animal might be of a monſtrous ſize, and yet be exceedingly ſtrong. In like manner, if we ſuppoſe the fleſh and bones of a giant to be greatly ſuperior in hardneſs and ſtrength to the bones of other men, the great ſize of his body will be no objection at all to his ſtrength. The whole of the matter therefore concerning the exiſtence of giants muſt reſt on the credibility of the accounts we have from thoſe who pretend to have ſeen them, and not on any arguments drawn *à priori*.

In the Scripture we are told of *giants*, who were produced from the marriages of the *ſons of God* with the *daughters of men* †. This paſſage indeed has been differently interpreted, ſo as to render it doubtful whether the word tranſlated *giants* does there imply any extraordinary ſtature. In other parts of Scripture, however, giants, with their dimenſions, are mentioned in ſuch a manner that we cannot poſſibly doubt; as in the caſe of Og king of Baſhan, and Goliath. In a memoir read before the Academy of Sciences at Rouen, M. Le Cat gives the following account of giants that are ſaid to have exiſted in different ages.

† See *Antediluvians*.

"Profane hiſtorians have given ſeven feet of height to

Ghost.

David Hunter's relation above quoted; but in that case they usually show signs of terror, by whining and creeping to their master for protection; and it is generally supposed that they often see things of this nature when their owner cannot; there being some persons, particularly those born on a Christmas eve, who cannot see spirits.

"The coming of a spirit is announced some time before its appearance, by a variety of loud and dreadful noises; sometimes rattling in the old hall like a coach and six, and rumbling up and down the staircase like the trundling of bowls or cannon balls. At length the door flies open, and the spectre stalks slowly up to the bed's foot, and opening the curtains, looks stedfastly at the person in bed by whom it is seen; a ghost being very rarely visible to more than one person, although there are several in company. It is here necessary to observe, that it has been universally found by experience, as well as affirmed by diverse apparitions themselves, that a ghost has not the power to speak till it has been first spoken to; so that, notwithstanding the urgency of the business on which it may come, every thing must stand still till the person visited can find sufficient courage to speak to it: an event that sometimes does not take place for many years. It has not been found that female ghosts are more loquacious than those of the male sex, both being equally restrained by this law.

"The mode of addressing a ghost is by commanding it, in the name of the Three Persons of the Trinity, to tell you who it is, and what is its business; this it may be necessary to repeat three times; after which it will, in a low and hollow voice, declare its satisfaction at being spoken to, and desire the party addressing it not to be afraid, for it will do him no harm. This being premised, it commonly enters into its narrative; which being completed, and its request or commands given, with injunctions that they be immediately executed, it vanishes away, frequently in a flash of light; in which case, some ghosts have been so considerate as to desire the party to whom they appeared to shut their eyes: sometimes its departure is attended with delightful music. During the narration of its business, a ghost must by no means be interrupted by questions of any kind; so doing is extremely dangerous: if any doubts arise, they must be stated after the spirit has done its tale. Questions respecting its state, or the state of any of their former acquaintance, are offensive, and not often answered; spirits perhaps being restrained from divulging the secrets of their prison house. Occasionally spirits will even condescend to talk on common occurrences, as is instanced by Glanvil in the apparition of Major George Sydenham to Captain William Dyke, relation 10th, wherein the major reproved the captain for suffering a sword he had given him to grow rusty: saying, 'Captain, captain, this sword did not use to be kept after this manner when it was mine.' This attention to the state of arms, was a remnant of the major's professional duty when living.

"It is somewhat remarkable that ghosts do not go about their business like the persons of this world. In cases of murder, a ghost, instead of going to the next justice of the peace, and laying its information, or to the nearest relation of the person murdered, appears to some poor labourer who knows none of the parties, draws the curtains of some decrepit nurse or alms woman, or hovers about the place where his body is deposited. The same circuitous mode is pursued with respect to redressing injured orphans or widows; when it seems as if the shortest and most certain way would be, to go to the person guilty of the injustice, and haunt him continually till he be terrified into a restitution. Nor is the pointing out lost writings generally managed in a more summary way; the ghost commonly applying to a third person ignorant of the whole affair, and a stranger to all concerned. But it is presumptuous to scrutinize too far into these matters: ghosts have undoubtedly forms and customs peculiar to themselves.

"If, after the first appearance, the persons employed neglect, or are prevented from, performing the message or business committed to their management, the ghost appears continually to them, at first with a discontented, next an angry, and at length with a furious, countenance, threatening to tear them in pieces if the matter is not forthwith executed; sometimes terrifying them, as in Glanvil's relation 26th, by appearing in many formidable shapes, and sometimes even striking them a violent blow. Of blows given by ghosts there are many instances, and some wherein they have been followed with an incurable lameness.

"It should have been observed, that ghosts, in delivering their commissions, in order to ensure belief, communicate to the persons employed some secret, known only to the parties concerned and themselves, the relation of which always produces the effect intended. The business being completed, ghosts appear with a cheerful countenance, saying they shall now be at rest, and will never more disturb any one; and, thanking their agents, by way of reward communicate to them something relative to themselves, which they will never reveal.

"Sometimes ghosts appear, and disturb a house, without deigning to give any reason for so doing: with these, the shortest and only way is to exorcise, and eject them; or, as the vulgar term is, lay them. For this purpose there must be two or three clergymen, and the ceremony must be performed in Latin; a language that strikes the most audacious ghost with terror. A ghost may be laid for any term less than 100 years, and in any place or body, full or empty; as, a solid oak—the pommel of a sword—a barrel of beer, if a yeoman or simple gentleman—or a pipe of wine, if an esquire or a justice. But of all places the most common, and what a ghost least likes, is the Red sea; it being related, in many instances, that ghosts have most earnestly besought the exorcists not to confine them in that place. It is nevertheless considered as an indisputable fact, that there are an infinite number laid there, perhaps from its being a safer prison than any other nearer at hand; though neither history nor tradition gives us any instance of ghosts escaping or returning from this kind of transportation before their time.

"Another species of human apparition may be here noticed, though it does not come under the strict description of a ghost. These are the exact figures and resemblances of persons then living, often seen not only by their friends at a distance, but many times by themselves;

felves; of which there are feveral inftances in Aubery's Mifcellanies: one of Sir Richard Napier, a phyfician of London, who being on the road from Bedfordfhire to vifit a friend in Berkfhire, faw at an inn his own apparition lying on his bed as a dead corpfe; he neverthelefs went forward, and died in a fhort time: another of Lady Diana Rich, daughter of the earl of Holland, who met her own apparition walking in a garden at Kenfington, and died a month after of the fmallpox. Thefe apparitions are called *fetches;* in Cumberland, *fwarths;* and in Scotland, *wraiths:* they moft commonly appear to diftant friends and relations, at the very inftant preceding the death of the perfon whofe figure they put on. Sometimes, as in the inftances above mentioned, there is a greater interval between the appearance and death." For a philofophical inquiry into the fubject of apparitions in general, fee the article SPECTRE.

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Each year of the giagh bears a name of fome animal: the firft that of a moufe; the fecond that of a bullock; the third of a lynx or leopard; the fourth of a hare; the fifth of a crocodile; the fixth of a ferpent; the feventh of a horfe; the eighth of a fheep; the ninth of a monkey; the tenth of a hen; the eleventh of a dog; and the twelfth of a hog.

They alfo divide the day into 12 parts, which they call *giaghs*, and diftinguifh them by the name of fome animals. Each giagh contains two of our hours, and is divided into eight kehs, as many as there are quarters in our hours.

GIALLOLINO, in *Natural Hiftory*, a fine yellow pigment, much ufed under the name of NAPLES YELLOW.

GIANT, a perfon of extraordinary bulk and ftature.

The romances of all ages have furnifhed us with fo many extravagant accounts of giants of incredible bulk and ftrength, that the exiftence of fuch people is now generally difbelieved. It is commonly thought, that the ftature of men hath been the fame in all ages; and fome have even pretended to *demonftrate* the impoffibility of the exiftence of giants mathematically. Of thefe our countryman M'Laurin hath been the moft explicit. "In general (fays he) it will eafily appear, that the efforts tending to deftroy the cohefion of beams arifing from their own gravity only, increafe in the quadruplicate ratio of their lengths: but that the oppofite efforts tending to preferve their cohefion, increafe only in the triplicate proportion of the fame lengths. From which it follows, that the greater beams muft be in greater danger of breaking than the leffer fimilar ones; and that though a leffer beam may be firm and fecure, yet a greater fimilar one may be made fo long, that it will neceffarily break by its own weight. Hence Galileo juftly concludes, that what appears very firm, and fucceeds very well in models, may be very weak and infirm, or even fall to pieces by its own weight, when it comes to be executed in large dimenfions according to the model. From the fame principle he argues, that there are neceffary limits in the operations of nature and art, which they cannot furpafs in magnitude. Were trees of a very enormous fize, their branches would fall by their own weight. Large animals have not ftrength in proportion to their fize; and if there were any land animals much larger than thofe we know, they could hardly move, and would be perpetually fubject to the moft dangerous accidents. As to the animals of the fea, indeed, the cafe is different; for the gravity of the water in a great meafure fuftains thofe animals; and in fact thefe are known fometimes to be vaftly larger than the greateft land animals. Nor does it avail againft this doctrine to tell us, that bones have fometimes been found which were fuppofed to have belonged to giants of immenfe fize; fuch as the fkeletons mentioned by Strabo and Pliny, the former of which was 60 cubits high, and the latter 46: for naturalifts have concluded on juft grounds, that in fome cafes thefe bones had belonged to elephants; and that the larger ones were bones of whales, which had been brought to the places where they were found by the revolutions of nature that have happened in paft times. Though it muft be owned, that there appears no reafon why there may not have been men who have exceeded by fome feet in height the talleft we have feen."

It will eafily be feen, that arguments of this kind can never be conclufive; becaufe, along with an increafe of ftature in any animal, we muft always fuppofe a proportional increafe in the cohefion of the parts of its body. Large works fometimes fail when conftructed on the plan of models, becaufe the cohefion of the materials whereof the model is made, and of the large work, are the fame; but a difference in this refpect will produce a very remarkable difference in the ultimate refult. Thus, fuppofe a model is made of firwood, the model may be ftrong and firm enough; but a large work made alfo of fir, when executed according to the plan of the model, may be fo weak that it will fall to pieces by its own weight. If, however, we make ufe of iron for the large work inftead of fir, the whole will be fufficiently ftrong, even though made exactly according to the plan of the model. The like may be faid with regard to large and fmall animals. If we could find an animal whofe bones exceeded in hardnefs and ftrength the bones of other animals as much as iron exceeds fir, fuch an animal might be of a monftrous fize, and yet be exceedingly ftrong. In like manner, if we fuppofe the flefh and bones of a giant to be greatly fuperior in hardnefs and ftrength to the bones of other men, the great fize of his body will be no objection at all to his ftrength. The whole of the matter therefore concerning the exiftence of giants muft reft on the credibility of the accounts we have from thofe who pretend to have feen them, and not on any arguments drawn *à priori.*

In the Scripture we are told of *giants*, who were produced from the marriages of the *fons of God* with the *daughters of men* †. This paffage indeed has been differently interpreted, fo as to render it doubtful whether the word tranflated *giants* does there imply any extraordinary ftature. In other parts of Scripture, however, giants, with their dimenfions, are mentioned in fuch a manner that we cannot poffibly doubt; as in the cafe of Og king of Bafhan, and Goliath. In a memoir read before the Academy of Sciences at Rouen, M. Le Cat gives the following account of giants that are faid to have exifted in different ages.

† See *Antediluvians.*

"Profane hiftorians have given feven feet of height to to Hercules their firſt hero; and in our days we have ſeen men eight feet high. The giant who was ſhown in Rouen in 1735, meaſured eight feet ſome inches. The emperor Maximian was of that ſize; Shenkius and Platerus, phyſicians of the laſt century, ſaw ſeveral of that ſtature; and Goropius ſaw a girl who was ten feet high.—The body of Oreſtes, according to the Greeks, was eleven feet and a half; the giant Galbara, brought from Arabia to Rome under Claudius Cæſar, was near ten feet; and the bones of Secondilla and Puſio, keepers of the gardens of Salluſt, were but ſix inches ſhorter. Funnam, a Scotſman, who lived in the time of Eugene II. king of Scotland, meaſured eleven feet and a half; and Jacob le Maire, in his voyage to the Straits of Magellan, reports, that on the 17th of December 1615, they found at Port Deſire ſeveral graves covered with ſtones; and having the curioſity to remove the ſtones, they diſcovered human ſkeletons of ten and eleven feet long. The chevalier Scory, in his voyage to the peak of Teneriffe, ſays, that they found in one of the ſepulchral caverns of that mountain the head of a Guanche which had 80 teeth, and that the body was not leſs than 15 feet long. The giant Ferragus, ſlain by Orlando nephew of Charlemagne, was 18 feet high. Rioland, a celebrated anatomiſt, who wrote in 1614, ſays, that ſome years before there was to be ſeen in the ſuburbs of St Germain the tomb of the giant Iſoret, who was 20 feet high. In Rouen, in 1509, in digging in the ditches near the Dominicans, they found a ſtone tomb containing a ſkeleton whoſe ſkull held a buſhel of corn, and whoſe ſhin bone reached up to the girdle of the talleſt man there, being about four feet long, and conſequently the body muſt have been 17 or 18 feet high. Upon the tomb was a plate of copper, whereon was engraved, "In this tomb lies the noble and puiſſant lord, the chevalier Ricon de Vallemont, and his bones." Platerus, a famous phyſician, declares, that he ſaw at Lucerne the true human bones of a ſubject which muſt have been at leaſt 19 feet high. Valence in Dauphiné boaſts of poſſeſſing the bones of the giant Bucart, tyrant of the Vivarais, who was ſlain with an arrow by the count de Cabillon his vaſſal. The Dominicans had a part of the ſhin bone, with the articulation of the knee, and his figure painted in freſco, with an inſcription, ſhowing that this giant was 22 feet and a half high, and that his bones were found in 1705, near the banks of the Morderi, a little river at the foot of the mountain of Cruſſol, upon which (tradition ſays) the giant dwelt.

"January 11. 1613, ſome maſons digging near the ruins of a caſtle in Dauphiné, in a field which (by tradition) had long been called the *giant's field*, at the depth of 18 feet diſcovered a brick tomb 30 feet long, 12 feet wide, and 8 feet high; on which was a gray ſtone, with the words *Theutobochus Rex* cut thereon. When the tomb was opened, they found a human ſkeleton entire, 25 feet and a half long, 10 feet wide acroſs the ſhoulders, and five feet deep from the breaſt bone to the back. His teeth were about the ſize each of an ox's foot, and his ſhin bone meaſured four feet. —Near Mazarino, in Sicily, in 1516, was found a giant 30 feet high; his head was the ſize of an hogſhead, and each of his teeth weighed five ounces. Near Palermo, in the valley of Mazara, in Sicily, a ſkeleton of a giant 30 feet long was found, in the year 1548; and another of 33 feet high, in 1550; and many curious perſons have preſerved ſeveral of theſe gigantic bones.

"The Athenians found near their city two famous ſkeletons, one of 34 and the other of 36 feet high.

"At Totu, in Bohemia, in 758, was found a ſkeleton, the head of which could ſcarce be encompaſſed by the arms of two men together, and whoſe legs, which they ſtill keep in the caſtle of that city, were 26 feet long. The ſkull of the giant found in Macedonia, September 1691, held 210 pounds of corn.

"The celebrated Sir Hans Sloane, who treated this matter very learnedly, does not doubt theſe facts; but thinks the bones were thoſe of elephants, whales, or other enormous animals.

"Elephants bones may be ſhown for thoſe of giants; but they can never impoſe on connoiſſeurs. Whales, which, by their immenſe bulk, are more proper to be ſubſtituted for the largeſt giants, have neither arms nor legs; and the head of that animal hath not the leaſt reſemblance to that of a man. If it be true, therefore, that a great number of the gigantic bones which we have mentioned have been ſeen by anatomiſts, and by them have been reputed real human bones, the exiſtence of giants is proved."

With regard to the credibility of all or any of theſe accounts, it is difficult to determine any thing. If, in any caſtle of Bohemia, the bones of a man's leg 26 feet in length are preſerved, we have indeed a deciſive proof of the exiſtence of a giant, in compariſon of whom moſt others would be but pigmies. Nor indeed could theſe bones be ſuppoſed to belong to an elephant: for an elephant itſelf would be but a dwarf in compariſon of ſuch an enormous monſter. But if theſe bones were really kept in any part of Bohemia, it ſeems ſtrange that they have not been frequently viſited, and particular deſcriptions of them given by the learned who have travelled into that country. It is certain, however, that there have been nations of men conſiderably exceeding the common ſtature. Thus, all the Roman hiſtorians inform us, that the Gauls and Germans exceeded the Italians in ſize; and it appears that the Italians in thoſe days were of much the ſame ſtature with the people of the preſent age. Among theſe northern nations, it is alſo probable, that there would be as great differences in ſtature as there are among the preſent race of men. If that can be allowed, we may eaſily believe that ſome of the barbarians might be called *giants*, without any great impropriety. Of this ſuperiority of ſize, indeed, the hiſtorian Florus gives a notable inſtance in Teutobochus, above mentioned, king of the Teutones: who being defeated and taken priſoner by Marius, was carried in triumph before him at Rome, when his head reached above the trophies that were carried in the ſame proceſſion.

But whether theſe accounts are credited or not, we are very certain, that the ſtature of the human body is by no means abſolutely fixed. We ourſelves are a kind of giants in compariſon of the Laplanders; nor are theſe the moſt diminutive people to be found upon the earth. The Abbé la Chappe, in his journey into Siberia in order to obſerve the laſt tranſit of Venus, paſſed through a village inhabited by people called

Wotiacks, neither men nor women of whom were above four feet high. The accounts of the Patagonians alſo, which cannot be entirely diſcredited, render it very probable, that ſomewhere in South America there is a race of people very conſiderably exceeding the common ſize of mankind, and conſequently that we cannot altogether diſcredit the relations of giants handed down to us by ancient authors; though what degree of credit we ought to give them, is not eaſy to be determined. See PATAGONIA.

Rebel GIANTS, in ancient mythology, were the ſons of Cœlus and Terra. According to Heſiod, they ſprang from the blood of the wound which Cœlus received from his ſon Saturn, and Hyginus calls them ſons of Tartarus and Terra. They are repreſented as men of uncommon ſtature, with ſtrength proportioned to their gigantic ſize. Some of them, as Cottus, Briareus, and Gyges, had each 50 heads and 100 arms, and ſerpents inſtead of legs. They were of a terrible aſpect, their hair hung looſe about their ſhoulders, and their beard was ſuffered to grow unmoleſted. Pallene and its neighbourhood was the place of their reſidence. The defeat of the Titans, to whom they were nearly related, incenſed them againſt Jupiter, and they all conſpired to dethrone him. Accordingly they reared Mount Oſſa upon Pelion, and Olympus upon Oſſa; and from thence attacked the gods with huge rocks, ſome of which fell into the ſea and became iſlands, and others fell on the earth and formed mountains. Jupiter ſummoned a council of the gods; when being informed that it was neceſſary to obtain the aſſiſtance of ſome mortal, he by the advice of Pallas called up his ſon Hercules; and with the aid of this hero he exterminated the giants Enceladus, Polybotes, Alcyon, Porphyrion, the two ſons of Alœus, Ephialtes, Othus, Eurytus, Clytius, Tithyus, Pallas, Hippolitus, Agrius, Thoon, and Typhon; the laſt of whom it was more difficult to vanquiſh than all the others. Jupiter having thus gained a complete victory, caſt the rebels down to Tartarus, where they were to receive the full puniſhment of their enormous crimes: according to the accounts of ſome of the poets, he buried them alive under Mount Ætna and different iſlands.

GIANTS *Cauſeway*, a vaſt collection of baſaltic pillars in the county of Antrim, on the north coaſt of Ireland. See BASALTES.

The principal or grand cauſeway conſiſts of a moſt regular arrangement of many hundred thouſands of columns of a black kind of rock, very hard: almoſt all of them are of a pentagonal figure, but ſo cloſely and compactly ſituated on their ſides, though perfectly diſtinct from top to bottom, that ſcarce any thing can be introduced between them. The columns are of an unequal height and breadth; ſome of the higheſt, viſible above the ſurface of the ſtrand, and at the foot of the impending angular precipice, may be about 20 feet; they do not exceed this height, at leaſt none of the principal arrangement. How deep they are fixed in the ſtrand, was never yet diſcovered. This grand arrangement extends nearly 200 yards, viſible at low water; how far beyond is uncertain: from its declining appearance, however, at low water, it is probable it does not extend under water to a diſtance any thing equal to what is ſeen above. The breadth of the principal cauſeway, which runs out in one continued range of columns, is, in general, from 20 to 30 feet; at one place or two it may be nearly 40 for a few yards. In this account are excluded the broken and ſcattered pieces of the ſame kind of conſtruction, that are detached from the ſides of the grand cauſeway, as they do not appear to have ever been contiguous to the principal arrangement, though they have frequently been taken into the width: which has been the cauſe of ſuch wild and diſſimilar repreſentations of this cauſeway, which different accounts have exhibited. The higheſt part of this cauſeway is the narroweſt, at the very foot of the impending cliff from whence the whole projects, where, for four or five yards, it is not above ten or fifteen feet wide. The columns of this narrow part incline from a perpendicular a little to the weſtward, and form a ſlope on their tops, by the very unequal height of the columns on the two ſides, by which an aſcent is made at the foot of the cliff, from the head of one column to the next above, *gradatim*, to the top of the great cauſeway, which, at the diſtance of half a dozen yards from the cliff, obtains a perpendicular poſition, and lowering in its general height, widens to about 20 or between 20 and 30 feet, and for 100 yards nearly is always above water. The tops of the columns for this length being nearly of an equal height, they form a grand and ſingular parade, that may be eaſily walked on, rather inclining to the water's edge. But from high water mark, as it is perpetually waſhed by the beating ſurges on every return of the tide, the platform lowers conſiderably, and becomes more and more uneven, ſo as not to be walked on but with the greateſt care. At the diſtance of 150 yards from the cliff, it turns a little to the eaſt for 20 or 30 yards, and then ſinks into the ſea. The figure of theſe columns is almoſt unexceptionably pentagonal, or compoſed of five ſides; there are but very few of any other figure introduced: ſome few there are of three, four, and ſix ſides, but the generality of them are five-ſided, and the ſpectator muſt look very nicely to find any of a different conſtruction: yet what is very extraordinary, and particularly curious, there are not two columns in ten thouſand to be found, that either have their ſides equal among themſelves, or whoſe figures are alike. Nor is the compoſition of theſe columns or pillars leſs deſerving the attention of the curious ſpectator. They are not of one ſolid ſtone in an upright poſition; but compoſed of ſeveral ſhort lengths, curiouſly joined, not with flat ſurfaces, but articulated into each other like ball and ſocket, or like the joints in the vertebræ of ſome of the larger kind of fiſh, the one end at the joint having a cavity, into which the convex end of the oppoſite is exactly fitted. This is not viſible, but by disjoining the two ſtones. The depth of the concavity or convexity is generally about three or four inches. And what is ſtill farther remarkable of the joint, the convexity, and the correſpondent concavity, is not conformed to the external angular figure of the column, but exactly round, and as large as the ſize or diameter of the column will admit; and conſequently as the angles of theſe columns are in general extremely unequal, the circular edges of the joint are ſeldom coincident with more than two or three ſides of the pentagon, and from the edge of the circular part of the joint to the exterior ſides and angles they are quite plain. It is ſtill ftill farther very remarkable, likewife, that the articulations of thofe joints are frequently inverted; in fome the concavity is upwards, in others the reverfe. This occafions that variety and mixture of concavities and convexities on the tops of the columns, which is obfervable throughout the platform of this caufeway, yet without any difcoverable defign or regularity with refpect to the number of either. The length alfo of thefe particular ftones, from joint to joint, is various: in general, they are from 18 to 24 inches long; and, for the moft part, longer toward the bottom of the columns than nearer the top, and the articulation of the joints fomething deeper. The fize or diameter likewife of the columns is as different as their length and figure; in general, they are from 15 to 20 inches in diameter. There are really no traces of uniformity or defign difcovered throughout the whole combination, except in the form of the joint, which is invariably by an articulation of the convex into the concave of the piece next above or below it; nor are there any traces of a finifhing in any part, either in height, length, or breadth, of this curious caufeway. If there is here and there a fmooth top to any of the columns above water, there are others juft by, of equal height, that are more or lefs convex or concave, which fhow them to have been joined to pieces that have been wafhed, or by other means taken off. And undoubtedly thofe parts that are always above water have, from time to time, been made as even as might be; and the remaining furfaces of the joints muft naturally have been worn fmoother by the conftant friction of weather and walking, than where the fea, at every tide, is beating upon it and continually removing fome of the upper ftones and expofing frefh joints. And farther, as thefe columns preferve their diameters from top to bottom, in all the exterior ones, which have two or three fides expofed to view, the fame may with reafon be inferred of the interior columns whofe tops only are vifible. Yet what is very extraordinary, and equally curious, in this phenomenon, is, that notwithftanding the univerfal diffimilitude of the columns, both as to their figure and diameter, and though perfectly diftinct from top to bottom, yet is the whole arrangement fo clofely combined at all points, that hardly a knife can be introduced between them either on the fides or angles.

The cliffs at a great diftance from the caufeway, efpecially in the bay to the eaftward, exhibit at many places the fame kind of columns, figured and jointed in all refpects like thofe of the grand caufeway: fome of them are feen near to the top of the cliff, which in general, in thefe bays to the eaft and weft of the caufeway, is near 300 feet in height; others again are feen about midway, and at different elevations from the ftrand. A very confiderable expofure of them is feen in the very bottom of the bay to the eaftward, near a hundred roods from the caufeway, where the earth has evidently fallen away from them upon the ftrand, and exhibits a moft curious arrangement of many of thefe pentagonal columns, in a perpendicular pofition, fupporting, in appearance, a cliff of different ftrata of earth, clay, rock, &c. to the height of 150 feet or more, above. Some of thefe columns are between 30 and 40 feet high, from the top of the floping bank below them; and, being longeft in the middle of the arrangement, fhortening on either hand in view, they have obtained the appellation of *organs*, from a rude likenefs in this particular to the exterior or frontal tubes of that inftrument; and as there are few broken pieces on the ftrand near it, it is probable that the outfide range of columns that now appears is really the original exterior line, to the feaward, of this collection. But how far they extend internally into the bowels of the incumbent cliff, is unknown. The very fubftance, indeed, of that part of the cliff which projects to a point, between the two bays on the eaft and weft of the caufeway, feems compofed of this kind of materials; for befides the many pieces that are feen on the fides of the cliff that circulate to the bottom of the bays, particularly the eaftern fide, there is, at the very point of the cliff, and juft above the narrow and higheft part of the caufeway, a long collection of them feen, whofe heads or tops juft appearing without the floping bank, plainly fhow them to be in an oblique pofition, and about half way between the perpendicular and horizontal. The heads of thefe, likewife, are of mixed furfaces, convex and concave, and the columns evidently appear to have been removed from their original upright, to their prefent inclining or oblique pofition, by the finking or falling of the cliff.

GIBBET, or GIBET, a machine in manner of a gallows, whereon notorious criminals, after execution, are hung in irons or chains, as fpectacles *in terrorem*. See GALLOWS.—The word in French, *gibet*, properly denotes what we call gallows: it is fuppofed to come originally from the Arabic *gibel*, "mount or elevation of ground;" by reafon *gibets* are ufually placed on hills or eminences.

GIBBON, EDWARD, a hiftorian of diftinguifhed eminence, was born at Putney in the year 1737. He was the fon of a gentleman of fortune and family diftinction, who fat as a member in two feparate parliaments. Edward when a boy, was of fuch an extremely delicate conftitution, that his life was frequently defpaired of. When at the fchool of Weftminfter, his progrefs was often retarded by repeated fhocks of bad health. After being for a long time under the management of the beft medical practitioners, his conftitution was radically changed for the better, which induced his father to place him in Magdalen college as a gentleman commoner, that he might be pufhed into manly acquifitions. This was prior to the completing of his fifteenth year. Before this time his reading had been of fuch a nature as to ftore his mind with much valuable hiftorical knowledge, although his grammatical and philofophical knowledge at this time was not fo extenfive as that of fome others at the fame period of life. He fays of himfelf; I arrived at Oxford with a ftock of erudition that might have puzzled a doctor, and a degree of ignorance of which a fchool-boy would have been afhamed. Under fuch circumftances he was but ill prepared to receive the benefits of an univerfity education, and this was no doubt the reafon why he exclaimed fo bitterly againft the public and private inftructions at Oxford.

He was fond of polemical divinity from his infancy, and during his leifure moments he turned his attention, when farther advanced, to the celebrated controverfy between Papifts and Proteftants; and as he had not then acquired talents fufficient to enable him to combat error

error and defend the truth, he fell a victim to the ſophiſtry of the church of Rome. His father, with a view to reclaim him from the love of what he conſidered as the moſt deſtructive of all errors, ſent him to Lauſanne in Switzerland, and put him under the care of Mr Pavilliard, a clergyman of the Calviniſtic perſuaſion. This gentleman called his pupil Edward, "A little thin figure, with a large head, diſputing, and urging with the greateſt ability, all the beſt arguments that had ever been uſed in favour of Popery." The maſterly exertions of Mr Pavilliard, who had to deal with a young man of ſolid reaſon and matured reflection, accompliſhed the recantation of Mr Gibbon, and he received the ſacrament in the Proteſtant church on the 25th of December 1754. At Lauſanne, too, he made great progreſs in many branches of knowledge which he had hitherto neglected, and acquired a regular habit of ſtudy. He became maſter of the French and Latin languages, and was a profound logician. He gave full ſcope to the exerciſe of reading excellent authors, which was his ruling paſſion. He did not appear fond of mathematics, and therefore ſoon relinquiſhed the ſtudy of them. At Lauſanne he fell in love with a young lady, the daughter of a village clergyman, but he was fruſtrated in his hopes, and the lady became afterwards the wife of the celebrated Necker.

On his return home in April 1758, his father received him with every mark of tenderneſs and affection, and his mother-in-law found means to conciliate his good opinion and his confidence. It is a ſingular circumſtance that he ſhould have taken a captain's commiſſion in the army, a profeſſion, one would have imagined, for which he was very ill calculated. Indeed he ſoon evinced the truth of this, for his tent and quarters were frequently encumbered with the odd furniture of Greek and Latin authors. On the event of peace he reſigned his commiſſion, and paid a viſit to Paris in the year 1763, where he reſided a few months, and afterwards went to Lauſanne, where he remained about a year, in order to prepare for a journey into Italy, which he accompliſhed in 1765. He thus ſpeaks on the occaſion of his entering Rome: "After a ſleepleſs night, I trod, with a lofty ſtep, the ruins of the forum; each memorable ſpot, where Romulus ſtood, or Tully ſpoke, or Cæſar fell, was at once preſent to my eye; and ſeveral days of intoxication were loſt or enjoyed before I could deſcend to a cool and minute inveſtigation." On the 15th of October, he informs us, the idea of writing the decline and fall of Rome firſt came into his mind, when the bare-footed friars were ſinging veſpers in the temple of Jupiter.

In the year 1770 Mr Gibbon loſt his father, and ſucceeded to an eſtate which was very much involved; yet he conſidered his circumſtances as very well adapted to the great and extenſive work he had undertaken to accompliſh, which in his own opinion he had probably never finiſhed, if he had been either poorer or richer than he was. He had an extenſive circle of acquaintance in London, but the time neceſſarily devoted to their company, he made up by early riſing and intenſe application. In the year 1774 he was choſen member of parliament for the borough of Liſkeard, by the influence of Lord Elliot, which threatened to give his ſtudies a very ſerious interruption. He ſat eight years in the houſe of commons without having the courage ſo much as once to open his mouth, notwithſtanding he was ſuch an elegant writer. When the firſt volume of his "Decline and Fall of the Roman Empire", made its appearance in 1776, it met with a greater degree of applauſe than he expected; but by no praiſe was he ſo highly gratified as by that which the two great hiſtorians of Scotland, Hume and Robertſon, beſtowed upon him. For his two chapters which relate to the ſpread of chriſtianity he met with many antagoniſts, to whom he made no reply but to a Mr Davis, which was conſidered as a maſterpiece. There can be no doubt that Gibbon was a real enemy to revelation in the diſguiſe of a believer, a conduct not ſo abominable as at firſt ſight may appear, ſo long as penal laws exiſt againſt an open declaration of opinion.

Soon after the publication of the firſt volume of his hiſtory, he paid another viſit to Paris, and did not appear to be in much haſte to complete his extenſive work. In 1781, however, the ſecond and third volumes of his hiſtory were given to the world; and, although in the eſtimation of many competent judges they were inferior to the firſt, they ſtill were allowed to poſſeſs ſufficient merit to ſupport his reputation. Having loſt his ſeat for Liſkeard, the influence of miniſtry brought him in as repreſentative for Lymington, and on the diſſolution of Lord North's miniſtry, he loſt his office as one of the lords of trade, which was a ſerious diminution of his income. He again determined to viſit his favourite Lauſanne, where he completed the remaining volumes of his hiſtory; but when the revolutionary mania began to rage on the continent, he quitted Lauſanne, and ſought for an aſylum in England. He mortally hated innovations of every kind, whether neceſſary or not, as appears from the following exclamation: "I beg leave to ſubſcribe my aſſent to Mr Burke's creed on the revolution of France. I admire his eloquence, I approve his politics, I adore his chivalry, and can almoſt excuſe his reverence for church eſtabliſhments."

During his conſoling viſit to Lord Sheffield, who had met with a trying domeſtic loſs, his attention was called to the rapid progreſs of a diſtemper which had ſubſiſted for about 30 years. A mortification at laſt enſued, which terminated his exiſtence on the 16th of January 1794, in the 67th year of his age. Mr Gibbon gives himſelf a character which is perhaps pretty near the truth. "I am endowed with a cheerful temper, a moderate ſenſibility, and a natural diſpoſition to repoſe rather than to activity: ſome miſchievous appetites and habits have perhaps been corrected by philoſophy or time. The love of ſtudy ſupplies each day, each hour, with a perpetual ſource of independent and rational pleaſure." Mr Gibbon poſſeſſed the manners and ſentiments of a gentleman in an eminent degree; he was eaſy in ſociety, of which he was extremely fond, and beloved by all who had the pleaſure of intimately knowing him.

GIBBOUS, a term in medicine, denoting any protuberance or convexity of the body, as a perſon hunched or hump-backed.

Infants are much more ſubject to gibboſity than adults, and it oftener proceeds from external than internal cauſes. A fall, blow, or the like, frequently thus diſtorts the tender bones of infants. When it proceeds from

from an internal caufe, it is generally from a relaxation of the ligaments that fuftain the fpine, or a caries of its vertebræ; though the fpine may be inflected forward, and the vertebræ thrown out by a too ftrong and repeated action of the abdominal mufcles. This, if not timely redreffed, grows up and fixes as the bones harden, till in adults it is totally irretrievable: but when the diforder is recent, and the perfon young, there are hopes of a cure. The common method is by a machine of pafteboard, wood, or fteel, which is made to prefs principally on the gibbous part; and this by long wearing may fet all right. The furgeons, however, have a different inftrument, which they call a *crofs*, much more efficacious, though not quite fo convenient in the wearing. By the ufe of this, the parts are always prevented from growing any worfe, and are often cured. During the application of thefe affiftances, the parts fhould be at times rubbed with Hungary water, fpirit of lavender, or the like, and defended with a ftrengthening plafter.

Gibbous, in *Aftronomy*, a term ufed in reference to the enlightened parts of the moon, whilft fhe is moving from the firft quarter to the full, and from the full to the laft quarter: for all that time the dark part appears horned or falcated; and the light one hunched out, convex, or gibbous.

GIBEAH, a city in the tribe of Benjamin, lying north of Jerufalem about 20 or 30 furlongs, and built upon a hill, as its name imports.—This city gave birth to Saul, the firft king of Ifrael, for which reafon it is frequently called Gibeah of Saul, or Gibeah the native country of Saul.

GIBELINS, or Gibellins, a famous faction in Italy, oppofite to another called the Guelphs.

Thofe two factions ravaged and laid wafte Italy for a long feries of years; fo that the hiftory of that country, for the fpace of two centuries, is no more than a detail of their mutual violences and flaughters. The Gibelins ftood for the emperor againft the pope: but concerning their origin and the reafon of their names we have but a very obfcure account. According to the generality of authors, they rofe about the year 1240, upon the emperor Frederick II.'s being excommunicated by Pope Gregory IX. Other writers maintain, that the two factions arofe ten years before, though ftill under the fame pope and emperor. But the moft probable opinion is that of Maimbourg, who fays, that the two factions of Guelphs and Gibelins arofe from a quarrel between two ancient and illuftrious houfes on the confines of Germany, that of the Henries of Gibeling, and that of the Guelphs of Adorf.

GIBEON, a city feated on an eminence about 40 furlongs from Jerufalem northward, and not far from the city of Gibeah. See Geba.

This was the capital city of the Gibeonites, who took the advantage of Jofhua's oath, and of that which the elders of Ifrael likewife fwore to them, upon an artificial reprefentation which they made of their belonging to a very remote country, and their defire of making an alliance with the Hebrews. Jofhua (ix. 3. 4, *et feq.*) and the elders inconfiderately entered into a league with thefe people; but foon difcovered their miftake. Upon this, fending for the Gibeonites, they reproached them with their fraud; and without revoking the promife which they had made to them, of giving them their lives, they condemned them to carry wood and water to the tabernacle of the Lord, as flaves and captives taken in war; in which ftate of fervitude they remained till the ruin and entire difperfion of the Jewifh nation.

The Gibeonites were defcended from the Hivites, the old inhabitants of that country; and poffeffed four cities, whereof Gibeon was the capital. The cities were Chephirath, Beeroth, Kirjathjearim, and Gibeon, Jofh. ix. 17. Thefe cities were afterwards given to the tribe of Benjamin, except Kirjathjearim, which fell to the tribe of Judah. The Gibeonites continued ever after fubject to thofe burdens which Jofhua had impofed on them, and were very faithful to the Ifraelites.

GIBLETS, the offals or entrails of a goofe; including the heart and liver, with the feet, gizzard, &c. The word is fuppofed to be formed of *goblets;* from the French *gobeau*, "mouthful."—Giblets make a confiderable article in cookery: they boil giblets, ftew giblets, make ragouts of giblets, giblet pies, &c.

GIBRALTAR, a famous promontory, or rather peninfula, of Spain, lying in N. Lat. 36. 6. W. Long. 5. 17. To the ancients it was known by the name of *Calpe*, and was alfo called one of the *Pillars of Hercules;* by the Arabians it is called *Gebel Tarek*, that is, "the mouth of Tarek," from *Tarek* the name of the Saracen general who conquered Spain in the beginning of the eighth century. The whole is an immenfe rock, rifing perpendicularly about 440 yards, meafuring from north to fouth about two Englifh miles, but not above one in breadth from eaft to weft.—The town lies along the bay on the weft fide of the mountain on a declivity; by which, generally fpeaking, the rains pafs through it, and keep it clean. The old town was confiderably larger than the new, which at prefent confifts of between 400 and 500 houfes. Many of the ftreets are narrow and irregular: the buildings are of different materials; fome of natural ftone out of the quarries, fome of a factitious or artificial ftone, and a few of brick. The people are fupplied with frefh provifions chiefly from the coaft of Barbary, with fruit, roots, and vegetables of all forts from thence, or from their own gardens. Befides what is properly called the town, there are feveral fpacious and commodious public edifices erected; fuch as barracks for the foldiers, with apartments for their officers, magazines of different kinds, ftorehoufes for provifions, &c. The inhabitants, exclufive of the Britifh fubjects dependent on the garrifon, or who refide there from other motives, confift of fome Spaniards, a few Portuguefe, a confiderable number of Genoefe, and about as many Jews; making in the whole, according to Dr Campbell, between two and three thoufand, without reckoning the garrifon; though fome make them much fewer. This town may be faid to have two ports; the firft lying to the north, and is proper only for fmall veffels; the other is very commodious for large veffels, and has a fine ftone quay. The bay is very beautiful and capacious, being in breadth about five miles, and in length eight or nine, with feveral fmall rivers running into it. It is very advantageous to the place. There is no ground to be found in the middle of it at 100 fathoms depth, fo that a fquadron may lie there in great fafety; the breezes from it are very refrefhing; and it contributes likewife likewise to the subsistence of the inhabitants, by supplying them with plenty of fish.

The strait of Gibraltar, through which the ocean passes into the Mediterranean, thereby dividing Europe from Africa, runs from west to east about 13 leagues. In this strait there are three remarkable promontories or capes on the Spanish side, and as many opposite to them on the Barbary side. The first of these, on the side of Spain, is Cape Trafalgar, opposite to which is Cape Spartel; and in the neighbourhood of this stood the fortress of Tangier, once in the possession of the British. The next on the Spanish side is Tariffa; and over against it lies Malabata, near the town of Alcassar, where the straits are about five leagues broad. Lastly, Gibraltar facing the mountain of Abyla, near the fortress and town of Ceuta, which make the eastern entry of the straits.

1
Fortress first erected by the Saracens.

This important fortress seems to have been first particularly noticed as a place of consequence in the year 712. At that time the general of the caliph Al Walid landed with an army of 12,000 men on the isthmus between Mount Calpe and the continent; and that he might secure an intercourse with Africa, ordered a castle to be built on the face of that hill. Part of the building still remains; and, from an inscription discovered above the principal gate, appears to have been finished in 725. It continued in the possession of the Saracens till the beginning of the 14th century, when it

2
Various revolutions.

was recovered by Ferdinand king of Castile. In 1333, however, it was obliged to surrender to the son of the emperor of Fez, who came to the assistance of the Moorish king of Granada. An attempt was made upon it in 1349 by Alonso king of Castile; but when the fortress had been reduced to the last extremity, a pestilential fever broke out in the Spanish camp, which carried off the king himself, with great part of his army; after which the enterprise was abandoned.

The fortress continued in the possession of the Saracen descendants of the prince of Fez until the year 1410, when it was taken possession of by Joseph III. king of Granada. A design of attacking it was formed by Henry de Gusman in 1435; but the enterprise having miscarried through his imprudence, he was defeated and slain. However, it was at length taken after a gallant defence by his son John de Gusman in 1462; since which time it has remained in the hands of the Christians. In 1540, it was surprised and pillaged by Piali Hamet, one of Barbarossa's corsairs; but the pirates having fallen in with some Sicilian galleys, were by them defeated, and all either killed or taken.

3
Its fortifications improved and strengthened.

In the reign of Charles V. the fortifications of Gibraltar were modernized, and such additions made as to render them almost impregnable. It was taken by the English, however, in the reign of Queen Anne, and since that time has remained in their possession; and probably will always do so, unless ceded by treaty, as it appears altogether impossible to reduce it by any force of artillery, let it be ever so great. In the year

4
Taken by Sir George Rooke in 1704.

1704, in consequence of the resolution adopted by the court of Britain to assist the archduke Charles in his pretensions to the Spanish crown, Sir George Rooke was sent with a powerful fleet into the Mediterranean. His orders being limited, nothing of consequence was done for some time, until at last an attempt on Gibraltar was resolved upon; not so much on account of the importance of the conquest, as to prevent any reflections against the admiral for inactivity. On the 21st of July that year, 1800 troops were landed upon the isthmus, under the command of the prince of Hesse Darmstadt; and on the refusal of the governor to surrender, preparations were made for attacking the place. Early in the morning of the 23d, a cannonade was begun from the fleet, and kept up so briskly, that in five or six hours the Spaniards were driven from many of their guns, especially at the new mole head. The admiral perceiving, that, by gaining this part of the fortification, the reduction of the rest would be facilitated, ordered out some armed boats to take possession of it. On their approach the Spaniards sprung a mine, which demolished part of the works, killed two lieutenants and 40 private soldiers, wounding about 60 more. Notwithstanding this disaster, the assailants kept possession of the work, and took a small bastion, now the eight-gun battery, half way between the mole and the town. On this the governor thought proper to capitulate, and the prince of Hesse took possession of the gates on the 24th. The garrison, consisting at most of 150 men, marched out with the honours of war; and the Spaniards who chose to remain were allowed the same privileges they had enjoyed under the reign of Charles II. The works were found very strong, and the place well provided with ammunition and military stores.

This conquest was atchieved with the loss of about 60 killed and 216 wounded on the part of the English. The prince of Hesse remained governor; and 18 men of war were left at Lisbon under the command of Sir John Leake, to succour the garrison if there should be occasion. The loss of such an important fortress, however, having alarmed both the courts of Madrid and Paris, orders were sent to the Marquis de Villadarias, a Spanish grandee, to lay siege to it, in which he was to be assisted by a naval force from Toulon. The prince immediately applied to Sir John Leake for assistance; but before the latter had time to comply with his request, a French fleet arrived, and debarked six battalions to the assistance of the Spaniards; after which they proceeded to the westward, leaving only six frigates in the bay. The trenches were opened on the 11th of October, about which time Sir John arrived with 20 sail of English and Dutch ships; but hearing that the French were about to attack him with a superior force, he judged it proper to return and refit. Having very prudently left orders at Lisbon to make preparations for this purpose in his absence, he was enabled to accomplish the work with such expedition, that on the 29th of the same month, he returned, and surprised in the bay three frigates, a fire ship, two English prizes, a tartan, and a store ship. After this exploit he landed some reinforcements, supplied the garrison with six months provision and ammunition; at the same time detaching on shore a body of 500 sailors to assist in repairing the breaches which had been made by the enemy's fire.

5
Besieged the same year by the Marquis de Villadarias.

6
The garrison supplied with reinforcements and provisions by Sir John Leake.

Thus the Spaniards were disappointed in their hopes of success from an attack which had been projected that very night, and for which purpose 200 boats had been collected. Still, however, they did not despair; and

Gibraltar.

and supposing that the garrison would be off their guard and secure on account of the vicinity of their fleet, they formed the rash design of attempting to surprise the place, though the British admiral was still before it. In this mad attempt 500 volunteers associated, taking the sacrament never to return unless they accomplished their purpose. They were conducted by a goat-herd to the south side of the rock near the cave guard, at that time called *the pass of locust trees*. This they mounted, and lodged themselves the first night in the cave of St Michael: the next they scaled Charles V.'s Wall; surprised and massacred the guard at Middle hill; where afterwards, by ropes and ladders, several hundreds of the party designed to support them were hauled up: but being discovered, they were attacked by a strong party of grenadiers, and all of them at last either killed or taken. These brave adventurers were to have been supported by a body of French troops, and some feints were proposed to draw off the attention of the garrison; but, through the disagreement of the commanding officers, these proposals were not put in execution, and thus the volunteers were left to their fate.

7 Desperate attempt of some Spanish volunteers.

8 They are all killed or taken.

9 The siege still continued.

Notwithstanding these misfortunes, the Spaniards still continued the siege, and fitted out a strong squadron from Cadiz, with a design to intercept the convoys of provisions which might be sent to the garrison; flattering themselves at the same time, that, on the arrival of their fleet, Sir John would be obliged to retire, and the garrison of consequence to surrender to their united attacks. They continued their fire therefore with additional fury, dismounted many of the cannon, and did essential injury to the works in several different places. The prince of Hesse, however, was by no means deficient in his endeavours to disappoint their expectations. As it was probable that an attempt might be made to storm the curtain, a cuvette was dug in the ditch, which was filled by the tide, and a double row of palisades placed parallel to the works. The chambers of the mine under the glacis were loaded, and all means taken to defeat such an attempt; but on a sudden the Spaniards seemed to have altered their design, and threatened an attack on the lines which the garrison had on the declivity of the hill to flank the glacis, and overlook their advanced works. While affairs remained in this situation, part of the succours they had long expected arrived in the bay, December 7. 1704, and in two days after, the remainder came in with near 2000 men, along with a proportionable quantity of ammunition and provisions. These had sailed from Cape Spartel under convoy of four frigates; but were in imminent danger of falling into the hands of the enemy, whose fleet they mistook for their own; however they escaped by the fortunate circumstance of being becalmed, so that they could not get up to them.

10 The garrison reinforced.

Sir John Leake having thus powerfully reinforced the garrison, thought his presence in the bay no longer necessary, and therefore set sail for Lisbon, where he arrived about the end of the year. In the beginning of January 1705 the Spaniards were reinforced by a considerable body of infantry, and on the 11th of the month made an attack on the extremity of the King's Lines, but were repulsed. The attack was renewed next day with 600 grenadiers, French and Walloons, supported by 1000 Spaniards, under Lieutenant General Fuy. They disposed themselves in such a manner as showed an intention to storm a breach which had been made in the Round Tower at the extremity of the King's Lines, and another in the intrenchment on the hill. The retrenchment which covered the latter breach, with part of the intrenchment joining the precipice of the rock, was defended at night by a captain, three subalterns, and 90 men; but it was customary for the captain to withdraw, with two subalterns and 60 men, at daybreak. The Round Tower was defended by 180 men, commanded by a lieutenant-colonel. The marquis, by deserters from the garrison, had obtained intelligence of the strength of these posts, and planned his attack accordingly. The detachment for the upper breach mounted the rock at midnight, and concealed themselves in the clifts until the captain had withdrawn; after which, advancing to the point of the intrenchment, they threw grenades on the subaltern and his party, so that they were obliged to leave the place. At the same time 300 men stormed the Round Tower, where Lieutenant Colonel Bar made a vigorous defence, though the enemy, having passed the breach above, annoyed them on the flanks with great stones and grenades. Observing, however, the Spaniards marching down to cut off his retreat from the town, he retired; and, by getting over the parapet of the King's Lines, descended into the covered way, where the English guards were posted. Thus the garrison were alarmed; all the regiments were assembled at their proper posts; and Captain Fisher endeavoured to stop the progress of the enemy with 17 men, but they were repulsed, and himself taken prisoner. At last, however, the Tower was retaken by Lieutenant Colonel Moncal at the head of 400 or 500 men, after it had been in the possession of the enemy upwards of an hour.

11 Vigorous attack by the Spaniards.

12 They are repulsed.

The garrison was now farther reinforced by six companies of Dutch troops and 200 English soldiers, together with some provisions and stores. The assailants, however, were still determined to go on. The marquis de Villadarias was superseded by Marischal Tesse, a Frenchman, with whom Admiral Pointis was desired to co-operate in blocking up the place. The marischal therefore joined the army with four fresh battalions, besides eight companies which had been sent before; the ordnance, which had been greatly injured by constant use, was exchanged for others, and the works, as they then stood, put into the best repair. On the part of the English, a reinforcement was ordered under the command of Sir Thomas Dilkes and Sir John Hardy, to join Admiral Leake at Lisbon: which junction being effected, the whole fleet, consisting of 28 English, 4 Dutch, and 8 Portuguese men of war, having on board two battalions of land forces, set sail from Lisbon. Happily for the besieged, however, the incessant rains and storms about this time had retarded the operations of the land forces, and greatly distressed the fleet of the enemy. Eight ships of the latter were forced from their anchors by the strong westerly wind, and obliged to drive aloft. At this critical period Sir John Leake, with the allied fleet, entered the straits. On his approach the few remaining French ships put out to sea; and the British admiral discovering five sail making out of the bay, and a gun fired at them from the garrison,

13 The siege carried on with fresh ardour.

14 The French fleet dispersed by a storm.

Gibraltar. garrison; immediately gave chase. Three French men of war were taken, and the admiral's ship and another driven on shore, where they were burnt. The rest, on hearing the report of the guns, had made the best of their way to Toulon.

15 The siege turned into a blockade, and at last raised.

The garrison was now so well supplied, that Marischal Tesse withdrew his troops from the trenches, and formed a blockade, drawing an intrenchment across the isthmus to prevent the garrison from ravaging the country. The prince of Hesse remained for some time in the place, where he repaired the batteries, and made some additions to the fortifications; after which he joined the archduke Charles at Lisbon. As the latter, however, was resolved to try his fortune with the earl of Peterborough in Valencia and Catalonia, the prince was sent back to Gibraltar to prepare part of the garrison for embarkation, and soon after was followed by the whole fleet. Major General Ramos was now appointed governor of Gibraltar, in which only two new battalions were left, as nothing was to be feared from the enemy. The new governor, however, brought with him 400 men for the greater security of the place; but soon resigned his government to Colonel Roger Elliot, during whose time Gibraltar was made a free port by a special order from the queen.

Colonel Elliot was succeeded by Colonel Congreve before the year 1714, and he by Colonel Cotton a short time after. In 1720 the Spaniards seem to have threatened another attack. Ceuta, a Spanish fortress in Barbary, had been for many years besieged by the Moors; and a powerful armament, commanded by the marquis de Lada, was now assembled in Gibraltar bay, under pretence of relieving the African fortress, but with a secret design of first surprising Gibraltar; for which purpose they had provided scaling ladders, &c. The armament, however, had not been fitted out with such secrecy, but that the British ministry had intelligence of it. On this they sent orders to Colonel Kane, governor of Minorca, to embark with part of his garrison for Gibraltar under convoy of the fleet in the Mediterranean. On his arrival he found the place in a critical situation. The garrison consisted only of three weak battalions under Major Hetherington, besides whom there was only one other field officer, Major Batteroux, in the place, and no more than 14 days provisions remaining. The posture of affairs, however, was altered by the arrival of Colonel Kane with 500 men, with provisions and ammunition; which reinforcement, together with the spirited behaviour of the British commodore, induced the Spanish commander to abandon his design, though he remained of opinion that the fortress might then have been carried by a general assault.

16 A new attack threatened by the Spaniards in 1720.

17 The design given up.

18 Another attempt in 1726.

Notwithstanding this disappointment, the Spaniards continued to keep a watchful eye over Gibraltar; and, in the latter end of the year 1726, assembled an army in the neighbourhood of Algesiras, encamping, on the 20th of January following, on the plain below St Roch, and erecting a battery on the beach to protect their camp. Though Admiral Hopson was then at anchor in the bay of Gibraltar, yet, as he had received no intelligence of the actual commencement of hostilities between Britain and Spain, he was obliged to allow the boats of the latter to pass with provisions, arms, and ammunition, between Algesiras and the camp, at the same time that colonel, afterwards Brigadier Kane, who had been a second time sent from Minorca, lay under similar embarrassments. The operations of the Spaniards, however, seemed so evidently to tend towards an attack, that the governor thought proper to order such of that nation as were in the town to leave it, and to forbid their galleys to anchor under his guns (A). Gibraltar.

The count de las Torres commanded the Spanish forces, amounting to near 20,000 men; and soon after forming his camp, he advanced within reach of the garrison. The brigadier then desired him to keep out of his reach, otherwise he should do his utmost to force him; but to this the Spanish commander replied, that, as the garrison could command no more than they had power to maintain, he should obey his Catholic majesty's orders, and encroach as far as possible. Hostilities, however, were not commenced until the 10th of February 1727, when the Spaniards, having brought materials for batteries to the old windmill on the neutral ground, it was determined in a council of war, that the Spanish general had commenced hostilities by encroaching so far on the liberties of the garrison. Still, however, the governor sent to the count to know the reason of breaking ground before the garrison; but received for answer, that "he was in his master's territories, and was not answerable to any other person for his conduct." On this the governor opened the batteries of the Old Mole and those of Willis upon the Spanish workmen: however, they persisted on carrying on their operations, and at night marched a party down to the Devil's Tower, where they immediately broke ground, and began a communication with their other works. The governor was now informed by some deserters, that the enemy were forming a mine in a cave under Willis's Battery, with a design to blow it up: but the plot being thus happily discovered, a party was immediately stationed to cut off the communication. On the 22d of February the Spaniards opened on the garrison with 17 pieces of cannon besides mortars; and the day following Brigadier Kane left Gibraltar to send a reinforcement from Minorca. On the 3d of March the enemy opened a new battery of 22 guns, on the Old Mole, and on the 8th another of 15 guns, bearing also upon the same mole, the guns of which had annoyed the western flank of their approaches.

All this time the garrison had kept up a constant and well directed fire from the batteries which bore upon the works of the enemy; but the ordnance in general being old, were frequently bursting; by which they suffered more than from the fire of the besiegers. The

(A) At this time the fortifications of Gibraltar were considerably different from what they had been in 1705. Several works were erected on the heights above the lines called *Willis's Batteries*; the Prince's Lines were extended to the extremity of the rock, and an inundation was formed out of the morass in front of the grand battery.

Gibraltar.

The latter were also greatly distressed by the fleet under Admiral Hopson and Sir Charles Wager, who, since the beginning of the siege, had intercepted their homebound ships, and at the same time greatly benefited the garrison by bringing the prizes into the bay. Finding the Spaniards, however, obstinately bent on their enterprise, they formed a design, on the 2d of April, to bombard Algesiras, from whence the besiegers were supplied with various articles of ammunition; but the fleet happening to be becalmed, the design was afterwards unaccountably abandoned; and on the arrival of a reinforcement from Minorca, they sailed to the westward, leaving the garrison to defend themselves the best way they could.

The enemy continued to augment their batteries, and erect new ones, until they amounted at last to 60 cannon besides mortars; and, on the 3d of May, the governor received intelligence that a general assault was intended; to repel which he took every proper precaution. The enemy, however, still added to their approaches, and considerable reinforcements were received by both parties. Hostilities, however, ceased on the 12th, when news arrived that the preliminaries of a general peace were signed; from which time to the year 1779, no farther attempts were made on Gibraltar.

19 Cessation of hostilities.

20 Great loss of the Spaniards in their attempts.

In the course of these two sieges the loss of the Spaniards was very considerable; that of 1705 costing them not less than 10,000 men, including those who died of sickness; and in that of 1727 their loss was computed at near 3000, besides casualties, which could not be ascertained. That of the garrison amounted in 1705 to 400; and in 1727 to 300; a very small number, considering that during the siege 70 cannon and 30 mortars burst on the batteries.

21 Gibraltar blocked up in 1779.

The hostile manifesto presented by the Spanish ambassador to the court of London at the commencement of the late war, was soon followed by an interruption of communication betwixt Spain and the fortress of Gibraltar. No direct intention of attacking or distressing it, however, was manifested till the 16th of July, when the port was completely blocked up by a squadron of two 74 gun ships, several frigates, galleys, &c. Ten days after they began to form a camp on the plain below St Roch, three miles from the fortress. The garrison at this time consisted of 5382 men, including officers, with a company of engineers and artificers; but the greatest expectations were formed from the abilities and valour of General Elliot the governor. As soon as the breaking off the communication with Spain indicated approaching hostilities, the governor took every precaution that could be suggested by military wisdom; but though informed of the rupture betwixt the two courts having actually taken place, and though he beheld the hostile operations of the enemy, no means were used to interrupt them till the 12th of September, when the batteries of Green's Lodge, Willis, and Queen Charlotte, were opened for a few hours, with a view to disturb the workmen.

22 Hostilities commenced by the garrison.

From this time to the beginning of the year 1780 the enemy continued the blockade both by sea and land, but without doing any damage to the works or garrison, and it was not until the 12th of January that a single person was wounded. This happened to be a woman, who, passing near one of the houses, was slightly hurt by a shot from the enemy. In the mean time, however, the usual supplies of provisions being cut off, the garrison began to feel all the horrors of famine.

23 A woman first wounded in the fortress.

24 Excessive dearness of provisions.

All the necessaries of life were very scarce, and to be procured only at exorbitant prices. Veal, mutton, and beef, sold from half a crown to four shillings per pound; fresh pork from two to three shillings; salted beef and pork fifteenpence; fowls eighteen shillings per couple; ducks a guinea; fire wood, five shillings per hundred weight; a pint of milk and water fifteenpence; a small cabbage cost five shillings, and a small bunch of outer leaves fivepence; Irish butter half a crown per pound; candles as much; and eggs sixpence each. As the rock, however, is almost surrounded by the sea, it was natural to suppose, that in such a scarcity of other provisions great benefit would have been derived from the ocean; but the fishermen, being all foreigners, and under no regulation, took advantage of the present scarcity of provisions in the garrison to exact a most exorbitant price for the fish they supplied.

25 The Spanish fleet defeated and their admiral taken by Rodney.

Had matters remained long in this state, it is plain that the fortress, however strong, must have fallen into the hands of the enemy. They were, however, effectually relieved in consequence of the victory gained by Admiral Rodney over the Spanish fleet commanded by Don Juan de Langara. The former had been furnished with a strong squadron, in order to relieve this important fortress; with which having set sail, he in a few days fell in with a Spanish fleet of 16 transports bound from Bilboa to Cadiz, and laden with provisions and naval stores, convoyed by a man of war of 64 guns, four frigates, and two armed vessels. Of these only a single transport escaped, the rest being all captured on the 8th of January 1780; and the loss of them, at the same time that it promised to be very serviceable to the garrison, was equally detrimental to the enemy, who were now in great want both of provisions and materials for their shipping.

This advantage was soon after followed by a much greater. On the 16th of the same month a Spanish squadron of 11 sail of the line was discovered off Cape St Vincent; and the British admiral having taken the proper methods to come up with them as quickly as possible, an engagement took place about four in the afternoon. At this time the headmost ships of the British line closed in with the nearest of the enemy, and in half an hour one of the Spaniards, mounting 70 guns, and having on board 600 men, blew up, and all on board perished. In two hours more another Spanish ship of the line was taken; notwithstanding which the fight continued with great vigour till two in the morning, when the headmost ship of the enemy struck to the Sandwich; after which the firing ceased. The weather throughout the night was so tempestuous that it was with the utmost difficulty the British could take possession of those ships which surrendered. These were six in number, but two of them drove ashore and were lost, only four being brought safe into Gibraltar. These were the admiral's ship of 80 guns and 700 men, with three others of 70 guns and 600 men. The engagement, however, happened so near the shore, and the British were so eager in securing the lee gage to prevent the enemy's escape, that Admiral Rodney's ship, together with some of the largest in the fleet, were in great danger of running on the shoals of St Lucar; nor

nor could they be got into deep water again without much labour and the exertion of great naval ſkill. It was the opinion of all who were preſent in the action, that had this engagement happened in the day time, or had the weather been leſs boiſterous, not one of the Spaniſh ſhips could have eſcaped; and even as it was, thoſe which got off were ſo eſſentially damaged as to be unfit for ſervice.

26 The garriſon relieved and reinforced.

The news of this important victory arrived at Gibraltar on the evening of the day after it was fought; and in two days more the garriſon was completely relieved by the arrival of the fleet and convoy, at the ſame time that they were farther reinforced by a regiment of Highlanders, conſiſting of 1051 men, officers included. An opportunity was alſo taken of ſending away with the fleet all the invalids and women in the garriſon; with whom they ſet ſail on the 10th of February, leaving in the bay only the Edgar and Panther ſhips of the line, with two frigates.

On the departure of the Britiſh fleet the blockade was immediately reſumed; and notwithſtanding the ample ſupplies lately received, the garriſon ſoon began again to experience the inconveniency of wanting freſh proviſions. It had hitherto received theſe in abundance from the coaſt of Barbary; but an unaccountable alteration had now taken place, ſo that the friendſhip of the emperor of Morocco was transferred from Great Britain to Spain in a manner totally unprecedented. His partiality towards the latter was the more ſurpriſing, as Britain had given no provocation, and the enmity between Spain and Morocco ſeemed to be in a manner conſtitutional, and founded upon ſuch

27 The garriſon again reduced to ſtraits.

cauſes as could never ceaſe to operate. Thus, however, the garriſon became daily more and more diſtreſſed, from being obliged to make conſtant uſe of their ſalt proviſions, and even this with the ſtricteſt economy. The induſtry and reſolution of the Britiſh ſeamen and officers, indeed, ſometimes overcame all obſtacles, ſo that they found means to procure the neceſſary refreſhments; though in ſo doing they were certainly expoſed to the utmoſt danger from the enemy. At the ſame time the defence of the garriſon was ſo vigorous, that while it continued to be ſupplied even in this ſcanty manner, the Spaniards began to loſe all hope of reducing it; for which reaſon they formed a project of burning all the Britiſh ſhipping in the bay.

28 Unſucceſsful attempts to burn the Britiſh ſhipping.

The night appointed for putting this ſcheme in execution was the 6th of June 1780, when 10 fire-ſhips, favoured by an uncommon darkneſs, ſtood over from the Spaniſh to the Britiſh ſide of the bay. Their deſign was to ſet fire to the ſtorehouſes neareſt to the water ſide, as well as to the ſhipping there; but having been too precipitate in firing their ſhips, and being received alſo by a very heavy cannonade, the attempt was fruſtrated. On this occaſion the ſkill and intrepidity of the Britiſh ſeamen were eminently diſplayed. Having manned their boats, they grappled the fire ſhips already in flames; and, notwithſtanding their dreadful appearance and the danger of their exploding, towed them clear of the veſſels under the walls, and extinguiſhed them.

The failure of this project was a grievous diſappointment to Don Barcelo the Spaniſh admiral, who lay ready with his ſquadron to intercept the Britiſh veſſels that might attempt to eſcape; at the ſame time that the batteries on their lines were in readineſs to bombard the town, if the fire-ſhips had ſucceeded in cauſing any conflagration on ſhore. The failure of the preſent attempt, however, was ſoon followed by other

29 Spaniſh works deſtroyed.

diſaſters. As ſoon as they had, with great labour, puſhed forward their new works, and conſtructed new batteries, they were certainly deſtroyed by the beſieged; and their mortification on theſe occaſions was the greater, as it was uſual for the governor to allow them to complete their works before he commenced his deſtructive operations. Thus the labour of many days was often loſt in a few hours, and afterwards was to be reſumed with as little proſpect of ſucceſs as before.

30 The garriſon annoyed by the Spaniſh gun boats.

The garriſon was now conſiderably annoyed by the Spaniſh gun boats, to which indeed the ſhipping were equally expoſed with themſelves. Theſe were veſſels from 30 to 40 tons burden, conſtructed ſo that they lay low in the water, which rendered them difficult to be aimed at. They had 15 oars on a ſide, carried 40 or 50 men, with a 26 pounder on the prow; and, from the facility of managing them, two were deemed, in calm weather to be a match for a frigate of moderate ſize. All their efforts, however, could ſtill do no more than to reduce the garriſon to great ſtraits for want of proviſions; and to this dreadful inconvenience the Britiſh ſubmitted with the greateſt cheerfulneſs. From the time of Admiral Rodney's departure in the month of February 1780 to the month of October, almoſt the only proviſions in the garriſon were ſuch as tended to produce the ſcurvy; which accordingly raged in ſuch a manner, as to threaten the moſt fatal conſequences.

31 The ſcurvy rages in the garriſon.

An antidote, however, was happily procured by the capture of a Daniſh dogger from Malaga laden with lemons and oranges, which the governor immediately purchaſed for the uſe of the garriſon and diſtributed among them. "At this time (ſays Captain Drinkwater) the ſcurvy had made dreadful ravages in our hoſpitals, and more were daily confined: many however, unwilling to yield to its firſt attacks, perſevered in their duty to the more advanced ſtages. It was therefore not uncommon, at this period, to ſee men, who, ſome months before, were hale, and capable of enduring any fatigue, ſupporting themſelves to their poſts upon crutches, and even with that aſſiſtance ſcarcely able to move along. The moſt fatal conſequences in ſhort were to be apprehended to the garriſon from this terrible diſorder, when this Dane was happily directed to our relief."

32 Cairncroſs's account of it.

According to Mr Cairncroſs, an eminent ſurgeon, who was preſent during this ſiege, "the ſcurvy which now raged in Gibraltar, differed in no reſpect from that diſeaſe uſually contracted by ſailors in long ſea voyages; and of which the immediate cauſe ſeemed to be the ſubſiſting for a length of time upon ſalted proviſions only, without a ſufficient quantity of vegetables or other aceſcent foods. The circumſtances related in the voyage of that celebrated circumnavigator Lord Anſon of conſolidated fractures diſuniting, and the calloſity of the bone being perfectly diſſolved, occurred frequently in our hoſpitals, and old ſores and wounds opened anew from the nature of the diſorder. Various antiſcorbutics were uſed without ſucceſs, ſuch as acid of vitriol, ſour crout, extract of malt, eſſence of ſpruce, &c.; but the only ſpecifics were freſh lemons and oranges given liberally; or, when they could not be

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be procured, the preſerved juice in ſuch quantities, from one to four ounces per day, as the patient could bear. Whilſt the lemons were ſound, from one to three were adminiſtered each day as circumſtances directed. The juice given to thoſe in the moſt malignant ſtate was ſometimes diluted with ſugar, wine, or ſpirits; but the convaleſcents took it without dilution. Women and children were equally affected; nor were the officers exempted from this dreadful diſorder. It became almoſt general at the commencement of the winter ſeaſon, owing to the cold and moiſture, and in the beginning of ſpring when vegetables were ſcarce.

33 Method of preſerving lemon juice.

The juice was preſerved by adding to 60 gallons of expreſſed liquor about five or ten gallons of brandy, which kept it in ſo wholeſome a ſtate, that ſeveral caſks were opened in good condition at the cloſe of the ſiege. The old juice, however, was not ſo ſpeedily efficacious as the fruit, though by perſevering longer in its uſe it ſeldom failed.

34 The garriſon diſtreſſed for want of proviſions.

Till this month the allowance of ſalt proviſions had continued undiminiſhed; but now it was judged neceſſary to reduce the allowance of bread and meat, and to make ſome other regulations in order to enforce the ſtricteſt economy with regard to food. Every thing of this kind that could be practiſed, however, ſeemed inſufficient to preſerve the garriſon from abſolute want. In the beginning of the year 1781 proviſions became exceedingly ſcarce, by reaſon of the almoſt total expenditure of what was contained in the public ſtores, and the vigilance of the enemy's cruiſers. About the middle of February the town bakers left off work for want of flour; and many of the poorer ſort wanted bread. The price of freſh proviſions again roſe to a moſt enormous height. Small pigs ſold at two guineas; turkeys at three; geeſe at 30 ſhillings; fowls and ducks at 10 ſhillings; damaged biſcuit a ſhilling the pound; peaſe 18d; and all other neceſſaries in proportion; at the ſame time the ſcarcity of fuel was ſuch, that it was ſometimes ſcarcely procurable in quantity ſufficient to dreſs the victuals.

35 The garriſon entirely deprived of the uſe of the neutral ground.

The garriſon had hitherto derived aſſiſtance occaſionally from the gardens on the neutral ground, though vaſt quantities of vegetables had been removed thence by the enemy. Towards the end of the month of October 1780, however, the Spaniards determined to expel the Britiſh from the gardens entirely: and this they accompliſhed in ſpite of all that could be done to prevent them. From this time the reſources with regard to vegetables depended entirely upon the attention paid to cultivation; which, happily for the garriſon, was attended with ſuch ſucceſs, eſpecially during the winter months, that the produce came at laſt to be nearly equal to the demand.

36 Supplied by the Britiſh fleet.

At laſt, on the 12th of April 1781, ſupplies were brought by the Britiſh fleet under Admirals Darby, Digby, and Roſs, though they could not be got in without great difficulty. The gun boats already mentioned were now much increaſed in number and ſtrength of conſtruction; infeſting the bay in ſuch a manner as greatly to interrupt the debarkation of the ſtores. As no veſſels of the ſame kind had been prepared to oppoſe them, they could ſcarce be prevented from effecting their purpoſe of burning the ſtore ſhips. With this view they had approached them every morning in hazy weather to the number of between 20 and 30, ſeveral of them carrying mortar-pieces; and as they uſed both ſails and oars, they eluded all purſuit, by withdrawing on the riſe of any breeze. To keep off theſe troubleſome gueſts, ſeveral ſtout frigates were obliged to ſtation themſelves along the bay for the protection of the ſhipping; but even this did not prevent them from continuing their moleſtation; and notwithſtanding the vigilance and activity of the Britiſh ſailors, it was ſeldom that they could come near enough to do them any damage. In ſpite of all their endeavours, however, the garriſon was effectually relieved: an exploit which ſo exceedingly irritated the court of Spain, that they determined to exert the utmoſt force of the kingdom rather than fail in the execution of their favourite project.

37 The Spaniards reſolve to exert themſelves to the utmoſt.

The works before the town were therefore carried on with more vigour than ever, and the moſt tremendous preparations made to cauſe the obſtinate garriſon feel the reſentment of an exaſperated enemy. Their batteries were now mounted with guns of the heavieſt metal, and with mortar pieces of the largeſt ſize; the number of the former augmented to near 200, and of the latter to upwards of 80. For three weeks this prodigious artillery continued to pour forth an almoſt inceſſant ſhower of ſhot and ſhells, inſomuch that, in the time juſt mentioned, they had conſumed 100,000lb. of gunpowder, and thrown into the town four or five thouſand ſhot or ſhells every 24 hours.

38 The town entirely deſtroyed.

By ſuch an immenſe bombardment the town was almoſt totally laid in ruins. The inhabitants, computed at more than 3000 in number, experienced every difficulty that could ariſe from the deſtruction of their habitations: ſeveral of them were killed, and all forced to leave the town, and take ſhelter under tents with what accommodation could be provided for them in ſuch ſcenes of horror and confuſion. Numbers took the opportunity of retiring with the fleet; while many that remained were now reduced from a ſtate of opulence to the greateſt diſtreſs. The conduct of Governor Elliot was very humane and compaſſionate to ſuch as were inclined to depart; allowing them a free paſſage to England, and ſupplying them with proviſions for the voyage.

39 Diſorderly behaviour of the ſoldiers.

During this bombardment, not only the greateſt part of the effects belonging to the inhabitants were deſtroyed, but the fortifications were in many places greatly injured; and the worſt was, that the remainder were deſtroyed by the ſoldiers, who had arrived at ſuch a pitch of licentiouſneſs, that they neither regarded nor would obey their officers. They were incited to this deſtructive ſcheme by the avarice of ſome of the inhabitants who had hoarded up and concealed a quantity of neceſſary articles, in order to procure an advanced price. They now, therefore, kept no bounds in diſſipation, waſte, and extravagance; a remarkable inſtance of which is given by Captain Drinkwater, in their roaſting a pig by a fire made of cinnamon. To put a ſtop to theſe atrocious proceedings, rigorous meaſures were of neceſſity adopted; and it was intimated, that any ſoldier convicted of being drunk or aſleep upon his poſt, or found marauding, ſhould be immediately executed. The loſs of human lives during this dreadful bombardment was leſs than could have been expected; but many remarkable circumſtances are taken

notice

notice of by Captain Drinkwater, some of which are related in the note (B.)

By the beginning of June 1781, the enemy had relaxed considerably in their firing, seldom exceeding 600 shot in a day; and continued gradually to diminish this number so remarkably, that towards the end of August they seldom fired in the day, and only discharged six or seven, and sometimes not above three, shot in the night. The batteries at land, however, were succeeded by the gun boats; which renewed their attacks every day, keeping the garrison in continual alarm, and never failing to do more or less execution. To restrain them, therefore, a battery of guns capable of throwing their shot to a great distance was erected as near as possible to the enemy; and as it reached their very camp, it was determined to open it upon them as often as the gun boats made their attacks; which being soon perceived, they thought it prudent to desist in some measure from that mode of hostility.

40 The works of the enemy brought to the utmost perfection.

They continued still, however, to improve their works, and for this purpose employed the best engineers both of France and Spain; so that by the latter part of November 1781, they had brought them to such a state of perfection as filled both kingdoms with the most sanguine expectations of success. Governor Elliot, however, far from being dismayed at these formidable bulwarks, suffered them to proceed without molestation to the end of their scheme, that he might as in a moment destroy the labour of so many months, and thus render the disappointment the greater. In the night of the 27th of November, a chosen party of 2000 men was detached, in order to destroy the enemy's works and batteries; and their success was equal to their most sanguine expectations. They marched out in great order and silence about two o'clock in the morning, under the command of Brigadier General Ross; after which they proceeded with the same circumspection, but with the utmost celerity, to the enemy's works, which they stormed and overthrew with astonishing rapidity. The Spaniards were instantly thrown into confusion, and fled on every side; the guns and mortars on the batteries were all spiked up; and

41 They are entirely destroyed.

(B) Two boys belonging to the artificer company were endowed with such wonderful strength of vision, that they could see the shot of the enemy in the air almost as soon as it came from the mouth of the gun; and were therefore constantly placed upon some part of the works to give notice to the soldiers of the approaching danger. During the time of the hottest fire, however, the men were so habituated to the fall of shells and shot around them, that they contracted an insensibility of danger, and almost required to be cautioned by their officers to avoid the explosion of a shell when lying with the fusee burning at their feet. In consequence of this inattention, they frequently neglected the advice of the boys above mentioned, and their neglect could not but be productive of fatal effects. An instance of this happened on the Princess Amelia's battery, where a shot thus disregarded came through one of the capped embrasures, carried off one of the legs from three soldiers, and wounded a fourth in both. In other cases, in which the persons themselves have observed the shot or shells coming towards them, they have been fascinated by its appearance, and unable to move from the spot, as small birds are said to be by the rattlesnake. "This sudden arrest of the faculties (says our author) was nothing uncommon: several instances occurred to my own observation, where men, totally free, have had their senses so engaged by a shell in its descent, that though sensible of their danger, even so far as to cry for assistance, they have been immoveably fixed to the place. But what is more remarkable, these men have so instantaneously recovered themselves on its fall to the ground, as to remove to a place of safety before the shell burst." In this manner Lieutenant Lowe of the 12th regiment was fascinated by a shot which he saw coming, but had not power to remove from the place before it fell upon him and took off his leg.

Where these shells burst they produced instant and certain destruction, mangling in the most dreadful manner. The following are some instances: A matross had the misfortune of breaking his thigh by some accident; and being a man of great spirit, could scarce bear the confinement necessary for its reunion. In consequence of this he went abroad too soon, and thus unfortunately broke the bone a second time. Being now confined to bed, a shell happened to fall into the room where he was, and, rebounding, lodged itself directly upon him. The convalescents and sick instantly summoned all their strength, and crawled out of the room, while the poor matross lay below the shell, kept down by its weight, and utterly unable to stir. In a few seconds it burst, and took off both his legs, and scorched him in a dreadful manner. He survived the explosion, was sensible to the last moment, and died regretting that he had not been killed on the batteries. The case of a soldier of the 73d regiment shows, that even in the most dangerous cases we should never despair of recovery while life remains. This unfortunate man had been knocked down by the wind of a shell, which, instantly bursting, killed his companion, and mangled himself in a shocking manner. His skull was dreadfully fractured, his left arm broken in two places, one of his legs shattered, the skin and muscles torn off from part of his right hand, the middle finger broken to pieces, and his whole body most severely bruised and marked with gunpowder. He presented so horrid an object to the surgeons, that they had not the least hopes of saving his life, and were at a loss what part to attend to first. He was that evening trepanned; a few days afterwards his leg was amputated, and other wounds and fractures were dressed. Being possessed of a most excellent constitution, nature performed wonders in his favour, and in 11 weeks his cure was completely effected. On the 18th of September a shell from the lines fell into a house where the town major Captain Burke, with Majors Mercier and Vignoles of the 39th regiment were sitting. It took off Major Burke's thigh; afterwards fell through the floor into the cellar: there it burst, and forced the flooring with the unfortunate major up to the ceiling. When assistance came, they found him almost buried in the ruins of the room. He was instantly conveyed to the hospital, where he died soon after the wounded part had been amputated. Majors Mercier and Vignoles and the artillerymen, artificers, and ſailors, exerted themſelves ſo vigorouſly, that in the ſpace of an hour the magazines were blown up, the ſtorehouſes of arms, ammunition, and military implements of every kind, and all the works that had been conſtructed, were ſet on fire, and totally conſumed; the whole damage done on this occaſion being eſtimated at upwards of two millions ſterling.

For ſeveral days after this diſaſter the Spaniards continued inactive, without even making any attempt to extinguiſh their batteries, which ſtill continued in flames; but in the beginning of December, as if ſuddenly arouſed from their reverie, upwards of 1000 men were ſet to work in order to prepare a great number of faſcines, from whence it was concluded that they deſigned to repair their works. In this they proceeded with their uſual perſeverance and diligence; but as the former methods of attack had conſtantly failed, it was evident, that if the place could be reduced at all, it muſt be by ſome means hitherto unattempted; and for the reduction of this ſingle fortreſs, the Spaniſh monarch, after the conqueſt of Minorca, determined to employ the whole ſtrength of his empire.

42 Floating batteries invented by the chevalier D'Arcon.

Among the various projects formed at this time, that of the chevalier D'Arcon, a French engineer of diſtinction, proved the moſt acceptable to the court of Spain; and though the expence attending it was immenſe, this ſeemed in the preſent circumſtances to be but a matter of ſmall conſideration. His plan was to conſtruct ſuch floating batteries as might neither be liable to be ſunk nor ſet on fire. With this view their bottoms were made of the thickeſt timber, and their ſides of wood and cork long ſoaked in water, with a layer of wet ſand betwixt them. Their thickneſs was ſuch, that they were impenetrable to cannon ſhot; and to prevent the effects of red-hot balls, a number of pipes were contrived to carry water through every part of the veſſel, and pumps ſufficient to furniſh a conſtant ſupply for the purpoſe. The people at the batteries were ſheltered from the bombs by a rope netting, made ſloping that they might roll off, and ſpread with wet ſkins to prevent fire. Ten of theſe batteries were conſtructed out of the hulls of large veſſels, ſome of 50 or 60 guns, cut down for that purpoſe, and carrying from 10 to 28 guns each, with about half as many in reſerve in caſe of accidents. Each gun was ſerved by 36 artillery men; and theſe floating batteries were to be ſeconded by 80 large boats carrying guns and mortars of heavy metal; a great number of ſhips of force and frigates, with ſome hundreds of ſmall craft, were to accompany them with troops, for the inſtant execution of what might be judged neceſſary. On this occaſion upwards of 1000 pieces of artillery and 80,000 barrels of gunpowder were provided. A body of 12,000 of the beſt troops of France were now added to the Spaniſh army before the place; the body of engineers was the beſt that both kingdoms could produce; and numbers of volunteers, of the beſt families in both, attended the ſiege. Numbers of military gentlemen alſo came from every part of Europe to be witneſſes of what paſſed at this celebrated ſiege, which was now compared to the moſt famous recorded in hiſtory. The conducting of it was committed to the duke de Crillon, who had diſtinguiſhed himſelf by the conqueſt of Minorca. Two princes of the blood royal of France, the count of Artois brother to the king, and the duke of Bourbon his couſin, came to be witneſſes of this extraordinary enterpriſe. Theſe behaved with the greateſt politeneſs both to the governor and garriſon. The count of Artois tranſmitted a packet of letters for various individuals in the garriſon, which had been intercepted and carried to Madrid, and which he requeſted that he might be the means of conveying to thoſe for whom they were deſigned. Both he and the duke of Bourbon ſignified to General Elliot the high regard they had for his perſon and character; and the duke de Crillon himſelf took this opportunity of expreſſing the ſame ſentiments, and to entreat him to accept of ſome refreſhments. General Elliot returned a polite anſwer, but accepted of the preſent with reluctance, and requeſted him for the future not to confer any favours of that kind upon him.

43 Prodigious armament brought before the fortreſs.

Such a prodigious armament raiſed the confidence of the beſiegers ſo high, that they looked upon the conqueſt

Vignoles had time to eſcape before the ſhell burſt; nevertheleſs they were ſlightly wounded by the ſplinters, as were a ſerjeant and his daughter, who happened to be in the cellar when the ſhell entered.

The following are related as inſtances of very extraordinary eſcapes from the deſtructive power of theſe engines, and which indeed it ſeems difficult to account for.—A corporal had the muzzle of his firelock cloſed, and the barrel twiſted like a French horn, by a ſhell, without any injury to his perſon. A ſhell happened to fall into a tent where two ſoldiers were aſleep, without awakening them by its fall. A ſerjeant in an adjacent tent heard it, and ran near 40 yards to a place of ſafety, when he recollected the ſituation of his comrades. Thinking the ſhell had fallen blind, he returned and awakened them; both immediately roſe, but continued by the place, debating on the narrow eſcape they had had, when the ſhell exploded, and forced them with great violence againſt a garden wall, but, "miraculouſly" did no further miſchief than deſtroying every thing in the tent. On the new year's day of 1772, an officer of artillery obſerved a ſhell falling towards the place where he ſtood, and got behind a traverſe for protection. This he had ſcarcely done, when the ſhell fell into the traverſe, and inſtantly entangled him in the rubbiſh: one of the guard, named *Martin*, obſerving his diſtreſs, generouſly riſked his own life in defence of his officer, and ran to extricate him: but finding his own efforts ineffectual, called for aſſiſtance; when another of the guard joining him, they relieved the officer from his ſituation; and almoſt at the ſame inſtant the ſhell burſt, and levelled the traverſe with the ground. Martin was afterwards promoted, and rewarded by the governor; who at the ſame time told him, that "he ſhould equally have noticed him for attending to his comrade." A ſhell happening to fall into the room where Enſign Mackenzie of the 73d regiment was ſitting, carried away part of his chair, and fell into the room below, where it burſt, lifting him and the chair from the floor without further injury.

conqueſt of the place as an abſolute certainty. They began to be impatient at the delays which aroſe in bringing matters to the utmoſt point of perfection; and the commander in chief was thought by far too modeſt, when he ſaid that the garriſon might hold out for a fortnight. "It appeared (ſays Captain Drinkwater) that they meant, previous to their final efforts, to ſtrike if poſſible a terror through their opponents, by diſplaying an armament more powerful than had probably ever been brought before any fortreſs. Forty-ſeven ſail of the line, including three inferior two-deckers; ten battering ſhips, deemed perfect in deſign, and eſteemed invincible, carrying 212 guns; innumerable frigates, xebeques, bomb ketches, cutters, gun and mortar boats, and ſmaller craft for diſembarking men, were aſſembled in the bay. On the land ſide were moſt ſtupendous and ſtrong batteries and works, mounting 200 pieces of heavy ordnance, and protected by an army of near 40,000 men, commanded by a victorious and active general, and animated by the immediate preſence of two princes of the blood royal of France, with other dignified perſonages, and many of their own nobility. In their certainty of ſucceſs, however, the enemy ſeemed entirely to have overlooked the nature of that force which was oppoſed to them; for though the garriſon ſcarcely conſiſted of more than 7000 effective men, including the marine brigade, they forgot that they were now veterans in this ſervice, had long been habituated to the effects of artillery, and were by degrees prepared for the arduous conflict that awaited them. We were at the ſame time commanded by officers of approved courage, prudence, and activity; eminent for all the accompliſhments of their profeſſion, and in whom we had unbounded confidence. Our ſpirits too were not a little elevated by the ſucceſs attending the firing of red-hot ſhot (c), which in this attack we hoped would enable us to bring our labours to a concluſion, and relieve us from the tedious cruelty of a vexatious blockade."

As a prelude to the dreadful ſtorm which was about to be poured forth on this devoted garriſon, the enemy, on the 9th of September 1782, opened a battery of 64 of their largeſt cannon, which was ſhortly accompanied with a terrible fire from other batteries, and a great number of mortars. On this and the following day an attack was made upon the batteries erected on Europa Point (ſo called from being the moſt ſoutherly point of the continent of Europe), which at that time were entirely under the management of Captain Curtis of the Brilliant frigate, who had diſtinguiſhed himſelf during the ſiege, and now commanded a brigade of ſeamen by whom the batteries were ſerved. By theſe the fire of the Spaniards was ſo warmly returned, that they not only could make no impreſſion, but were forced to retire, after having received ſo much damage, that two of their principal ſhips were obliged to withdraw to the bay of Algeſiras oppoſite to Gibraltar, in order to refit. On the 12th the enemy made preparations for the enſuing day, which was allotted for their grand and deciſive attack.

44 Deciſive attack on the 13th of September 1782.

Accordingly, on the morning of the 13th, the ten floating batteries came forward, under the command of Don Buenventura de Moreno, a Spaniſh officer of great gallantry, and who had ſignalized himſelf at the taking of Minorca. Before ten o'clock they had all got into their proper ſtations, anchoring in a line about a thouſand yards diſtant from the ſhore. As ſoon as they were properly arranged, they began a heavy cannonade, and were ſeconded by all the cannon and mortars in the enemy's lines and approaches, at the ſame time that the garriſon opened all its batteries both with hot and cold ſhot from the guns, and ſhells from the howitzers and mortars. This terrible fire continued on both ſides without intermiſſion until noon; when that of the Spaniards began to ſlacken, and the fire of the garriſon to obtain a ſuperiority. About two o'clock the principal battering ſhip commanded by Don Moreno was obſerved to emit ſmoke as if on fire, and ſome men were ſeen buſy upon the roof ſearching from whence it proceeded. The fire from the garriſon was now kept up without the leaſt diſcontinuance or diminution, while that from the floating batteries was perceived ſenſibly to decreaſe; ſo that about ſeven in the evening they fired but few guns, and that only at intervals. At midnight the admiral's ſhip was plainly ſeen to burn, and in an hour after was completely in

45 Terrible deſtruction of the Spaniards.

flames. Eight more of theſe batteries took fire ſucceſſively; and on the ſignals of diſtreſs made by them, the multitude of feluccas, launches, and boats, with which they were ſurrounded, all came to their aſſiſtance, and began to take the men out of the burning veſſels. Captain Curtis, who lay ready with the gunboats to take advantage of any favourable circumſtance, came upon them at two in the morning, and forming a line on the enemy's flank, advanced upon them with ſuch order and expedition as to throw them into immediate confuſion. At this ſudden and unexpected attack they were ſo aſtoniſhed and diſconcerted, that they fled precipitately with all their boats, totally abandoning the floating batteries to be burnt, and all who were in them to periſh in the flames. This would undoubtedly have been their fate, had not Captain Curtis extricated them from the fire at the imminent danger of his own life and that of his men. In this work he was ſo eager, that while his boat was alongſide of one of the largeſt batteries, it blew up, and the fragments of the wreck ſpreading all around to a vaſt diſtance, ſome heavy pieces of timber fell into his boat and pierced through its bottom, killing one man and wounding ſeveral others. He eſcaped with difficulty out of this boat, which was ſunk, as well as another, by the ſame accident. The floating batteries were every one conſumed; and the violence with which they exploded was ſuch that doors and windows at a great diſtance on ſhore were burſt open. About 400 people were ſaved from them; many of whom were picked up floating on rafts and pieces of timber. Indeed the blowing up of the

(c) This was ſuggeſted by Lieutenant Governor Boyd, and had been attended with remarkable ſucceſs, September 8th, when the enemy's advanced works were almoſt deſtroyed by it.

Gibraltar. the batteries as the flames reached their powder rooms, and the discharge of the guns in succession as the metal became heated by the fire, rendered any attempt to save them very dangerous.

46 Inactivity of the combined fleet. This terrible catastrophe took place in sight of the combined fleets of France and Spain. It had been proposed that they should co-operate upon this important occasion, by attacking the garrison at Europa Point, and such places as appeared most exposed to an attempt by sea. This, it was afterwards said, must have occasioned a material diversion of the garrison's force, and, by dividing it, have weakened considerably the vigorous means of defence used in those parts which were actually attacked. The reason assigned for this inactivity was the want of wind.

47 The blockade continued. Though this terrible repulse effectually convinced the Spaniards that Gibraltar could not be taken by force, some hope still remained, that, without any further exertions on their part, the garrison would be obliged to surrender from want of ammunition and provisions. With this view they continued to blockade it closely, and to cut off all communication, flattering themselves that Britain would not be able to collect a naval force sufficient to drive their fleet from the bay before the fortress was reduced to extremity; and this they imagined must be the case in a few days. Such diligence, however, had been used on the part of the British, that a fleet was already assembled at Portsmouth, consisting of 35 sail of the line, in excellent condition, and filled with the best officers and sailors in Europe. The command was given to Lord Howe, who was accompanied in the expedition by Admirals Barrington, Milbank, Hood, Sir Richard Hughes, and Commodore Hotham, all of them men eminent in their profession. At the same time also it fortunately happened, that a large British fleet of merchantmen had just arrived in safety from the Baltic; and that a Dutch squadron, which had been cruising on their own coasts, not being able to penetrate southwards, in order to join the French, had retired into port, and given up the intention of effecting any junction for that season.

At this time the British nation was in the utmost anxiety about the fate of Gibraltar. The progress of the ships was delayed by contrary winds, and it was not until they had gained the southern coast of Portugal that they received information of the defeat of the enemy's attempt on the 13th of September. On the 11th of October Lord Howe entered the Straits, and several of the store ships destined for Gibraltar came safe to anchor under the cannon of the fort without any molestation from the enemy. The combined fleet in the mean time had been much damaged by a storm; two ships of the line were driven ashore near Algesiras; two more were driven out of the bay into the Mediterranean; others lost their masts, and most of them suffered considerably. One in particular, a ship of 70 guns, was carried by the storm across the bay, and ran aground under the works of Gibraltar, where she was taken by the garrison, with her whole complement of men, consisting of 700. Notwithstanding the endeavours of the enemy to destroy her, she was safely got off, and properly repaired. The combined fleet, however, put to sea on the 13th, with a view to prevent the remaining storeships that had overshot the bay to the east from making good their entrance into it; and at the same time to rejoin the two ships that had been separated from the main body by the storm. Having the advantage of the wind, they bore down upon the British fleet, which drew up in order of battle to receive them; but notwithstanding their superiority, they declined coming to an engagement. On the wind becoming more favourable next day, Lord Howe took the opportunity to bring in the storeships that were in company; and the day following the remainder were conveyed to Gibraltar, the troops for the reinforcement of the garrison were landed, with a large supply of powder, and ample provision in every other respect. As they returned through the straits they were threatened with an engagement by the combined fleets; but though the latter had a superiority of 12 ships of the line, they kept a wary distance. Some firing indeed took place, but it was attended with little effect on either side.

This last relief proved entirely decisive; for though the blockade continued till news arrived of the preliminaries of peace being signed, in the beginning of February 1783, no other attack was made. The news of the pacification were received with the utmost joy by the Spaniards. Mutual civilities passed between the commanders in chief, and the Duke de Crillon paid many handsome compliments to the governor and garrison for their noble defence; declaring that he had exerted himself to the utmost of his abilities, and though he had not proved successful, yet he was happy in having his sovereign's approbation of his conduct. 48 The garrison finally relieved.

The possession of Gibraltar is esteemed of very great consequence to Britain. It not only gives us the command of the Straits, and their navigation; but affords refreshment and accommodation to our fleets in time of war, and to our merchantmen at all times; which, to a maritime power, is of very great advantage. From its situation, it divides both the kingdoms of France and Spain; that is, it hinders a ready communication by sea between the different parts of these kingdoms. This, of course, hinders the conjunction of their fleets and squadrons with each other, or at least renders it so difficult as to be a perpetual check upon these ambitious powers. It awes also the piratical states of Barbary, and in like manner the emperor of Morocco; insomuch, that our commerce is more safe than that of any other European power, which gives us great advantages in point of freight. It is otherwise highly favourable to our trade in the Mediterranean and Levant. It procures us the respect of the Italian and other powers; who, though far distant from Britain, must consider this as an instance of her power to hurt or assist them. It also saves us the expence of squadrons or convoys, upon any disputes or disturbances that may happen among these powers, and which would otherwise be necessary for the protection of our navigation. 49 Importance of Gibraltar.

"The form of this mountain is (says Major Imrie) oblong; its summit a sharp craggy ridge; its direction is nearly from north to south; and its greatest length, in that direction, falls very little short of three miles. Its breadth varies with the indentations of the shore, but it nowhere exceeds three quarters of a mile. The line of its ridge is undulated, and the two extremes are somewhat higher than its centre.

"The summit of the Sugar Loaf, which is the point 50 Natural history.

of

Gibraltar. of its greatest elevation towards the south, is 1439 feet; the Rock Mortar, which is the highest point to the north, is 1350; and the Signal House, which is nearly the central point between these two, is 1276 feet above the level of the sea. The western side of the mountain is a series of rugged slopes, interspersed with abrupt precipices. Its northern extremity is perfectly perpendicular, except towards the north-west, where what are called the Lines intervene, and a narrow passage of flat ground that leads to the isthmus, and is entirely covered with fortification. The eastern side of the mountain mostly consists of a range of precipices; but a bank of sand, rising from the Mediterranean in a rapid acclivity, covers a third of its perpendicular height. Its southern extremity falls, in a rapid slope from the summit of the Sugar Loaf, into a rocky flat of considerable extent, called Windmill Hill.

"The principal mass of the mountain rock consists of a gray, dense (what is generally called primary) marble; the different beds of which are to be examined in a face of 1350 feet of perpendicular height, which it presents to Spain in a conical form. These beds, or strata, are of various thickness, from 20 to upwards of 40 feet, dipping in a direction from east to west, nearly at an angle of 35 degrees. In some parts of the solid mass of this rock are found testaceous bodies entirely transmuted into the constituent matter of the rock, and their interior hollows filled up with calcareous spar; but these do not occur often in its composition, and its beds are not separated by any intermediate strata.

"The caves of Gibraltar are many, and some of them of great extent. That which most deserves attention and examination is called St Michael's Cave, which is situated upon the southern part of the mountain, almost equally distant from the Signal Tower and the Sugar Loaf. Its entrance is 1000 feet above the level of the sea: This entrance is formed by a rapid slope of earth, which has fallen into it at various periods, and which leads to a spacious hall, incrusted with spar, and apparently supported in the centre by a large massy stalactitical pillar. To this succeeds a long series of caves of difficult access. In these cavernous recesses, the formation and process of stalactites is to be traced, from the flimsy quilt-like cone, suspended from the roof, to the robust trunk of a pillar, three feet in diameter, which rises from the floor, and seems intended by Nature to support the roof from which it originated.

"The only inhabitants of these caves are bats, some of which are of a large size. The soil, in general, upon the mountain of Gibraltar is but thinly sown; and in many parts that thin covering has been washed off by the heavy autumnal rains, which have left the superficies of the rock, for a considerable extent, bare and open to inspection. In those situations, an observing eye may trace the effects of the slow, but constant, decomposition of the rock, caused by its exposure to the air, and the corrosion of sea-salts, which, in the heavy gales of easterly winds, are deposited with the spray on every part of the mountain. Those uncovered parts of the mountain rock also expose to the eye a phenomenon worthy of some attention, as it tends clearly to demonstrate, that, however high the surface of this rock may now be elevated above the level of the sea, it has once been the bed of agitated waters. This phenomenon is to be observed in many parts of the rock, and is constantly found in the beds of torrents. It consists of pot-like holes, of various sizes, hollowed out of the solid rock, and formed apparently by the attrition of gravel or pebbles, set in motion by the rapidity of rivers or currents in the sea. Gibraltar.

"Upon the west side of the mountain, towards its base, some strata occur, which are heterogeneal to the mountain rock: the first, or highest, forms the segment of a circle; its convex side is towards the mountain, and it slopes also in that direction. This stratum consists of a number of thin beds; the outward one, being the thinnest, is in a state of decomposition, and is mouldering down into a blackish brown or ferruginous coloured earth. The beds, inferior to this, progressively increase in breadth to 17 inches, where the stratification rests upon a rock of an argillaceous nature.

"This last bed, which is 17 inches thick, consists of quartz of a blackish blue colour, in the septa or cracks of which are found fine quartz crystals, colourless, and perfectly transparent. These crystals are composed of 18 planes, disposed in hexangular columns, terminated at both extremities by hexangular pyramids. The largest of those that Major Imrie saw did not exceed one-fourth of an inch in length: They, in general, adhere to the rock by the sides of the column, but are detached without difficulty. Their great degree of transparency has obtained them the name of *Gibraltar diamonds*."

"In the perpendicular fissures of the rock, and in some of the caverns of the mountain (all of which afford evident proofs of their former communication with the surface), a calcareous concretion is found, of a reddish brown ferruginous colour, with an earthy fracture, and considerable induration, inclosing the bones of various animals, some of which have the appearance of being human. These bones are of various sizes, and lie in all directions, intermixed with shells of snails, fragments of the calcareous rock, and particles of spar; all of which materials are still to be seen in their natural uncombined states, partially scattered over the surface of the mountain. These have been swept, by heavy rains at different periods, from the surface into the situations above described, and having remained for a long series of years in those places of rest, exposed to the permeating action of water, have become enveloped in, and cemented by, the calcareous matter which it deposits. 51 Bones found in fissures of the rock.

"The bones, in this composition, have not the smallest appearance of being petrified; and if they have undergone any change, it is more like that of calcination than that of petrifaction, as the most solid parts of them generally admit of being cut and scraped down with the same ease as chalk.

"Bones combined in such concretions are not peculiar to Gibraltar: they are found in such large quantities in the country of Dalmatia and upon its coasts, in the islands of Cherso and Osero, that some naturalists have been induced to go so far as to assert, that there has been a regular stratum of such matter in that country, and that its present broken and interrupted appearance has been caused by earthquakes, or other convulsions, experienced in that part of the globe. But, of late years, a traveller (Abbé Alberto Fortis) has given a minute description of the concretion in which the bones are found in that country: And by his account it appears, that with regard to situation, composition, and colour,

Gibraltar.

colour, it is perfectly ſimilar to that found at Gibraltar. By his deſcription, it alſo appears that the two mountain rocks of Gibraltar and Dalmatia conſiſt of the ſame ſpecies of calcareous ſtone; from which it is to be preſumed, that the concretions in both have been formed in the ſame manner and about the ſame periods.

"Perhaps if the fiſſures and caves of the rocks of Dalmatia were ſtill more minutely examined, their former communications with the ſurface might yet be traced as in thoſe deſcribed above; and, in that caſe, there would be at leaſt a ſtrong probability, that the materials of the concretions of that country have been brought together by the ſame accidental cauſe which has probably collected thoſe found in the caverns of Gibraltar. Major Imrie traced, in Gibraltar, this concretion, from the loweſt part of a deep perpendicular fiſſure, up to the ſurface of the mountain. As it approached to the ſurface, the concretion became leſs firmly combined, and, when it had no covering of the calcareous rock, a ſmall degree of adheſion only remained, which was evidently produced by the argillaceous earth, in its compoſition, having been moiſtened by rain and baked by the ſun.

"The depth at which theſe materials had been penetrated by that proportion of ſtalactitical matter, capable of giving to the concretion its greateſt adheſion and ſolidity, he found to vary according to its ſituation, and to the quantity of matter to be combined. In fiſſures, narrow and contracted, he found the concretion poſſeſſing a great degree of hardneſs at ſix feet from the ſurface; but in other ſituations, more extended, and where a larger quantity of the materials had been accumulated, he found it had not gained its greateſt degree of adheſion at double that depth. In one of the caves, where the maſs of concretion is of conſiderable ſize, he perceived it to be divided into different beds, each bed being covered with a cruſt of the ſtalactitical ſpar, from one inch to an inch and a half in thickneſs, which ſeems to indicate, that the materials have been carried in at various periods, and that thoſe periods have been very remote from each other.

"At Roſia bay, upon the weſt ſide of Gibraltar, this concretion is found in what has evidently been a cavern, originally formed by huge unſhapely maſſes of the rock which have tumbled in together. The fiſſure, or cavern, formed by the diſruption and ſubſidence of thoſe maſſes, has been entirely filled up with the concretion, and is now expoſed to full view by the outward maſs having dropped down in conſequence of the encroachments of the ſea. It is to this ſpot that ſtrangers are generally led to examine the phenomenon; and the compoſition, having here attained to its greateſt degree of hardneſs and ſolidity, the haſty obſerver, ſeeing the bones incloſed in what has ſo little the appearance of having been a vacuity, examines no further, but immediately adopts the idea of their being incaſed in the ſolid rock. The communication from this former chaſm, to the ſurface from which it has received the materials of the concretion, is ſtill to be traced in the face of the rock, but its opening is at preſent covered by the baſe of the line wall of the garriſon. Here bones are found that are apparently human; and thoſe of them that appear to be of the legs, arms, and vertebræ of the back, are ſcattered among others of various kinds and ſizes, even down to the ſmalleſt bones of ſmall birds. Major Imrie found here the complete jaw-bone of a ſheep; it contained its full complement of teeth, the enamel of which was perfect, and its whiteneſs and luſtre in no degree impaired. In the hollow parts of ſome of the large bones was contained a minute cryſtallization of pure and colourleſs calcareous ſpar; but, in moſt, the interior part conſiſted of a ſparry cruſt of a reddiſh colour, ſcarcely in any degree tranſparent.

"At the northern extremity of the mountain, the concretion is generally found in perpendicular fiſſures. The miners there employed upon the fortifications, in excavating one of thoſe fiſſures, found, at a great depth from the ſurface, two ſkulls, which were ſuppoſed to be human; but, to the Major, one of them, if not both, appeared to be too ſmall for the human ſpecies. The bone of each was perfectly firm and ſolid; from which it is to be preſumed, that they were in a ſtate of maturity before they were incloſed in the concretion. Had they appertained to very young children, perhaps the bone would have been more porous, and of a leſs firm texture. The probability is, that they belonged to a ſpecies of monkey, which ſtill continues to inhabit, in conſiderable numbers, thoſe parts of the rock which are to us inacceſſible.

"This concretion varies, in its compoſition, according to the ſituation in which it is found. At the extremity of Prince's Lines, high in the rock which looks towards Spain, it is found to conſiſt only of a reddiſh calcareous earth, and the bones of ſmall birds cemented thereby. The rock around this ſpot is inhabited by a number of hawks, that, in the breeding ſeaſon, neſtle here and rear their young: the bones in this concretion are probably the remains of the food of thoſe birds. At the baſe of the rock, below King's Lines, the concretion conſiſts of pebbles of the prevailing calcareous rock. In this concretion, at a very conſiderable depth under the ſurface, was found the under parts of a glaſs bottle, uncommonly ſhaped, and of great thickneſs; the colour of the glaſs was of a dark green*."

* *Phil. Tranſ. Edin.* vol. iv.

52 Subterraneous galleries.

"The ſubterraneous galleries are very extenſive, pierce the rock in ſeveral places and in various directions, and at various degrees of elevation; all of them have a communication with each other, either by flights of ſteps cut in the rock, or by wooden ſtairs where the paſſages are required to be very perpendicular.

"The centinels may now be relieved during a ſiege from one poſt to another in perfect ſafety; whereas, previouſly to the conſtructing of theſe galleries a vaſt number of men were killed by the Spaniards while marching to their ſeveral ſtations. The width of theſe galleries is about twelve feet, their height about fourteen. The rock is broken through in various places, both for the purpoſe giving light and for placing the guns to bear on the enemy. In different parts there are ſpacious receſſes, capable of accommodating a conſiderable number of men. To theſe receſſes they give names, ſuch as St Patrick's Chamber, St George's Hall, &c. The whole of theſe ſingular ſtructures have been formed out of the ſolid rock by blaſting with gunpowder. Through the politeneſs of an officer on duty, a place called Smart's Reſervoir was opened for our inſpection, which is a great curioſity, and not generally permitted to be ſhewn. It is a ſpring at a conſiderable depth in the body of the rock, and is above 700 feet above the level of the ſea; we deſcended into the cavern that contains

Gibraltar, Gibson. tains it by a rope ladder, and with the aid of lighted candles proceeded through a narrow paſſage over cryſtallized protuberances of the rock till we came to a hollow, which appears to have been opened by ſome convulſion of nature. Here, from a bed of gems, ariſes the ſalutary fount, clear as the brilliant of the caſt, and cold as the icicle. We hailed the nymph of the grot, and, proſtrating ourſelves, quaffed hygean nectar from her ſparry urn. When reſtored to the light of day, we obtained, through the medium of the ſame gentleman, the key of St George's Hall, at which we arrived by a very intricate and gloomy path to the ſpacious excavation, which is upwards of an hundred feet in length, its height nearly the ſame. It is formed in a ſemicircular part of the rock; ſpacious apertures are broken through, where cannons of a very large calibre command the iſthmus, the Spaniſh lines, and a great part of the bay. The top of the rock is pierced through, ſo as to introduce ſufficient light to enable you to view every part of it. It appears almoſt incredible that ſo large an excavation could be formed by gunpowder, without blowing up the whole of that part of the rock, and ſtill more ſo, that they ſhould be able to direct the operations of ſuch an inſtrument, ſo as to render it ſubſervient to the purpoſe of elegance. We found in the hall a table, placed, I ſuppoſe, for the conveniency of thoſe who are traverſing the rock. The cloth was ſpread, the wine went round, and we made the vaulted roof reſound with the accents of mirth and the ſongs of conviviality*."

* *Month. Mag.* 1798.

GIBSON, Richard, an Engliſh painter, commonly called the *Dwarf*, was originally page to a lady at Mortlake; who, obſerving that his genius led him to painting, had the generoſity to get him inſtructed in the rudiments of that art. He devoted himſelf to Sir Peter Lely's manner, and copied his pictures to admiration, eſpecially his portraits: his paintings in water colours were alſo eſteemed. He was in great favour with Charles I. who made him his page of the back ſtairs; and he had the honour to inſtruct in drawing Queen Mary and Queen Anne when they were princeſſes. He married one Mrs Anne Shepherd, who was alſo a dwarf; on which occaſion King Charles I. honoured their marriage with his preſence, and gave away the bride. Mr Waller wrote a poem on this occaſion, entitled "The Marriage of the Dwarfs;" in which are theſe lines:

Deſign or change makes others wive,
But nature did this match contrive;
Eve might as well have Adam fled,
As ſhe deny'd her little bed
To him for whom heav'n ſeem'd to frame
And meaſure out this only dame."

Mr Fenton, in his notes on this poem, obſerves that he had ſeen this couple painted by Sir Peter Lely; and that they were of an equal ſtature, each being three feet ten inches high. They had nine children, five of whom arrived at maturity; theſe were well proportioned, and of the uſual ſtandard of mankind. But what nature denied this couple in ſtature, ſhe gave them in length of days: for Mr Gibſon died in the 75th year of his age; and his wife, having ſurvived him almoſt 20 years, died in 1709, aged 89.

Gibson, *Dr Edmund*, biſhop of London, was born in Weſtmorland, in 1669. He applied himſelf early and vigorouſly to learning, and diſplayed his knowledge in ſeveral writings and tranſlations, which recommended him to the patronage of Archbiſhop Tenniſon. He was appointed domeſtic chaplain to his Grace; and we ſoon after find him rector of Lambeth, and archdeacon of Surry. Becoming thus a member of the convocation, he engaged in a controverſy, which was carried on with great warmth by the members of both houſes, and defended his patron's rights, as preſident, in eleven pamphlets; he then formed and completed his more comprehenſive ſcheme of the legal duties and rights of the Engliſh clergy, which was at length publiſhed under the title of *Codex Juris Eccleſiaſtici Anglicani*, in folio. Archbiſhop Tenniſon dying in 1715, and Dr Wacke biſhop of Lincoln being made archbiſhop of Canterbury, Dr Gibſon ſucceeded the latter in the ſee of Lincoln, and in 1720 was promoted to the biſhoprick of London. He now not only governed his dioceſe with the moſt exact regularity, but by his great care promoted the ſpiritual affairs of the church of England colonies in the Weſt Indies. He was extremely jealous of the leaſt of the privileges belonging to the church; and therefore, though he approved of the toleration of the Proteſtant Diſſenters, he continually guarded againſt all the attempts made to procure a repeal of the corporation and teſt acts; in particular, his oppoſition to thoſe licentious aſſemblies called *maſquerades*, gave great umbrage at court, and effectually excluded him from all further favours. He ſpent the latter part of his life in writing and printing paſtoral letters, viſitation-charges, occaſional ſermons, and tracts againſt the prevailing immoralities of the age. His paſtoral letters are juſtly eſteemed as the moſt maſterly productions againſt infidelity and enthuſiaſm. His moſt celebrated work, the *Codex*, has been already mentioned. His other publications are, 1. An edition of Drummond's *Polemo-Middinia*, and James V. of Scotland's *Cantileua Ruſtica*, with notes. 2. The *Chronicon Saxonicum*, with a Latin tranſlation, and notes. 3. *Reliquiæ Spelmannianæ*, the poſthumous works of Sir Henry Spelman, relating to the laws and antiquities of England. 4. An edition of *Quintilian de Arte Oratoria*, with notes. 5. An Engliſh tranſlation of Camden's *Britannia*, with additions, two volumes folio: and, 6. A number of ſmall pieces, that have been collected together and printed in three volumes folio.—His intenſe application to ſtudy impaired his health; notwithſtanding which, he attained the age of 79. He expired in September 1748, after an epiſcopate of near 33 years.—With regard to Biſhop Gibſon's private life and character, he was in every reſpect a perfect economiſt. His abilities were ſo well adapted to diſcharge the duties of his ſacred function, that during the incapacity of Archbiſhop Wake, the tranſaction of eccleſiaſtical affairs was committed to the biſhop of London. He was a true friend to the eſtabliſhed church and government, and as great an enemy to perſecution. He was uſually conſulted by the moſt learned and exalted perſonages in church and ſtate, and the greateſt deference was paid to his judgment. He poſſeſſed the ſocial virtues in an eminent degree; his beneficence was very extenſive; and he had ſuch generoſity,

rosity, that he freely gave two thousand five hundred pounds, left him by Dr Crow, who was once his chaplain, to Crow's own relations, who were very poor.

GIDEON the son of Joash, of the tribe of Manasseh. He dwelt in the city of Ophrah; and had a very extraordinary call to deliver the Israelites from the oppression of the Midianites, to which they had become subject after the death of Barak and Deborah. Having effected their deliverance by supernatural aid, he was chosen judge of Israel in the year of the world 2759, and died in 2768. (See Judges, chap. vi. vii. and viii.)

GIFT, *Donum*, in *Law*, is a conveyance which passeth either lands or goods; and is of a larger extent than a grant, being applied to things moveable and immoveable; yet as to things immoveable, when taken strictly, it is applicable only to lands and tenements given in tail; but *gift* and *grant* are too often confounded.

New Year's GIFTS, presents made on new year's day, as a token of the giver's good will, as well as by way of presage of a happy year.

This practice is very ancient, the origin of it among the Romans being referred to Tatius king of the Sabines, who reigned at Rome conjointly with Romulus, and who having considered as a good omen a present of some sprigs of vervain gathered in a wood consecrated to Strenia the goddess of strength, which he received on the first day of the new year, authorized this custom afterwards, and gave to these presents the name of Strenæ. However this may be, the Romans on that day celebrated a festival in honour of Janus, and paid their respects at the same time to Juno; but they did not pass it in idleness, lest they should become indolent during the rest of the year. They sent presents to one another of figs, dates, honey, &c. to show their friends that they wished them a happy and agreeable life. Clients, that is to say, those who were under the protection of the great, carried presents of this kind to their patrons, adding to them a small piece of silver. Under Augustus, the senate, the knights, and the people, presented such gifts to him, and in his absence deposited them in the Capitol. Of the succeeding princes some adopted this custom, and others abolished it, but it always continued among the people. The early Christians condemned it, because it appeared to be a relick of Paganism, and a species of superstition; but when it began to have no other object than that of being a mark of veneration and esteem, the church ceased to disapprove of it.

GIGG, GIGA, or JIG, in *Music* and *Dancing*, a gay, brisk, sprightly composition, and yet in full measure, as well as the allemand, which is more serious. Menage takes the word to arise from the Italian *giga*, a musical instrument mentioned by Dante. Others suppose it to be derived from the Teutonic *gieg*, or *ghiighe*, "a fiddle." This is a favourite air in most nations of Europe: its characteristic is duple time, marked $\frac{6}{8}$, or $\frac{12}{8}$: it consists of two strains, without any determinate number of bars.

GIGGLEWICK, a town in the west riding of Yorkshire, half a mile from Settle, stands on the river Ribble, where, at the foot of a mountain, is a spring, the most noted in England for ebbing and flowing sometimes thrice in an hour, and the water subsides three quarters of a yard at the reflux, though the sea is 30 miles off. At this town is an eminent free grammar school; and in the neighbourhood are dug up flags, slate, and stone.

GIHON, in *Ancient Geography*, one of the rivers of Paradise; according to Wells, the eastern branch of the Euphrates, into which it divides after its conjunction with the Tigris.

GILAN, or GHILAN, a considerable province of Persia, on the side of the Caspian sea, to the southwest. It is supposed to be the Hyrcania of the ancients. It is very agreeably situated, having the sea on one side and high mountains on the other; and there is no entering in but through narrow passes, which may easily be defended. The sides of the mountains are covered with many sorts of fruit trees, and in the highest parts of them there are deer, bears, wolves, leopards, and tygers; which last the Persians have a method of taming, and hunt with them as we do with dogs. Gilan is one of the most fruitful provinces of Persia, and produces abundance of silk, oil, wine, rice, and tobacco, besides excellent fruits. The inhabitants are brave, and of a better complexion than the other Indians, and the women are accounted extremely handsome. Resht is the capital town.

GILBERT, or GILBERD, *William*, a physician, was born at Colchester in the year 1540, the eldest son of the recorder of that borough. Having spent some time in both universities, he went abroad; and at his return settled in London, where he practised with considerable reputation. He became a member of the College of Physicians, and physician in ordinary to Queen Elizabeth, who, we are told, gave him a pension to encourage him in his studies. From his epitaph it appears that he was also physician to King James I. He died in the year 1603, aged 63; and was buried in Trinity church in Colchester, where a handsome monument was erected to his memory. His books, globes, instruments, and fossils, he bequeathed to the College of Physicians, and his picture to the school gallery at Oxford. He wrote, 1. *De Magnete, magneticisque corporibus, et de magno magnete tellure, physiologia nova;* London 1600, folio. 2. *De mundo nostro sublunari philosophia nova:* Amsterdam 1651, 4to. He was also the inventor of two mathematical instruments for finding the latitude at sea without the help of sun, moon, or stars. A description of these instruments was afterwards published by Thomas Blondeville in his *Theoriques of the Planets*.

GILBERT, *Sir Humphrey*, a brave officer and skilful navigator, was born about the year 1539, in Devonshire, of an ancient and honourable family. Though a second son, he inherited a considerable fortune from his father. He was educated at Eton, and afterwards at Oxford; where probably he did not continue long. It seems he was intended to finish his studies in the Temple; but being introduced at court by his aunt Mrs Catharine Ashley, then in the queen's service, he was diverted from the study of law, and commenced soldier. Having distinguished himself in several military expeditions, particularly that to Newhaven in 1563, he was sent over to Ireland to assist in suppressing a rebellion; where, for his signal services, he was made commander in chief and governor of Munster, and knighted by the lord deputy, Sir Henry Sidney, on the first day of the year 1570. He returned soon after to England, where he married a rich heiress. Nevertheless, in 1572, he failed with a squadron of nine ships to reinforce Colonel Morgan, who at that time meditated the recovery of Flushing. Probably on his return to England he resumed his cosmographical studies, to which he was naturally inclined: for, in the year 1576, he published his book on the north-west passage to the East Indies; and as Martin Frobisher failed the same year, probably it was in consequence of this treatise. In 1578, he obtained from the queen a very ample patent, empowering him to discover and possess in North America any lands then unsettled. He failed to Newfoundland, but soon returned to England without success; nevertheless, in 1583, he embarked a second time with five ships, the largest of which put back on account of a contagious distemper on board. Our general landed on Newfoundland on the third of August, and on the fifth took possession of the harbour of St John's. By virtue of his patent, he granted leases to several people; but though none of them remained there at that time, they settled afterwards in consequence of these leases; so that Sir Humphry deserves to be remembered as the real founder of the vast American empire. On the 20th of August he put to sea again, on board a small sloop; which on the 29th foundered in a hard gale of wind. Thus perished Sir Humphrey Gilbert; a man of quick parts, a brave soldier, a good mathematician, a skilful navigator, and of a very enterprising genius. We learn also, that he was remarkable for his eloquence, being much admired for his patriotic speeches both in the English and Irish parliaments. He wrote "A discourse to prove a passage by the north-west to Cathaia and the East Indies, printed London 1576." This treatise, which is a masterly performance, is preserved in Hakluyt's Collection of Voyages, vol. iii. p. 11. The style is superior to most, if not to all, the writers of that age; and shows the author to have been a man of considerable reading. He mentions, at the close of this work, another treatise on navigation, which he intended to publish: it is probably lost.

GILBERTINES, an order of religious, thus called from St Gilbert of Sempringham, in the county of Lincoln, who founded the same about the year 1148: the monks of which observed the rule of St Augustine; and were accounted canons: and the nuns that of St Benedict.

The founder of this order erected a double monastery, or rather two different ones, contiguous to each other, the one for men, the other for women, but parted by a very high wall.

St Gilbert himself founded 13 monasteries of this order, viz. four for men alone, and nine for men and women together, which had in them 700 brethren and 1500 sisters. At the dissolution there were about 25 houses of this order in England and Wales.

GILBOA, in *Ancient Geography*, mountains of Samaria, stretching out from west to east, on the confines of the half tribe of Manasseh, and of the tribe of Issachar, and to the south part of the valley of Jezreel; beginning westward at the city of Jezreel, situated at the foot of these mountains, reaching almost quite to the Jordan, lying at the distance of six miles from Scythopolis. Famous for the death of Saul and his son Jonathan, and the defeat of the Israelites by the Philistines.

GILCHRIST, Dr Ebenezer, an eminent Scots physician, was born at Dumfries in 1707. He began the study of medicine at Edinburgh, which he afterwards prosecuted at London and Paris. He obtained the degree of doctor of medicine from the university of Rheims; and in the year 1732 he returned to the place of his nativity, where he afterwards constantly resided, and continued the practice of medicine till his death. It may with justice be said, that few physicians of the present century have exercised their profession in a manner more respectable or successful than Dr Gilchrist; and few have contributed more to the improvement of the healing art. Having engaged in business at an early period of life, his attention was wholly devoted to observation. Endowed by nature with a judgment acute and solid, with a genius active and inventive, he soon distinguished himself by departing, in various important particulars, from established but unsuccessful modes of practice. Several of the improvements which he introduced have procured him great and deserved reputation both at home and abroad. His practice, in ordinary cases, was allowed to be judicious, and placed him high in the confidence and esteem of the inhabitants of that part of the country where he lived. But his usefulness was not confined to his own neighbourhood. On many occasions he was consulted by letter from the most distant parts of the country. In different collections are to be found several of his performances, which prove that he had something new and useful to offer upon every subject to which he applied himself. But those writings which do him the greatest honour, are two long dissertations on Nervous Fevers, in the Medical Essays and Observations published by a Society in Edinburgh; and a treatise on the use of Sea Voyages in medicine, which first made its appearance in the year 1757, and was afterwards reprinted in 1771. By means of the former, the attention of physicians was first turned to a species of fever which is now found to prevail universally in this country; and the liberal use of wine, which he was the first among the moderns to recommend, has since been adopted in these fevers by the most judicious physicians of the present age, and has probably contributed not a little to the success of their practice. His treatise on Sea Voyages points out in a manner so clear, and so much on the sure footing of experience, their utility in various distempers, particularly in consumptions, that there is now a prospect of our being able to employ a remedy in this untractable disease much more efficacious than any hitherto in use. Dr Gilchrist died in 1774.

GILD, or Guild. See Guild.

GILDAS, surnamed *the Wise*, was born in Wales in the year 511. Where he was educated is uncertain; but it appears from his own writings that he was a monk. Some writers say that he went over to Ireland; others, that he visited France and Italy. They agree however in asserting, that after his return to England he became a celebrated and most assiduous preacher of the gospel. Du Pin says he founded a monastery at Venetia in Britain. Gildas is the only British author of the sixth century whose works are printed;

Gilding.

printed; they are therefore valuable on account of their antiquity, and as containing the only information we have concerning the times of which he wrote. His History of Britain is, however, a very flimſy performance, and his ſtyle obſcure and inelegant.

GILDING, the art of ſpreading or covering a thing over with gold, either in leaf or liquid. The art of gilding was not unknown among the ancients, though it never arrived among them at the perfection to which the moderns have carried it. Pliny aſſures us, that the firſt gilding ſeen at Rome was after the deſtruction of Carthage, under the cenſorſhip of Lucius Mummius, when they began to gild the ceilings of their temples and palaces; the Capitol being the firſt place on which this enrichment was beſtowed. But he adds, that luxury advanced on them ſo haſtily, that in a little time you might ſee all, even private and poor perſons, gild the very walls, vaults, &c. of their houſes.

1 Gilding when firſt introduced at Rome.

We need not doubt but they had the ſame method with us, of beating gold, and reducing it into leaves; though it ſhould ſeem they did not carry it to the ſame height, if it be true which Pliny relates, that they only made 750 leaves of four fingers ſquare out of a whole ounce. Indeed he adds, that they could make more; that the thickeſt were called *bracteæ Prænestinæ*, by reaſon of a ſtatue of the goddeſs Fortune at Præneſte gilt with ſuch leaves; and that the thinner ſort was called *bracteæ queſtoriæ*.

The modern gilders do alſo make uſe of gold leaves of divers thickneſſes; but there are ſome ſo fine, that a thouſand do not weigh above four or five drachms. The thickeſt are uſed for gilding on iron and other metals; and the thinneſt on wood. But we have another advantage over the ancients in the manner of uſing or applying the gold: the ſecret of painting in oil, diſcovered of late ages, furniſhes us with means of gilding works that ſhall endure all the injuries of time and weather, which to the ancients was impracticable.— They had no way to lay the gold on bodies that would not endure the fire but with whites of eggs or ſize, neither of which will endure the water; ſo that they could only gild ſuch places as were ſheltered from the moiſture of the weather.

2 Ancient gilding inferior to the modern.

The Greeks called the compoſition on which they applied their gilding on wood *leucophæum* or *leucophorum*; which is deſcribed as a ſort of glutinous compound earth, ſerving in all probability to make the gold ſtick and bear poliſhing. But the particulars of this earth, its colour, ingredients, &c. the antiquaries and naturaliſts are not agreed upon.

The luſtre and beauty of gold have occaſioned ſeveral inquiries and diſcoveries concerning the different methods of applying it to different ſubſtances. Hence the art of gilding is very extenſive, and contains many particular operations and various management.

3 Falſe gilding with laquer or Dutch leaf.

A colour of gold is given by painting and by varniſhes, without employing gold; but this is a falſe kind of gilding. Thus a very fine golden colour is given to braſs and to ſilver, by applying upon theſe metals a gold-coloured varniſh, which, being tranſparent, ſhows all the brilliancy of the metals beneath. Many ornaments of braſs were varniſhed in this manner, which is called *gold laquering*, to diſtinguiſh them from thoſe which are really gilt. Silver leaves thus varniſhed are put upon leather, which is then called *gilt leather*. See LAQUER.

Gilding.

Amongſt the falſe gilding may alſo be reckoned thoſe which are made with thin leaves of copper or braſs, called *Dutch leaf*. In this manner are made all the kinds of what is called *gilt paper*.

In the true gilding, gold is applied to the ſurface of bodies. The gold intended for this purpoſe ought in general to be beat into thin leaves, or otherwiſe divided into very fine parts.

As metals cannot adhere well merely by contact to any but to other metallic ſubſtances, when gold is to be applied to the ſurface of ſome unmetallic body, that ſurface muſt be previouſly covered with ſome gluey and tenacious ſubſtance by which the gold ſhall be made to adhere. Theſe ſubſtances are in general called *ſizes*. Some of theſe are made of vegetable and animal glues, and others of oily, gluey, and drying matters. Upon them the leaves of gold are applied, and preſſed down with a little cotton or a hare's foot; and when the whole is dry, the work is to be finiſhed and poliſhed with a hard inſtrument, called a *dog's tooth*, to give luſtre. 4 Gilding with ſize.

When the work is required to be capable of reſiſting rain or moiſture, it ought to be previouſly covered with a compoſition of drying oil and yellow ochre ground together; otherwiſe a water ſize may be uſed, which is prepared by boiling cuttings of parchment or white leather in water, and by mixing with this ſome chalk or whiting: ſeveral layers of this ſize muſt be laid upon the wood, and over theſe a layer of the ſame ſize mixed with yellow ochre. Laſtly, Another mixture, called *gold ſize*, is to be applied above theſe; upon which the gold leaves are to be fixed. This gold ſize, the uſe of which is to make the gold leaf capable of being burniſhed, is compoſed of tobacco-pipe clay, ground with ſome ruddle or black lead, and tempered with a little tallow or oil of olives. The edges of glaſſes may be gilt by applying firſt a very thin coat of varniſh, upon which the gold leaf is to be fixed; and when the varniſh is hardened, may be burniſhed. This varniſh is prepared by boiling powdered amber with linſeed oil in a braſs veſſel to which a valve is fitted, and by diluting the above ſolution with four or five times its quantity of oil of turpentine; and that it may dry ſooner, it may be ground with ſome white lead. 5 With oil.

The method of applying gold upon metals is entirely different. The ſurface of the metal to be gilt is firſt to be cleaned; and then leaves are to be applied to it, which, by means of rubbing with a poliſhed bloodſtone, and a certain degree of heat, are made to adhere perfectly well. In this manner ſilver leaf is fixed and burniſhed upon braſs in the making of what is called *French plate*, and ſometimes alſo gold leaf is burniſhed upon copper and upon iron. 6 Of gilding metals.

Gold is applied to metals in ſeveral other ways. One of theſe is by previouſly forming the gold into a paſte or amalgam with mercury. In order to obtain a ſmall amalgam of gold and mercury, the gold is firſt to be reduced into thin plates or grains, which are heated red hot, and thrown into mercury previouſly heated, till it begins to ſmoke. Upon ſtirring the mercury with an iron rod, the gold totally diſappears. The proportion of mercury to gold is generally as ſix or eight to one.

With

With this amalgam the ſurface of the metal to be gilded is to be covered; then a ſufficient heat is to be applied to evaporate the mercury: and the gold is laſtly to be burniſhed with a blood-ſtone.

This method of gilding by amalgamation is chiefly uſed for gilding copper, or an alloy of copper, with a ſmall portion of zinc, which more readily receives the amalgam; and is alſo preferable for its colour, which more reſembles that of gold than the colour of copper. When the metal to be gilt is wrought or chaſed, it ought to be previouſly covered with quickſilver before the amalgam is applied, that this may be eaſier ſpread: but when the ſurface of the metal is plain, the amalgam may be applied directly to it. The quickſilver or amalgam is made to adhere to the metal by means of a little aquafortis, which is rubbed on the metallic ſurface at the ſame time, by which this ſurface is cleanſed from any ruſt or tarniſh which might prevent the union or adheſion of the metals. But the uſe of the nitrous acid in this operation is not, as is generally ſuppoſed, confined merely to cleanſe the ſurface of the metal to be gilt from any ruſt or tarniſh it may have acquired; but it alſo greatly facilitates the application of the amalgam to the ſurface of that metal, probably in the following manner: It firſt diſſolves part of the mercury of the amalgam; and when this ſolution is applied to the copper, this latter metal having a ſtronger affinity for nitrous acid than the mercury has, precipitates the mercury upon its ſurface, in the ſame manner as a poliſhed piece of iron precipitates copper upon its ſurface from a ſolution of blue vitriol. When the metal to be gilt is thus covered over with a thin precipitated coat of mercury, it readily receives the amalgam. In this ſolution and precipitation of mercury, the principal uſe of the nitrous acid in the proceſs of gilding appears to conſiſt. The amalgam being equally ſpread over the ſurface of the metal to be gilt by means of a bruſh, the mercury is then to be evaporated by a heat juſt ſufficient for that purpoſe; for if it be too great, part of the gold may alſo be expelled, and part of it will run together, and leave ſome of the ſurface of the metal bare: while the mercury is evaporating, the piece is to be from time to time taken from the fire, that it may be examined, that the amalgam may be ſpread more equally by means of a bruſh, that any defective parts of it may be again covered, and that the heat may not be too ſuddenly applied to it: when the mercury is evaporated, which is known by the ſurface being entirely become of a dull yellow colour, the metal muſt then undergo other operations, by which the fine gold colour is given to it. Firſt, The gilded piece of metal is rubbed with a ſcratch bruſh (which is a bruſh compoſed of braſs wire) till its ſurface is made ſmooth; then it is covered over with a compoſition called *gilding wax*, and is again expoſed to the fire till the wax be burnt off. This wax is compoſed of bees wax, ſometimes mixed with ſome of the following ſubſtances; red ochre, verdigriſe, copper ſcales, alum, vitriol, borax: but according to Dr Lewis, the ſaline ſubſtances alone are ſufficient, without any wax. By this operation the colour of the gilding is heightened; and this effect ſeems to be produced by a perfect diſſipation of ſome mercury remaining after the former operation. This diſſipation is well effected by this equable application of heat. The gilt ſurface is then covered over with a ſaline compoſition, conſiſting of nitre, alum, or other vitriolic ſalt, ground together, and mixed up into a paſte with water or urine. The piece of metal thus covered is expoſed to a certain degree of heat, and then quenched in water. By this method its colour is further improved, and brought nearer to that of gold. This effect ſeems to be produced by the acid of nitre (which is diſengaged by the vitriolic acid of the alum, or other vitriolic ſalt, during the expoſure to heat) acting upon any particles of copper which may happen to lie on the gilded ſurface. Laſtly, Some artiſts think that they give an additional luſtre to their gilt work by dipping it in a liquor prepared by boiling ſome yellow materials, as ſulphur, orpiment, or turmeric. The only advantage of this operation is, that a part of the yellow matter, as the ſulphur or tumeric, remains in ſome of the hollows of the carved work, in which the gilding is apt to be more imperfect, and to which it gives a rich and ſolid appearance.

7
Uſe of the nitrous acid in gilding.

Iron cannot be gilt by amalgamation, unleſs, as it is ſaid, it be previouſly coated with copper by dipping in a ſolution of blue vitriol. Iron may alſo receive a golden coat from a ſaturated ſolution of gold in aqua-regia, mixed with ſpirit of wine, the iron having a greater affinity with the acid, from which it therefore precipitates the gold. Whether any of theſe two methods be applicable to uſe, is uncertain: but the method commonly employed of fixing gold upon iron is that above mentioned, of burniſhing gold leaf upon this metal when heated ſo as to become blue; and the operation will be more perfect if the ſurface has been previouſly ſcratched or graved.

Another method is mentioned by authors of gilding upon metals, and alſo upon earthen ware, and upon glaſs; which is, to fuſe gold with regulus of antimony, to pulverize the maſs which is ſufficiently brittle to admit that operation, to ſpread this powder upon the piece to be gilt, and expoſe it to ſuch a fire that the regulus may be evaporated, while the gold remains fixed. The inconveniences of this method, according to Dr Lewis, are, that the powder does not adhere to the piece, and cannot be equally ſpread; that part of the gold is diſſipated along with the regulus; that glaſs is fuſible with the heat neceſſary for the evaporation of regulus of antimony; and that copper is liable to be corroded by the regulus, and to have its ſurface rendered uneven.

8
Improvement by Dr Lewis. *Phil. Com. of Arts.*

On this ſubject of gilding by amalgamation Dr Lewis has the following remarks. "There are two principal inconveniences in this buſineſs: One, that the workmen are expoſed to the fumes of the mercury, and generally, ſooner or later, have their health greatly impaired by them: the other, the loſs of the mercury; for though part of it is ſaid to be detained in cavities made in the chimney for that purpoſe, yet the greateſt part of it is loſt. From ſome trials I have made, it appeared that both theſe inconveniences, particularly the firſt and moſt conſiderable one, might in good meaſure be avoided, by means of a furnace of a due conſtruction. If the communication of a furnace with its chimney, inſtead of being over the fire, is made under the grate, the aſh-pit door, or other apertures beneath the grate, cloſed, and the mouth of the furnace left open; the current of air, which otherwiſe would have entered beneath, Gilding. neath, enters now at the top, and paſſing down through the grate to the chimney, carries with it completely both the vapour of the fuel and the fumes of ſuch matters as are placed upon it: the back part of the furnace ſhould be raiſed a little higher above the fire than the fore part, and an iron plate laid over it, that the air may enter only at the front, where the workman ſtands, who will be thus effectually ſecured from the fumes and from being incommoded with the heat, and at the ſame time have full liberty of introducing, inſpecting, and removing the work. If ſuch a furnace is made of ſtrong forged (not milled) iron plate, it will be ſufficiently durable: the upper end of the chimney may reach above a foot and a half higher than the level of the fire: over this is to be placed a larger tube, leaving an interval of an inch or more all round between it and the chimney, and reaching to the height of 10 or 12 feet, the higher the better. The external air, paſſing up between the chimney and the outer pipe, prevents the latter from being much heated, ſo that the mercurial fumes will condenſe againſt its ſides into running quickſilver, which, falling down to the bottom, is there catched in a hollow rim, formed by turning inwards a portion of the lower part, and conveyed, by a pipe at one ſide, into a proper receiver.

9 M. du Fay's method of raiſing gold figures.

"Mr Hellot communicates, in the Memoirs of the French Academy for the year 1745, a method of making raiſed figures of gold on works of gold or ſilver, found among the papers of M. du Fay, and of which M. du Fay himſelf had ſeen ſeveral trials. Fine gold in powder, ſuch as reſults from the parting of gold and ſilver by aquafortis, is directed to be laid in a heap on a levigating ſtone, a cavity made in the middle of the heap, and half its weight of pure mercury put into the cavity; ſome of the fetid ſpirit obtained from garlic root by diſtillation in a retort, is then to be added, and the whole immediately mingled and ground with a muller till the mixture is reduced into an uniform gray powder. The powder is to be ground with lemon juice to the conſiſtence of paint, and applied on the piece previouſly well cleaned and rubbed over with the ſame acid juice; the figures drawn with it may be raiſed to any degree by repeating the application. The piece is expoſed to a gentle fire till the mercury is evaporated ſo as to leave the gold yellow, which is then to be preſſed down, and rubbed with the finger and a little ſand, which makes it appear ſolid and brilliant; after this it may be cut and embelliſhed. The author obſerves, that being of a ſpongy texture, it is more adviſable to cut it with a chiſſel than to raiſe it with a graver; that it has an imperfection of being always pale; and that it would be a deſirable thing to find means of giving it colour, as by this method ornaments might be made of exquiſite beauty and with great facility. As the paleneſs appears to proceed from a part of the mercury retained by the gold, I apprehend it might be remedied by the prudent application of a little warm aquafortis, which diſſolving the mercury from the exterior part, would give at leaſt a ſuperficial high colour: if the piece is ſilver, it muſt be defended from the aquafortis by covering it with wax. Inſtruments and ornaments of gold, ſtained by mercury where the gold is connected with ſubſtances incapable of bearing fire, may be reſtored to their colour by the ſame means.

"The foregoing proceſs is given entirely on the authority of the French writer. I have had no experience of it myſelf, but have ſeen very elegant figures of gold raiſed upon ſilver, on the ſame principle, by a different procedure. Some cinnabar was ground, not with the diſtilled ſpirit, but with the expreſſed juice of garlic, a fluid remarkably tenacious. This mixture was ſpread all over the poliſhed ſilver; and when the firſt layer is dry, a ſecond, and after this a third, was applied. Over theſe were ſpread as many layers of another mixture, compoſed chiefly of aſphaltum and linſeed oil boiled down to a due conſiſtence. The whole being dried with a gentle heat on a kind of wire grate, the figures were traced and cut down to the ſilver ſo as to make its ſurface rough: the inciſions were filled with an amalgam of gold, raiſed to different heights in different parts according to the nature of the deſign; after which a gentle fire, at the ſame time that it evaporated the mercury, deſtroyed the tenacity of the gummy juice, ſo that the coating, which ſerved to confine the amalgam, and as a guide in the application of it, was now eaſily got off. The gold was then preſſed down and embelliſhed as in the former method; and had this advantage, that the ſurface of the ſilver under it having been made rough, it adhered more firmly, ſo as not to be in danger of coming off, as M. du Fay ſays the gold applied in his way ſometimes did. The artiſt, however, found the proceſs ſo troubleſome, that though he purchaſed the receipt for a conſiderable ſum, he has laid the practice aſide." Gilding. 10 Another method.

Finally, Some metals, particularly ſilver, may be gilt in the following manner:

Let gold be diſſolved in aqua regia. In this ſolution pieces of linen are to be dipt, and burnt to black aſhes. Theſe aſhes being rubbed on the ſurface of the ſilver by means of a wet linen rag, apply the particles of gold which they contain, and which by this method adhere very well. The remaining part of the aſhes is to be waſhed off; and the ſurface of the ſilver, which in this ſtate does not ſeem to be gilt, is to be burniſhed with a blood-ſtone, till it acquire a fine colour of gold. This method of gilding is very eaſy, and conſumes a very ſmall quantity of gold. Moſt gilt ornaments upon fans, ſnuff boxes, and other toys of much ſhow and little value, are nothing but ſilver gilt in this manner. 11 Eaſy method of gilding ſilver.

Gold may alſo be applied to glaſs, porcelain, and other vitrified matters. As the ſurface of theſe matters is very ſmooth, and conſequently is capable of a very perfect contact with gold leaves, theſe leaves adhere to them with ſome force, although they are not of metallic nature. This gilding is ſo much more perfect, as the gold is more exactly applied to the ſurface of the glaſs. The pieces are then to be expoſed to a certain degree of heat, and burniſhed ſlightly to give them luſtre. 12 Methods of gilding glaſs.

A more ſubſtantial gilding is fixed upon glaſs, enamel, and porcelain, by applying to theſe ſubſtances powder of gold mixed with a ſolution of gum arabic, or with ſome eſſential oil, and a ſmall quantity of borax; after which a ſufficient heat is to be applied to ſoften the glaſs and the gold, which is then to be burniſhed. With this mixture any figures may be drawn. The powders for this purpoſe may be made, 1. By grinding gold leaf with honey, which is afterwards

to

to be waſhed away with water. 2. By diſtilling to dryneſs a ſolution of gold in aqua regia. 3. By evaporating the mercury from an amalgam of gold, taking care to ſtir well the maſs near the end of the proceſs. 4. By precipitating gold from its ſolution in aqua regia, by applying to it a ſolution of green vitriol in water, or ſome copper, and perhaps ſome other metallic ſubſtances.

GILEAD, the ſon of Machir, and grandſon of Manaſſeh, had his inheritance allotted him in the mountains of Gilead, from whence he took his name. The mountains of Gilead were part of that ridge which runs from Mount Lebanon ſouthward, on the eaſt of the Holy Land; gave their name to the whole country which lies on the eaſt of the ſea of Galilee, and included the mountainous region called in the New Teſtament *Trachonitis*. Jeremiah (xxii. 6.) ſeems to ſay, that Gilead begins from Mount Libanus. 'Thou art Gilead unto me, and the head of Lebanon.' Jacob, at his return from Meſopotamia, came in ſix days to the mountains of Gilead (Gen. xxxi. 21. &c.) where this patriarch, with Laban his father-in-law, raiſed a heap of ſtones, in memory of their agreement and covenant, and called it *Galeed*, i. e. "an heap of witneſſes," and which Laban called *Jegar-ſahadutha*. Theſe mountains were covered with a ſort of trees abounding with gum, called the *balm of Gilead*, which the Scripture commends much (Jer. viii. 21. xlvi. 11. li. 8). The merchants who bought Joſeph came from Gilead, and were carrying balm into Egypt, (Gen. xxxvii. 25.)

The Gileadites being invaded by the Ammonites, &c. choſe Jephthah for their general, who vanquiſhed all their enemies.

Balm of GILEAD. See AMYRIS, BOTANY *Index*.

GILGAL, in *Ancient Geography*, a place between Jericho and Jordan, noted for the firſt encampment of the Iſraelites on this ſide Jordan, about a mile from Jericho. It ſometimes alſo denotes Galilee, (Joſhua xii. 23.)

GILL, JOHN, D. D. a Proteſtant diſſenting miniſter of the Baptiſt denomination, and the ſon of Edward and Elizabeth Gill, was born at Kettering in Northamptonſhire, Nov. 23. 1697. At a very early period of life, his father, who was a deacon of the Baptiſt church at Kettering, diſcovered in him an uncommon capacity for learning; and his ability for literary purſuits afterwards appeared by the rapid progreſs in whatever became the object of his ſtudy. He was ſent to a grammar ſchool in the neighbourhood; where he ſoon ſurpaſſed thoſe boys who were much his ſeniors in age and as pupils. At this ſchool he continued till he arrived at his 11th year; where he read moſt of the Latin claſſics, and made conſiderable proficiency in the Greek language.

Mr Gill's celebrity as a ſcholar, and his ſtrong attachment to books, were ſoon obſerved by the neighbouring clergy, who frequently met and converſed with him at a bookſeller's ſhop, to which he reſorted for the purpoſe of reading; and indeed ſuch was his application to books, that it became a proverbial ſaying among the common people, "Such a thing is as certain, as that John Gill is in the bookſeller's ſhop."

He left the grammar ſchool, however, early in life. This was occaſioned by the imperious conduct of his maſter, who inſiſted that the children of diſſenting parents ſhould, with other ſcholars that belonged to the eſtabliſhment, attend him to church on week days during the performance of divine ſervice. The diſſenters conſidered this requiſition as a ſtretch of power to which his engagements with them gave no claim; and as it was virtually making conformity a teſt by which his pupils were to expect the benefits of tuition, they reſented his conduct; and the children of thoſe parents that were in affluent circumſtances were removed to ſeminaries where the ſame advantages might be obtained without being ſubject to the impoſitions of clerical bigotry. But as the parents of Mr Gill had it not in their power to confer on him the ſame privilege, the ſame ſteps could not be taken to facilitate his advancement in learning. To pave the way, however, for the completion of his ſtudies, efforts were made by ſeveral miniſters, of different denominations, to get him upon one or other of the funds in London. For this purpoſe ſpecimens of his progreſs in the different branches of literature were tranſmitted to the metropolis: in anſwer to which it was objected, "that he was too young, and that ſhould he continue, as it might be expected he would, to make ſuch rapid advances in his ſtudies, he would go through the common circle before he would be capable of taking care of himſelf, or of being employed in any public ſervice." But theſe formidable objections were of no weight with our young ſcholar: his love of learning was unconquerable. Inſuperable difficulties, it is true, obſtructed the way in which literary eminence is uſually acquired; but theſe difficulties could neither repreſs his ardent deſire of knowledge, nor damp the zeal and application that had marked his former ſtudies. For though his time was daily devoted to the buſineſs of his father; yet he had ſo far improved the hours of leiſure, as to be able, before he arrived at his 19th year, to read all the Greek and Latin authors that fell in his way. He ſtudied logic, rhetoric, moral and natural philoſophy; and learnt the Hebrew language ſo as to read it with eaſe, without any other aſſiſtance than Buxtorf's grammar and lexicon.

Neither the purſuit of learning, however, nor the other neceſſary avocations incumbent on Mr Gill, could eradicate thoſe religious impreſſions received in early life. On November 1. 1716, he made a public profeſſion of his faith before the Baptiſt church at Kettering, and was baptized the ſame day by Mr Thomas Wallis. Of this church Mr Gill had not been long a member before he was called to the work of the miniſtry: ſoon after which, he removed to Higham-Ferrers, with a view to purſue his ſtudies under the direction of Mr Davis; but his ſtay at this place was ſoon interrupted by an invitation from London in 1719, to preach to the Baptiſt church in Horſlydown, over which he was the ſame year, being the 22d of his age, ordained paſtor; which office he ſuſtained upwards of 51 years.

Mr Gill had not been long in London, before rabbinical learning, of which he had before conſiderable knowledge, became an object of purſuit. To facilitate his progreſs through the intricacies of this labyrinth, he contracted an acquaintance with one of the moſt learned Jewiſh rabbies. He read the Targums, the Talmuds, the Rabbot, their ancient commentaries, the book Zohar, and whatever elſe of this kind he was able to procure. Of the oriental languages he made

 himſelf

Gill.

himfelf a complete mafter: in fhort, there was no branch of knowledge that could either enlarge or enrich Biblical learning, which, however difficult, was not attempted and attained: and it may be truly affert-ed, that in this line he had but few equals, and that the annals of literature do not exhibit a character by whom he was excelled.

In 1748 Mr Gill publifhed a commentary on the New Teftament in three volumes folio. The immenfe reading and learning difcoverable in this arduous work, attracted the attention of the Marifchal College and Univerfity of Aberdeen; and procured for him, without either his folicitation or his knowledge, a diploma, creating him doctor in divinity. This intelligence was communicated to the doctor in the moft handfome terms by the profeffors Ofborn and Pollock; who declared, "that on account of his knowledge of the Scriptures, of the Oriental languages, and of Jewifh antiquities, of his learned defence of the Scriptures againft Deifts and Infidels, and the reputation gained by his other works; the univerfity had, without his privity, unanimoufly agreed to confer on him the degree of doctor in divinity."

Dr Gill's fentiments, as a divine, were throughout Calviniftic: "And perhaps no man (fays the Rev. Mr Toplady, a minifter in the church of England) fince the days of Auftin, has written fo largely in defence of the fyftem of grace; and certainly no man has treated that momentous fubject in all its branches, more clofely, judicioufly, and fuccefsfully. What was faid of Edward the Black Prince, that he never fought a battle which he did not win; what has been remarked of the great duke of Marlborough, that he never undertook a fiege which he did not carry; may be juftly accommodated to our great philofopher and divine; who, fo far as the diftinguifhing doctrines of the gofpel are concerned, never befieged an error which he did not force from its ftrong holds, nor ever encountered an adverfary whom he did not baffle and fubdue. His learning and labours, if exceedable, were exceeded only by the invariable fanctity of his life and converfation. From his childhood to his entrance on the miniftry, and from his entrance on the miniftry to the moment of his diffolution, not one of his moft inveterate oppofers was ever able to charge him with the leaft fhadow of immorality. Himfelf, no lefs than his writings, demonftrated that the doctrine of grace does not lead to licentioufnefs. Thofe who had the honour and happinefs of being admitted into the number of his friends, can go ftill farther in their teftimony. They know that his moral demeanor was more than blamelefs: it was from firft to laft confiftently exemplary. And indeed an undeviating confiftency, both in his views of evangelical truths, and in his obedience as a fervant of God, was one of thofe qualities by which his caft of character was eminently marked. He was in every refpect a burning and a fhining light: Burning with love to God, to truth, and to fouls; fhining as an example to believers, in word, in faith, in purity; a pattern of good works, and a model of all holy converfation and godlinefs; and while true religion and found learning have a fingle friend remaining in the Britifh empire, the works and name of Gill will be precious and revered."

He died at Camberwell, October 14, 1771, ad 73 years 10 months and 10 days. In 1718 the Doctor married Mrs Elizabeth Negus; by whom he had many children, two of whom only furvived him. Mrs Gill died in 1764.

Gill ‖ Gilolo.

His works are, A Commentary on the Old and New Teftament in 9 vols folio. A Body of Divinity in 3 vols quarto. The Caufe of God and Truth, 4 vols 8vo. A Treatife concerning the Prophecies of the Old Teftament refpecting the Meffiah. A Differtation on the antiquity of the Hebrew Language, Letters, Vowel Points, and Accents. Sermons on the Canticles, folio; befides a great number of fermons and controverfial pieces on different fubjects.

Gill, a meafure of capacity, containing a quarter of an Englifh pint.

GILLS or Branchiæ of fifhes. See Anatomy *Index*.

GILLINGHAM, a parifh in Dorfetfhire, on the river Stour, near the foreft of its own name; where, anno 1016, King Edmund Ironfide vanquifhed the Danes. It is one of the largeft parifhes in the county, being 41 miles in circuit, containing 64,000 acres. It lies on the borders of Wilts and Somerfet, four miles north-weft of Shaftfbury. It has a manufacture of linen, but the chief produce is grazing and the dairies. Near it are the traces of an ancient refidence of Norman or Saxon kings, 320 feet long and 240 broad, furrounded by a rampart of earth. Henry I. refided here, and King John repaired it at the expence of the county. Edward I. fpent his Chriftmas here in 1270; but the whole of the materials are removed, and the foundation of the houfe only can be traced, which was in the form of the letter L, in length 180 feet by 80 broad, and the foot of the letter 48 by 40; the area of the houfe containing 168,000 fquare feet. It ftood half a mile from the church, on the road to Shafton; encompaffed by a moat, now dry, in fome places nine feet deep and 20 broad. The rampart appears to have been 30 feet thick. Here is a free fchool, a large old building, and a workhoufe, as well as two ftone bridges. In 1694 it received damage of near 4000l. by a fire. Near it is Gillingham foreft, four miles long and one mile broad. The church is a large ancient fabric.

Gillingham, a parifh of Kent, three miles below Chatham, and on the fame fide of the Medway. Part of Chatham dock is in this parifh; and here is a caftle well furnifhed with guns that commands the river, there being no lefs than 170 embrafures for cannon; which would ftop the progrefs of any enemy that fhould happen to make way by Sheernefs fort, before they could reach Chatham. Here are alfo copperas works. At this place 600 Norman gentlemen, who came over in the retinue of the two princes Alfred and Edward, were all barbaroufly murdered by Earl Godwin. It was in remote times the property of the archbifhop of Canterbury, who had here an elegant palace, the old hall of which is now converted into a barn; it is built principally of flint, but the windows are filled up with brick. Near it are the remains of the chapel, &c. and a great part of the whole of its original outer walls may be traced.

GILOLO, a large ifland of the Pacific ocean, lying between 1° S. Lat. and 2° N. Lat. and between 125° and 128° E. Long. It belongs to the Dutch; but

Gilpin. but does not produce any of the fine ſpices, though it lies in the neighbourhood of the ſpice iſlands. The natives are fierce and cruel ſavages.

GILPIN, Bernard, rector of Houghton, diſtinguiſhed by his extraordinary piety and hoſpitality, was deſcended from an ancient and honourable family in Weſtmorland, and born in 1517. As he was bred in the Catholic religion, ſo he for ſome time defended it againſt the reformers, and at Oxford held a diſputation with Hooper afterward biſhop of Worceſter and a martyr for the Proteſtant faith; but was ſtaggered in another diſputation with Peter Martyr, and began ſeriouſly to examine the conteſted points by the beſt authorities. Thus, being preſented to the vicarage of Norton in the dioceſe of Durham, he ſoon reſigned it, and went abroad to conſult eminent profeſſors on both ſides; and after three years abſence returned a little before the death of Queen Mary, ſatisfied in the general doctrines of the reformation. He was kindly received by his uncle Dr Tonſtall, biſhop of Durham; who ſoon after gave him the archdeaconry of Durham, to which the rectory of Eſſington was annexed. When repairing to his pariſh, though the perſecution was then at its height, he boldly preached againſt the vices, errors, and corruptions of the times, eſpecially in the clergy, on which a charge conſiſting of 13 articles was drawn up againſt him, and preſented in form to the biſhop. But Dr Tonſtall found a method of diſmiſſing the cauſe in ſuch a manner as to protect his nephew, without endangering himſelf, and ſoon after preſented him to the rich living of Houghton le Spring. He was a ſecond time accuſed to the biſhop, and again protected; when his enemies, enraged at this ſecond defeat, laid their complaint before Dr Bonner, biſhop of London; who immediately gave orders to apprehend him. Upon which Mr Gilpin bravely prepared for martyrdom; and ordering his houſe ſteward to provide him a long garment that he might make a decent appearance at the ſtake, ſet out for London. Luckily, however, he broke his leg on the journey; which protracted his arrival until the news of the queen's death freed him from all further apprehenſions. Being immediately ſet at liberty, he returned to Houghton, where he was received by his pariſhioners with the ſincereſt joy.

Upon the deprivation of the Popiſh biſhops, he was offered the ſee of Carliſle, which he declined; and confining his attention to his rectory, diſcharged all the duties of his function in the moſt exemplary manner. To the greateſt humanity and courteſy, he added an unwearied application to the inſtruction of thoſe under his care. He was not ſatisfied with the advice he gave in public, but uſed to inſtruct in private; and brought his pariſhioners to come to him with their doubts and difficulties. He had a moſt engaging manner towards thoſe whom he thought well diſpoſed: nay, his very reproof was ſo conducted, that it ſeldom gave offence; the becoming gentleneſs with which it was urged made it always appear the effect of friendſhip. Thus, with unceaſing aſſiduity, did he employ himſelf in admoniſhing the vicious, and engaging the well-intentioned; by which means, in a few years, he made a greater change in his neighbourhood than could well have been imagined. A remarkable inſtance, what reformation a ſingle man may effect, when he hath it earneſtly at heart!

Gilpin. But his hopes were not ſo much in the preſent generation, as in the ſucceeding. It was an eaſier taſk, he found, to prevent vice, than to correct it; to form the young to virtue, than to amend the bad habits of the old. He employed much of his time, therefore, in endeavouring to improve the minds of the younger part of his pariſh; ſuffering none to grow up in an ignorance of their duty; but preſſing it as the wiſeſt part to mix religion with their labour, and amidſt the cares of this life to have a conſtant eye upon the next. He attended to every thing which might be of ſervice to his pariſhioners. He was very aſſiduous in preventing all law ſuits among them. His hall is ſaid to have been often thronged with people, who came to him about their differences. He was not indeed much acquainted with law; but he could decide equitably, and that ſatisfied: nor could his ſovereign's commiſſion have given him more weight than his own character gave him.

His hoſpitable manner of living was the admiration of the whole country. He ſpent in his family every fortnight 40 buſhels of corn, 20 buſhels of malt, and a whole ox; beſides a proportionable quantity of other kinds of proviſion. Strangers and travellers found a cheerful reception. All were welcome that came; and even their beaſts had ſo much care taken of them, that it was humorouſly ſaid, "If a horſe was turned looſe in any part of the country, it would immediately make its way to the rector of Houghton's."

Every Sunday, from Michaelmas till Eaſter, was a ſort of public day with him. During this ſeaſon he expected to ſee all his pariſhioners and their families. For their reception, he had three tables well covered: the firſt was for gentlemen, the ſecond for huſbandmen and farmers, and the third for day labourers. This piece of hoſpitality he never omitted, even when loſſes, or a ſcarcity of proviſion, made its continuance rather difficult to him. He thought it his duty, and that was a deciding motive. Even when he was abſent from home, no alteration was made in his family expences; the poor were fed as uſual, and his neighbours entertained.

But notwithſtanding all this painful induſtry, and the large ſcope it had in ſo extended a pariſh, Mr Gilpin thought the ſphere of his benevolence yet too confined. It grieved him extremely to ſee everywhere, in the pariſhes around him, ſo great a degree of ignorance and ſuperſtition, occaſioned by the ſhameful neglect of the paſtoral care in the clergy of thoſe parts. Theſe bad conſequences induced him to ſupply, as far as he could, what was wanting in others. For this purpoſe, every year he uſed regularly to viſit the moſt neglected pariſhes in Northumberland, Yorkſhire, Cheſhire, Weſtmorland, and Cumberland; and that his own pariſh in the mean time might not ſuffer, he was at the expence of a conſtant aſſiſtant. In each place he ſtaid two or three days; and his method was, to call the people about him, and lay before them, in as plain a way as poſſible, the danger of leading wicked or even careleſs lives; explaining to them the nature of true religion; inſtructing them in the duties they owed to God, their neighbour, and themſelves; and ſhowing them how greatly a moral and religious conduct would contribute to their preſent as well as future happineſs.

As Mr Gilpin had all the warmth of an enthuſiaſt, though

Gilpin. though under the direction of a very calm and sober judgment, he never wanted an audience, even in the wildest parts; where he roused many to a sense of religion, who had contracted the most inveterate habits of inattention to every thing of a serious nature. And wherever he came, he used to visit all the gaols and places of confinement; few in the kingdom having at that time any appointed minister. And by his labours, and affectionate manner of behaving, he is said to have reformed many very abandoned persons in those places. He would employ his interest likewise for such criminals whose cases he thought attended with any hard circumstances, and often procured pardons for them.

There is a tract of country upon the border of Northumberland, called *Readſ-dale* and *Tine-dale*, of all barbarous places in the north at that time the most barbarous. Before the Union, this place was called the *debateable land*, as subject by turns to England and Scotland, and the common theatre where the two nations were continually acting their bloody scenes. It was inhabited by a kind of desperate banditti, rendered fierce and active by constant alarms: they lived by theft, used to plunder on both sides of the barrier; and what they plundered on one, they exposed to sale on the other; by that means escaping justice. And in this dreadful country, where no man would even travel that could help it, Mr Gilpin never failed to spend some part of every year.

He generally chose the Christmas holidays for his journey, because he found the people at that season most disengaged, and most easily assembled. He had set places for preaching, which were as regularly attended as the assize towns of a circuit. If he came where there was a church, he made use of it: if not, of barns, or any other large building; where great crowds of people were sure to attend him, some for his instructions, and others for his charity. This was a very difficult and laborious employment. The country was so poor, that what provision he could get, extreme hunger only could make palatable. The inclemency of the weather, and the badness of the roads through a mountainous country, and at that season covered with snow, exposed him likewise often to great hardships. Sometimes he was overtaken by the night, the country being in many places desolate for several miles together, and obliged to lodge out in the cold. At such times, we are told, he would make his servant ride about with his horses, whilst himself on foot used as much exercise as his age and the fatigues of the preceding day would permit. All this he cheerfully underwent; esteeming such services well compensated by the advantages which he hoped might accrue from them to his uninstructed fellow creatures.

The disinterested pains he took among these barbarous people, and the good offices he was always ready to do them, drew from them the warmest and sincerest expressions of gratitude. Indeed, he was little less than adored among them, and might have brought the whole country almost to what he pleased. One instance that is related, shows how greatly he was revered. By the carelessness of his servants, his horses were one day stolen. The news was quickly propagated, and every one expressed the highest indignation at the fact. The thief was rejoicing over his prize, when, by the report of the country, he found whose horses he had taken. Terrified at what he had done, he instantly came trembling back, confessed the fact, returned the horses, and declared he believed the devil would have seized him directly, had he carried them off knowing them to have been Mr Gilpin's.

We have already taken notice of Mr Gilpin's uncommonly generous and hospitable manner of living. The value of his rectory was about 400l. a year: an income, indeed, at that time very considerable, but yet in appearance very disproportionate to the generous things he did: indeed, he could not have done them; unless his frugality had been equal to his generosity. His friends, therefore, could not but wonder to find him, amidst his many great and continual expences, entertain the design of building and endowing a grammar school: a design, however, which his exact economy soon enabled him to accomplish, though the expence of it amounted to upwards of 500l. His school was no sooner opened, than it began to flourish; and there was so great a resort of young people to it, that in a little time the town was not able to accommodate them. He put himself, therefore, to the inconvenience of fitting up a part of his own house for that purpose, where he seldom had fewer than 20 or 30 children. Some of these were the sons of persons of distinction, whom he boarded at easy rates: but the greater part were poor children, whom he not only educated, but clothed and maintained: he was at the expence likewise of boarding in the town many other poor children. He used to bring several every year from the different parts where he preached, particularly Readſ-dale and Tine-dale; which places he was at great pains in civilizing, and contributed not a little towards rooting out that barbarism which every year prevailed less among them.

As to his school, he not only placed able masters in it, whom he procured from Oxford, but himself likewise constantly inspected it. And, that encouragement might quicken the application of his boys, he always took particular notice of the most forward: he would called them *his own scholars*, and would send for them often into his study, and there instruct them himself. One method used by him to fill his school was a little singular. Whenever he met a poor boy upon the road, he would make trial of his capacity by a few questions, and if he found it such as pleased him, he would provide for his education. And besides those whom he sent from his own school to the universities, and there wholly maintained, he would likewise give to others, who were in circumstances to do something for themselves, what farther assistance they needed. By which means he induced many parents to allow their children a liberal education, who otherwise would not have done it. And Mr Gilpin did not think it enough to afford the means only of an accademical education to these young people; but endeavoured to make it as beneficial to them as he could. He still considered himself as their proper guardian; and seemed to think himself bound to the public for their being made useful members of it, as far as it lay in his power to make them so. With this view he held a punctual correspondence with their tutors; and made the youths themselves frequently write to him, and give him an account of their studies. So solicitous indeed was he about

about them, knowing the many temptations to which their age and ſituation expoſed them, that once every other year he generally made a journey to the univerſities to inſpect their behaviour. And this uncommon care was not unrewarded; for many of his ſcholars became ornaments to the church, and exemplary inſtances of piety.

To the account that hath been already given of Mr Gilpin's hoſpitality and benevolence, the following particulars may be added. Every Thurſday throughout the year, a very large quantity of meat was dreſſed wholly for the poor; and every day they had what quantity of broth they wanted. Twenty-four of the pooreſt were his conſtant penſioners. Four times in the year a dinner was provided for them; when they received from his ſteward a certain quantity of corn, and a ſum of money: and at Chriſtmas they had always an ox divided among them.

Whenever he heard of any in diſtreſs, whether of his own pariſh or any other, he was ſure to relieve them. In his walks abroad, he would frequently bring home with him poor people, and ſend them away clothed as well as fed. He took great pains to inform himſelf of the circumſtances of his neighbours, that the modeſty of the ſufferer might not prevent his relief. But the money beſt laid out was, in his opinion, that which encouraged induſtry. It was one of his greateſt pleaſures to make up the loſſes of his laborious neighbours, and prevent their ſinking under them. If a poor man had loſt a beaſt, he would ſend him another in its room: or if any farmer had had a bad year, he would make him an abatement in his tythes. Thus, as far as he was able, he took the misfortunes of his pariſh upon himſelf; and, like a true ſhepherd, expoſed himſelf for his flock. But of all kinds of induſtrious poor, he was moſt forward to aſſiſt thoſe who had large families; ſuch never failed to meet with his bounty, when they wanted to ſettle their children in the world.

In the diſtant pariſhes where he preached, as well as in his own neighbourhood, his generoſity and benevolence were continually ſhowing themſelves; particularly in the deſolate parts of Northumberland. "When he began his journey," ſays an old manuſcript life of him, "he would have 10 pounds in his purſe; and, at his coming home, he would be 20 nobles in debt, which he would always pay within a fortnight after. In the gaols he viſited, he was not only careful to give the priſoners proper inſtructions, but uſed to purchaſe for them likewiſe what neceſſaries they wanted.

Even upon the public road, he never let ſlip an opportunity of doing good. He has often been known to take off his cloak, and give it to a half naked traveller: and when he has had ſcarce money enough in his pocket to provide himſelf a dinner, yet would he give away part of that little, or the whole, if he found any who ſeemed to ſtand in need of it. Of this benevolent temper, the following inſtance is preſerved. One day returning home he ſaw in a field ſeveral people crowding together; and judging ſomething more than ordinary had happened, he rode up, and found that one of the horſes in a team had ſuddenly dropped down, which they were endeavouring to raiſe; but in vain, for the horſe was dead. The owner of it ſeemed much dejected with his misfortune; and declaring how grievous a loſs it would be to him, Mr Gilpin bade him not be diſheartened: "I'll let you have (ſays he), honeſt man, that horſe of mine," and pointed to his ſervant's.—"Ah! maſter (replied the countryman), my pocket will not reach ſuch a beaſt as that." "Come, come (ſaid Mr Gilpin), take him, take him; and when I demand my money, then thou ſhalt pay me."

This worthy and excellent divine, who merited and obtained the glorious titles of *the Father of the Poor*, and the *Apoſtle of the North*, died in 1583, in the 66th year of his uge.

GILTHEAD. See Sparus, Ichthyology *Index*.

GIN. See Geneva.

Gin, in mechanics, a machine for driving piles, fitted with a windlaſs and winches at each end, where eight or nine men heave, and round which a rope is reeved that goes over the wheel at the top: one end of this rope is ſeized to an iron monkey, that hooks to a beetle, of different weights, according to the piles they are to drive, being from eight to thirteen hundred weight; and when hove up to a croſs piece, near the wheel, it unhooks the monkey, and lets the beetle fall on the upper end of the pile, and forces the ſame into the ground: then the monkey's own weight overhauls the windlaſs, in order for its being hooked again to the beetle.

GINGER, the root of a ſpecies of amomum. See Amomum, Botany *Index*.

GINGIDIUM, a genus of plants, belonging to the pentandria claſs. See Botany *Index*.

GINGIRO, or Zindero, a ſmall territory of Africa, to the ſouth of Abyſſinia, being ſeparated from it by the river Zebee, by which it is alſo almoſt entirely ſurrounded. This river is extremely large, having more water than the Nile, and being much more rapid; ſo that, during the rainy ſeaſon, it would be altogether impaſſable, were it not for the large rocks which are in its channel. The extreme difficulty which occurs in paſſing this river, however, is the means of preſerving the kingdom of Gingiro, which would otherwiſe be conquered in a ſingle ſeaſon by the Galla.

The moſt remarkable particular with regard to this kingdom is, that the ſovereign is a profeſſed votary of the devil. "This ſuperſtition (ſays Mr Bruce) reaches down all the weſtern ſide of the continent on the Atlantic ocean, in the countries of Congo, Angola, and Benin. In ſpite of the firmeſt foundation in true philoſophy, a traveller, who decides from the information and inveſtigation of facts, will find it very difficult to treat theſe appearances as abſolute fictions, or as owing to the ſuperiority of cunning of one man in overreaching another. For my own part, I confeſs, I am equally at a loſs to aſſign reaſons for diſbelieving the fiction on which their pretenſions to ſome preternatural information are founded, as to account for them by the operation of ordinary cauſes."

In this kingdom every thing is conducted, or pretended to be conducted, by magic; and all thoſe ſlaves, which in other African countries are ſold to Europeans, are here ſacrificed to the devil, human blood being a neceſſary part in all their accurſed ſolemnities. "How far (ſays Mr Bruce) this reaches to the ſouthward, I do not know; but I look upon this to be the geographical bounds of the reign of the

devil.

devil on the north side of the equator in the peninsula of Africa."

With regard to this country, very little farther is known, than some of the customs of the people transiently picked up by the Jesuit missionaries in Abyssinia. From them we learn, that the kingdom is hereditary in one family, though it does not regularly descend to the eldest son, the king being chosen by the nobles; in which they resemble their neighbours the Abyssinians. When the king dies, his body is wrapped in a fine cloth, and a cow is killed. The body so wrapped up is next enclosed in the cow's skin; and all the princes of the royal family fly and hide themselves in the bushes, while those who are intrusted with the election enter the thickets, beating about everywhere as if for game. At last a bird of prey, called in their language *liber*, appears, and hovers over the person destined to be king; crying and making a great noise wi hout quitting his station. By this means the person destined to be elected is found out, surrounded, as is reported, by lions, tigers, panthers, and other wild beasts; all which are supposed to be brought by the power of magic or of the devil.—After the king is found, he flies upon those who came in quest of him with great fury, killing and wounding as many as he can reach, until at last he is dragged to the throne whether he will or not. One particular family have the privilege of conducting him to the throne; and if they should not happen to find him at first, they have a right to take him out of the hands of those who did so; and thus another battle ensues before the vacant throne can be filled. Lastly, Before he enters his palace, two men must be killed; one at the foot of a tree by which the house is supported; and the other at the threshold of the door, which is besmeared with the blood of the victim. It is the particular privilege of one family to afford these victims; and so far are they from seeking to avoid this fate, that they glory in the occasion, and willingly offer themselves to meet it. This last particular, Mr Bruce says, he had in Abyssinia from people coming from Gingiro.

GINGIVÆ, the gums. See Gums.

GINGLYMUS, in *Anatomy*, one of the species of articulation. It is that jointure of the bones where each bone mutually receives the other; so that each bone both receives and is received. See ANATOMY *Index*.

GINKGO, the MAIDEN-HAIR TREE. See MAURITIA, BOTANY *Index*.

GINORA, a genus of plants belonging to the dodecandria class, and in the natural method ranking with those of which the order is doubtful. See BOTANY *Index*.

GINSENG. See PANAX, BOTANY and MATERIA MEDICA *Index*.

GIOIA, FLAVIO, of Amalfi, in the kingdom of Naples, the celebrated mathematician; who, from his knowledge of the magnetic powers, invented the mariner's compass, by which the navigation of the Europeans was extended to the most distant regions of the globe: before this invention, navigation was confined to coasting. The king of Naples being a younger branch of the royal family of France, he marked the north point with a fleur-de-lis, in compliment to that country. It is said the Chinese knew the compass long before; be this as it may, the Europeans are indebted to Gioia for this invaluable discovery. He flourished A. D. 1300.

GIORDANA, LUCA. See JORDANO.

GIORGIONE, so called from his comely aspect, was an illustrious Venetian painter, born in 1478. He received his first instructions from Giovanni Bellino; but studying afterwards the works of Leonardo da Vinci, he soon surpassed them both, being the first among the Lombards who found out the admirable effects of strong lights and shadows. Titian became his rival in this art; and was so careful in copying the life, that he excelled Giorgione in discovering the delicacies of nature, by tempering the boldness of his colouring. The most valuable piece of Giorgione in oil is that of Christ carrying his cross, now in the church of San Rovo in Venice; where it is held in great veneration. He died of the plague young, in 1511.

GIRAFFE. See CERVUS, MAMMALIA *Index*.

GIRALD, BARRY, or *Giraldus Cambrensis*. See BARRY.

GIRALDI, LILIO GREGORIO, an ingenious critic, and one of the most learned men that modern Italy has produced, was born at Ferrara in 1479. He was at Rome when it was plundered by the emperor Charles V.; and having thus lost all he had, and being tormented by the gout, he struggled through life with ill fortune and ill health. He wrote, nevertheless, 17 performances, which were collected and published at Basil in 2 vols. folio in 1580, and at Leyden in 1696. Authors of the first rank have bestowed the highest eulogies on Giraldus; particularly Casaubon and Thuanus.

GIRALDI, *John Baptist Cintio*, an Italian poet of the same family with the foregoing Lilio, was born in 1504. He was secretary to the duke of Ferrara, and afterwards became professor of rhetoric at Pavia. He died in 1573. His works, which consist chiefly of tragedies, were collected and published at Venice by his son Celso Giraldi, in 1583; and some scruple not to rank him among the best tragic writers Italy has produced.

GIRARDON, FRANCIS, a celebrated French architect and sculptor, born at Troyes in 1627. Louis XIV. being informed of his great talents, sent him to Rome with a pension of 1000 crowns. At his return into France, he laboured for the royal palaces and the gardens of Versailles and Trianon; where there are many of his works executed in bronze and in marble, from the designs of Charles le Brun. The mausoleum of Cardinal de Richelieu, in the Sorbonne, and the equestrian statue of Louis XIV. at the Place de Vendome, where the statue and horse are cast in one piece, pass for his most excellent performances. Girardon was professor, rector, and chancellor, of the Academy of Painting and Sculpture; and had the post of inspector general of all the works done in sculpture. He died in 1715.

GIRDERS, in *Architecture*, the largest pieces of timber in a floor. Their ends are usually fastened into the summers, or brest summers; and the joists are framed at one end to the girders.

By the statute for rebuilding London, no girder is to to be lefs than ten inches into the wall, and their ends to be always laid in loam, &c.

GIRDLE (*Cingulus* or *Zona*), a belt or band of leather or other matter, tied about the reins, to keep that part more firm and tight.

It was anciently the cuftom for bankrupts and other infolvent debtors to put off and furrender their girdle in open court. The reafon of this was, that our anceftors ufed to carry all their neceffary utenfils, as purfe, keys, &c. tied to the girdle; whence the girdle became a fymbol of the ftate. Hiftory relates that the widow of Philip I. duke of Burgundy, renounced her right of fucceffion by putting off her girdle upon the duke's tomb.

The Romans always wore a girdle to tuck up the tunica when they had occafion to do any thing: this cuftom was fo general, that fuch as went without girdles, and let their gowns hang loofe, were reputed idle diffolute perfons.

Maiden's or *Virgin's* GIRDLE. It was a cuftom among the Greeks and Romans for the hufband to untie his bride's girdle. Homer, lib. xi. of his Odyffey, calls the girdle παρθενιην ζωνην, *maid's girdle*. Feftus relates, that it was made of fheep's wool, and that the hufband untied it in bed; he adds, that it was tied in the Herculanean knot; and that the hufband unloofed it, as a happy prefage of his having as many children as Hercules, who at his death left feventy behind him.

The poets attribute to Venus a particular kind of girdle called *ceftus*, to which they annexed a faculty of infpiring the paffion of love.

GIRGASHITES, or GERGESENES, an ancient people of the land of Canaan, whofe habitation was beyond the fea of Tiberias, where we find fome footfteps of their name in the city of *Gergefa*, upon the lake of Tiberias. The Jewifh doctors inform us, that when Jofhua firft came into the land of Canaan, the Girgafhites took a refolution rather to forfake their country than fubmit to the Hebrews, and accordingly retired into Africa. Neverthelefs, it is certain that a good number of them ftaid behind, fince Jofhua (xxiv. 11.) informs us that he fubdued the Girgafhites, and they whom he overcame were certainly on this fide Jordan.

GIRGENTI, a town of Sicily, which occupies part of the fite of the ancient *Agrigentum*. It has only one ftreet fit for carriages. It is inhabited by 15,000 perfons; but has no remarkable buildings or works of art that deferve mention: the only antiquities to be feen were a Latin infcription of the time of the Antonines, as is pretended, relative to fome affociation between Agrigentum and Lilybæum; and a piece of ancient mafonry in the foundations of a church pretended to be the remains of a temple of Jupiter. At fome diftance, on the old ground in the vale, ftands the cathedral, a clumfy building patched up by barbarous architects with various difcordant parts. This church is enriched with no works of modern painters or fculptors that claim any title to praife, but the baptifmal font is made out of an ancient farcophagus faced with very beautiful baffo relievos. This fee is the richeft in Sicily, but has the character of being lefs enlightened and polifhed than the reft of the ifland. Among the curiofities belonging to the cathedral is an Etrufcan vafe of rare fize and prefervation. There are alfo fome golden pateras of extreme rarity. The monaftery of San Nicolo ftands on a little eminence in the centre of the old city, admirably fituated. The range of hills towards the fouth-eaft finks gradually, fo as to admit a noble reach of fea and of plain, terminated on each fide by thick groves of fruit trees. Above appear the remains of ancient grandeur, wonderfully contrafted with the humble ftraw cottages built at their feet. In the orchard of this convent is a fquare building with pilafters, which is fuppofed to have been part of the palace of the Roman prætor.

Girgenti has the convenience of a port; for which, however, it is lefs indebted to its natural fituation than to the recent affiftance of art. The harbour is formed by means of a pier carried out in three fides of an octagon, with a battery at the head; the lighthoufe is to be erected on the cliffs on fhore, as there is no poffibility of raifing it high enough on the mole without danger of finking. The work is admirable as to ftrength and neatnefs, but the intention of creating a fafe and complete haven has not been fully anfwered; the Sirocco commands it entirely, and drives in great quantities of fand, which it is feared will in time choke up the port; even now fhips of burden find it difficult to get in, but the Caricatore is confiderable, and the magazines in the rocks along the fhore are very fpacious.

GIRONNE, or GIRONNY, in *Heraldry*, a coat of arms divided into girons, or triangular figures, meeting in the centre of the fhield, and alternately colour and metal.

GIRT, the fituation of a fhip which is moored fo ftrait by her cables, extending from the *hawfe* to two diftant anchors, as to be prevented from fwinging or turning about according to any change of the wind or tide, to the current of which her head would otherwife be directed. The cables are extended in this manner, by a ftrong application of mechanical powers within the fhip; fo that when fhe veers, or endeavours to fwing about, her fide bears upon one of the cables, which catches on her heel, and interrupts her in the act of traverfing. In this pofition fhe muft ride with her broadfide to the wind or current, till one or both of the cables are flackened.

GISCO, fon of Himilco the Carthaginian general, was banifhed from Carthage by the influence of his enemies. Being afterwards recalled, he was made general in Sicily againft the Corinthians, about 309 years before the Chriftian era, and by his fuccefs and intrepidity he obliged the enemies of his country to fue for peace. See CARTHAGE.

GISBOROUGH, a town of England, in the weft riding of Yorkfhire, on the road from Whitby to Durham, 224 miles from London, and four miles from the mouth of the Tees, where is a bay and harbour for fhips. It had formerly an abbey, which was once the common burial place of the nobility of thefe parts, and its church by the ruins feems to have been equal to the beft cathedrals in England. The foil, befides its fertility in pafture and a conftant verdure adorned with plenty of field flowers almoft all the year, has earths of fundry colours, fome iron, and mines of alum, which were firft difcovered in the reign of King James I. and have been fince very much improved. Sir Paul Pindar,

dar, who first farmed them, paid rents to the king 12,500l. to the Earl Musgrave 1640l. and to Sir William Penniman 600l. and had moreover 800 men by sea and land in constant pay; yet he was a considerable gainer, because there was then scarce any other to be had, and the price was 26l. a ton; but now there are several other alum works in this county, which have taken a great part of the trade from hence; so that the works here have for some years lain neglected.

GITTITH, a Hebrew word occurring frequently in the Psalms, and generally translated *wine presses*. The conjectures of interpreters are various concerning this word. Some think it signifies a sort of musical instrument; others, that the psalms with this title were sung after the vintage; lastly, others, that the hymns of this kind were invented in the city of Gath. Calmet is rather of opinion, that it was given to the class of young women or songstresses of Gath to be sung by them, Psal. viii. 1. lxxxi. 1. lxxxxiv. 1. Dr Hammond thinks that the psalms with this title were all set to the same tune, and made on Goliath the Gittite.

GIULA, a strong town of Upper Hungary, on the frontiers of Transylvania. It was taken by the Turks in 1566, and retaken by the Imperialists in 1695. It is seated on the river Keresblan, in E. Long. 21. 1. N. Lat. 46. 25.

GIUSTANDEL, a large and strong town of Turkey in Europe, and in Macedonia, with a Greek archbishop's see. It is seated near the lake Ochrida, in E. Long. 20. 50. N. Lat. 41. 10.

GLACIERS, a name given to some very extensive fields of ice among the ALPS. Mr Coxe observes of these mountains in general, that they are composed of many parallel chains, the highest of which occupy the centre, and the others gradually diminish in proportion as we recede from thence. The central chain appears covered with pointed rocks; all parts of which, that are not absolutely perpendicular, lie hid under perpetual snow and ice even in summer. On each side of this ridge are fertile and cultivated valleys, interspersed with numerous villages, and watered by numerous streams. The elevated peaks of the central chain are covered with snow: but their declivities, excepting those that are extremely steep, have all a covering of ice as well as snow; the intermediate parts being filled with vast fields of ice, terminating in the cultivated valleys above mentioned. The same phenomena, though on a smaller scale, occur in those chains that are at a distance from the principal one: In those which are most remote, no ice, and scarcely any snow, is observed, unless upon some of the most elevated summits; and the mountains diminishing in height and ruggedness, appear covered with verdure, until at last they terminate in small hills and plains.

Thus the glaciers may be divided into two sorts; one occupying the deep valleys situated in the bosom of the Alps, and distinguished by the name of Ice valleys; the others are those which clothe the declivities and sides of the mountains. These two kinds of glaciers are distinguished by Mr Coxe into the upper and lower glaciers.

The lower glaciers are by far the most considerable; some of them extending several leagues in length. They do not communicate with each other, as has been generally supposed, few of them being parallel to the central chain; but, stretching mostly in a transverse direction, are bordered at the higher extremity by inaccessible rocks, and at the lower extending into the cultivated valleys. The thickness of the ice varies in different parts. In the glacier des Bois, which extends more than 15 miles in length, and upwards of three in breadth, M. Saussure found it generally from 80 to 100 feet; but he was credibly informed, that in some places it was not less than 600 feet, and even more. These vast masses of ice usually rest on an inclined plane; where, being pushed forward by their own weight, and but weakly supported by the rugged rocks beneath them, they are intersected by large crevices, and have an appearance of walls, pyramids, &c. according to the position of the eye in viewing them. In those parts, however, where they lie upon even ground, or such as has only a gentle inclination, the surface of the ice is nearly uniform, the crevices being few and narrow, and the glacier being crossed by travellers on foot without any difficulty. The surface of the ice is rough and granulated, so that people may walk upon it, excepting such places as have a steep descent. It is opaque, full of small bubbles about the size of a pea, very porous, and greatly resembles a mixture of snow and water congealed. A vast quantity of stones and earth falls down from the mountains upon the glaciers, and are by them thrown off on each side according to the descent of the ice, as will be afterwards explained. The place on which these rest is more hard and elevated than the rest of the ice, and is very difficult to walk upon; the earth is likewise laid upon them in such regular heaps, that it appears to have been done by art. This collection of earth and stones is termed by the natives the *Moraine*.

Mr Coxe, who visited the glacier des Bois, informs us, that the appearance of it at a distance was so tremendous, that it seemed impracticable to cross it. Numerous and broad chasms intersected it in every direction; but entering upon it, the company found that courage and activity were only required to accomplish the task. They had large nails in their shoes, and spiked sticks; which on this occasion were found to be particularly serviceable. Having passed the moraine, and descended upon the glacier itself, they found the ice softened by a warm wind which rendered it less slippery than usual. Having walked across it for about a quarter of an hour, they came again to the moraine, along which they continued their journey for half an hour, and then entered upon the great body of the glacier. "Here (says Mr Coxe) it was curious to observe the numerous little rills produced by the collection of drops occasioned by the thawing of the ice on the upper part of the glacier: these little rills hollow out small channels, and, torrent-like, precipitate themselves into the chasms with a violent noise, increasing the body of waters formed by the melting of the interior surface, and finding an outlet under the immense arch of ice in the valley of Chamouni, from which the Arveron rushes." As our traveller proceeded on his journey, he was surprised by the noise of a large fragment of rock which had detached itself from one of the highest needles, and bounded from one precipice to another with great rapidity; but before it reached the plain, it was almost reduced to dust. "Having proceeded about an hour (says

Glaciers.

(says he) we were astonished with a view more magnificent than imagination can conceive: hitherto the glaciers had scarcely answered my expectations, but now they far surpassed them. Nature had clad herself in all her terrors. Before us was a valley of ice 20 miles in extent, bounded by a circular glacier of pure unbroken snow, named Takul, which leads directly to the foot of Mount Blanc, and is surrounded by large conical rocks, terminating in sharp points like the towers on an ancient fortification; to the right rose a range of magnificent peaks, the intervals filled with glaciers; and far above the rest, the magnificent summit of Mount Blanc, his highest point obscured with clouds. He appeared of such immense magnitude, that, at his presence, the circumjacent mountains, however gigantic, seemed to shrink before him, and *hide their diminished heads*. In half an hour we arrived at the moraine, which forms a boundary of the valley, crossed it, and proceeded upon a body of ice about three quarters of a mile broad. Here the ice was more even and free from chasms than in the great valley. We then passed a second moraine, and beyond that another mass of ice to a third moraine: descending from thence we came upon the last ridge of ice, broader considerably than the two former, and full of large chasms: it is separated from the rock only by a very narrow moraine. These moraines contain great quantities of crystal."

They continued to ascend the valley of ice, the scene constantly increasing in magnificence and horror; and having walked about five miles on the ice, they arrived at last at the foot of the eminence named *Couvercle*, where they were obliged to quit the ice. The doing this was extremely dangerous, and at one place very tremendous. It was a bulging smooth rock, with a precipice of considerable depth terminated by a vast crevice in the ice, which seemed to stop all further progress: a small hollow in the middle, however, afforded room for one foot; and having fixed this, they sprung over to the other side, being helped and directed by the guides who went over first. Having gained the top of the Couvercle, they had a view of three of the glaciers, viz. that of *Talefre* to the left, *l'Echaut* in front, and *Takul* on the right; all uniting in that great one called the *Glacier de Bois*. The Couvercle itself is a most extraordinary rock, having the appearance of a large irregular building with many sides; the substance of which is granite. Having reached the top, they were surprised with a thunder storm, from which they took shelter under an impending rock. The view was exceedingly magnificent; the glaciers appearing like a rugged expanse of frozen sea bounded by gigantic rocks, and terminated by Mount Blanc. A single rock appeared of a triangular figure covered with Alpine plants; and which by reason of its contrast with the rugged and snowy mountains in the neighbourhood, has obtained the name of the *Garden*. During this, as well as other excursions among the Alps, Mr Coxe had occasion to observe that the colour of the sky was of a much deeper blue than in the lower regions.

The upper glaciers may be subdivided into those which cover the summits, and those which extend along the sides of the Alps. Those on the very summit, however, though they have the appearance of ice, are not so in reality, but consist entirely of snow hardened by the extreme cold. M. Saussure found that which covered the top of Mount Blanc to be penetrable, though with difficulty, by a stick; but below this hard crust was a soft snow without coherence. The sides are covered with a mixture of ice and snow; by reason of the superior power of the summer sun to dissolve the snow, which afterwards congeals into hard ice.

Several conjectures have been made concerning the formation of these extraordinary bodies of ice. Mr Coxe agrees with M. Gruner in opinion, that they are produced by the continual dissolution of the snow in summer, and its congelation by the succeeding frosts. Hence, on the summits of the mountains where the sun has very little power, the glacier is soft, and contains no ice: as we descend the mountains the consistence becomes firmer, because there is a considerable mixture of snow water, the congelation of which augments the hardness; and in the valleys, the glacier is hardest of all, because the portion of water is there much superior to that of the snow. Hence it seems plain that the glaciers derive their origin from the melting of the snow on the upper parts of the mountains, and the congelation of the water as it advances: and to this cause M. Saussure adds the quantity of snow which often rolls down into the valleys, and congeals along with the water just mentioned.

Another question concerning the glaciers naturally occurs, namely, Whether they are to be considered as in a state of increase or diminution? Mr Coxe is of opinion, that they occasionally increase and decrease; in proof of which he adduces the following observation: "The borders of the glacier of Montanvert are mostly skirted with trees: towards its base a vast arch of ice rises to near 100 feet in height; under which the river Arveron rushes with considerable force, and in a large body of water. As we approached the ice, we passed through a wood of firs: those trees which stand at a little distance from the arch are about 80 feet high, and are undoubtedly of a very great age. Between these and the glacier the trees are of a later growth; as is evident from their texture and inferior size. Others, still smaller, have been overturned and enveloped in the ice: there seems to be a kind of regular gradation in the age of these several trees, from the largest which are standing to the smallest that lie prostrate."—Hence our author concludes, that the glacier once extended as far as the row of small firs; but that upon its gradual dissolution, a number of trees shot up on the spot it had occupied; since which time the ice has again advanced, and overturned the last grown trees before they had attained to any considerable height.—This he thinks also confirmed by the following fact.—"Large stones of granite are usually found at a small distance from the extremities of the glacier. These stones have certainly fallen from the mountains upon the ice; have been carried on in its progress; and have tumbled into the plain upon the dissolution or sinking of the ice which supported them. These stones, which the natives call *Moraine*, form a kind of border towards the foot of the valley of ice, and have been pushed forward by the glacier in its advances: they extend even to the place occupied by the larger pines."

In opposition to those who maintain that there is a constant accumulation of ice and snow in the Alpine regions, our author makes the following remarks: 1. Between the years 1776 and 1785 the glacier of Grindelevald

Grindelevald had diminiſhed to ſuch a degree, that the ſpot which its extremity occupied in the former year, was at leaſt 400 paces from that occupied by it in the latter. 2. In the year 1785 the Murailles de Glace, which in 1776 he had deſcribed as forming the border of the glacier of Boſſon, no longer exiſted; and young trees had ſhot up in the parts which were then covered by the glacier of Montanvert. Still, however, it may be urged, that theſe changes only take place in the valleys where the power of the ſun is conſiderable; and that from thence we cannot form any adequate idea of what paſſes in the more elevated regions, where in all probability more ſnow falls than can be diſſolved. In ſupport of this opinion, it is alleged, that the cold produced by the maſs of ice already formed ought to augment it ſtill more; and that within the memory of the preſent generation, many places have been covered with ice which were not ſo before. To theſe arguments, however, Mr Coxe replies, that the cauſes, which diminiſh the ice in the upper regions, are no leſs powerful than the cold which tends to augment it. Theſe are, 1. Rain or ſleet; which falling upon the lower glaciers, thaw the ice, increaſe the rills on its ſurface, excavate channels, and in many ways tend to diminiſh its quantity. 2. Evaporation, which takes place even from the ſurface of the ice itſelf, acts ſtill more powerfully; and its action is not confined to any particular ſeaſon. 3. The falling of the ſnow and ice; both that which comes gradually from the clouds, and that which deſcends from the mountains in great maſſes, called by the natives *avalanches*. When theſe laſt fall down into milder regions, though ſometimes they may reſiſt the influence of the ſun and form ice valleys, yet they generally diſſolve. They are moſt common in the upper glaciers, though ſometimes they deſcend upon the lower, while the gradual deſcent of ſnow from the clouds, which chiefly takes place in the lower, contributes very much to leſſen the maſs. 4. All the lower glaciers or valleys of ice reſt on an inclined plane, are hollow, and undermined by torrents which are conſtantly flowing from the upper glaciers, as well as from their own lowermoſt ſurface. Their foundation being thus conſtantly diminiſhing, the lower glaciers are carried imperceptibly forward into the cultivated fields, where an end is neceſſarily put to their progreſs by the heat of the ſun. Hence we may ſee the reaſon of that ſtrange phenomenon taken notice of by Mr Coxe, that with one hand he could touch ripe corn, and with the other ſolid ice. This deſcent of the glacier is demonſtrable from the trees overturned by it, and the moraine always obſerved at the bottom of the lower glaciers. 5. The heat of the ſun is an evident cauſe of the diminution of the glaciers. To this Mr Coxe adds another cauſe leſs generally known, viz. the warm winds which blow by night as well as by day both in the upper and lower glaciers. "Theſe warm winds (ſays he) are during ſummer ſo common in thoſe parts, that I never croſſed a glacier without feeling in ſome particular poſitions a warmth ſimilar to the air of a hot bath." 6. Another cauſe is the mean temperature of the earth itſelf; which, where it is not expoſed to the piercing cold of the atmoſphere, is found to have a temperature always above the freezing point. As the vaſt thickneſs of the ſuperincumbent ice, therefore, is in the preſent caſe abundantly ſufficient to prevent the acceſs of the atmoſphere, it is plain that the lower ſurface of it muſt, by being in contact with the earth, continually decay.—With regard to the other argument drawn from the known increaſe of the ice in ſome places, Mr Coxe does not deny it; but inſiſts, that there is no continual increaſe of the whole, but that if it increaſes in ſome places, it diminiſhes in others; and his opinion in this reſpect was confirmed by thoſe who frequent the mountains.

GLACIS, in building, an eaſy inſenſible ſlope or declivity.

The deſcent of the glacis is leſs ſteep than that of the talus. In gardening, a deſcent ſometimes begins in talus, and ends in glacis.

The glacis of the corniche, is an eaſy imperceptible ſlope in the cymatium, to promote the deſcent and draining off the rain water.

GLACIS, in *Fortification*, that maſs of earth which ſerves as a parapet to the covered way, ſloping eaſily towards the champaign or field.

GLADE, in *Gardening* and *Agriculture*, an opening and light paſſage made through a wood, by lopping off the branches of trees along that way,

GLADIATORS, in antiquity, perſons who fought, generally in the arena at Rome, for the entertainment of the people.

The gladiators were uſually ſlaves, and fought out of neceſſity; though ſometimes freemen made profeſſion thereof, like our prize-fighters, for a livelihood.

The Romans borrowed this cruel diverſion from the Aſiatics: ſome ſuppoſe that there was policy in the practice, the frequent combats of gladiators tending to accuſtom the people to deſpiſe dangers and death.

The origin of ſuch combats ſeems to be as follows: From the earlieſt times with which we have any acquaintance in profane hiſtory, it had been the cuſtom to ſacrifice captives, or priſoners of war, to the manes of the great men who had died in the engagement; thus Achilles, in the Iliad, lib. xxiii. ſacrifices twelve young Trojans to the manes of Patroclus; and in Virgil, lib. xi. ver. 81. Æneas ſends captives to Evander, to be ſacrificed at the funeral of his ſon Pallas.

In courſe of time they came alſo to ſacrifice ſlaves at the funerals of all perſons of condition: this was even eſteemed a neceſſary part of the ceremony; but as it would have appeared barbarous to have maſſacred them like beaſts, they were appointed to fight with each other, and endeavour to ſave their own lives by killing their adverſary. This ſeemed ſomewhat leſs inhuman, becauſe there was a poſſibility of avoiding death, by an exertion of ſkill and courage.

This occaſioned the profeſſion of gladiator to become an art: hence aroſe maſters of the art, and men learned to fight and exerciſe. Theſe maſters, whom the Latins called *laniſtæ*, bought them ſlaves to be trained up to this cruel trade, whom they afterwards ſold to ſuch as had occaſion to preſent the people with ſo horrible a ſhow.

Theſe exhibitions were at firſt performed near the ſepulchre of the deceaſed, or about the funeral pile; but were afterwards removed to the circus and amphitheatres, and became ordinary amuſements.

The firſt ſhow of gladiators, called *munus gladiatorium*, was exhibited at Rome, according to Valerius Maximus, by

Gladiators. by M. and D. Brutus, upon the death of their father, in the year of the city 490. On this occasion there were probably only three pair of gladiators. In 537, the three sons of M. Æmilius Lepidus the augur, who had been three times consul, entertained the people with the cruel pleasure of seeing 22 gladiators fight in the forum. In 547, the first Africanus diverted his army at New Carthage with a show of gladiators, which he exhibited in honour of his father and uncle, who had begun the reduction of Spain. In process of time, the Romans became so fond of these bloody entertainments, that not only the heir of any great and rich citizen lately deceased, but all the principal magistrates, presented the people with shows of this nature, to procure their affection. The ædiles, prætors, consuls, and, above all, the candidates for offices, made their court to the people, by entertaining them frequently with these fights: and the priests were sometimes the exhibitors of the barbarous shows; for we meet with the *ludi pontificales* in Suetonius, August. cap. 44. and with the *ludi sacerdotales*, in Pliny, Epist. lib. vii. As for the emperors, it was so much their interest to ingratiate themselves with the populace, that they obliged them with combats of gladiators almost upon all occasions; and as these increased, the number of combatants increased likewise. Accordingly, Julius Cæsar, in his ædileship, diverted the people with 320 couple. Titus exhibited a show of gladiators, wild beasts, and representations of sea fights, which lasted 100 days; and Trajan continued a solemnity of this nature for 123 days; during which time he brought out 1000 pair of gladiators. Before this time, under the republic, the number of gladiators was so great, that when the conspiracy of Catiline broke out, the senate ordered them to be dispersed into the garrisons and secured, lest they should have joined the disaffected party. See GLADIATORS *War*.

These sports were become so common, and their consequences in a variety of respects so dangerous, that Cicero preferred a law that no person should exhibit a show of gladiators within two years before he appeared candidate for any office. Julius Cæsar ordered, that only a certain number of men of this profession should be in Rome at a time; Augustus decreed, that only two shows of gladiators should be presented in a year, and never above sixty couple of combatants in a show; and Tiberius provided by an order of senate, that no person should have the privilege of gratifying the people with such a solemnity unless he was worth 400,000 sesterces. They were also considerably regulated by Nerva.

The emperor Claudius restrained them to certain occasions; but he soon afterwards annulled what he decreed, and private persons began to exhibit them at pleasure as usual; and some carried the brutal satisfaction so far as to have them at their ordinary feasts. And not slaves only, but other persons, would hire themselves to this infamous office.

The master of the gladiators made them all first swear that they would fight to death; and if they failed, they were put to death either by fire, or swords, clubs, whips, or the like.

It was a crime for the wretches to complain when they were wounded, or to ask for death or seek to avoid it when overcome; but it was usual for the emperor or the people to grant them life when they gave no signs of fear, but waited the fatal stroke with courage and intrepidity: Augustus even decreed that it should always be granted them. Gladiators.

From slaves and freedmen the inhuman sport at length spread to people of rank and condition; so that Augustus was obliged to issue a public edict that none of the senatorian order should become gladiators; and soon after he laid the same restraint on the knights: nevertheless Nero is related to have brought upwards of 400 senators and 600 Roman knights upon the arena; though Lipsius takes both these numbers to be falsified, and not without reason reduces them to 40 senators and 60 knights: yet Domitian, that other monster of cruelty, refined upon Nero, exhibiting combats of women in the night time.

Constantine the Great is said to have first prohibited the combats of gladiators in the East. At least he forbade those who were condemned to death for their crimes to be employed; there being an order still extant to the *præfectus prætorii* rather to send them to work in the mines in lieu thereof: it is dated at Berytus in Phœnicia, the first of October 325.

The emperor Honorius forbade them at Rome on occasion of the death of Telemachus, who coming out of the East into Rome at the time of one of these spectacles, went down into the arena, and used all his endeavours to prevent the gladiators from continuing the sport; upon which the spectators of that carnage, fired with anger, stoned him to death. It must be observed, however, that the practice was not entirely abolished, in the West before Theodoric king of the Ostrogoths. Honorius, on the occasion first mentioned, had prohibited them; but the prohibition does not seem to have been executed. Theodoric, in the year 500, abolished them finally.

Some time before the day of combat, the person who presented the people with the shows gave them notice thereof by programmas or bills, containing the names of the gladiators, and the marks whereby they were to be distinguished: for each had his several badge; which was most commonly a peacock's feather, as appears from the scholiast of Juvenal on the 158th verse of the third satire, and Turnebus Advers. lib. ii. cap. 8. They also gave notice how long the shows would last, and how many couples of gladiators there were; and it even appears, from the 52d verse of the seventh satire of the second book of Horace, that they sometimes made representations of these things in painting, as is practised among us by those who have any thing to show at fairs.

The day being come, they began the entertainment by bringing two kinds of weapons; the first were staves or wooden foils, called *rudes*; and the second were effective weapons, as swords, poniards, &c. The first were called *arma lusoria*, or *exercitoria*; the second *decretoria*, as being given by decree or sentence of the prætor, or of him at whose expence the spectacle was exhibited. They began to fence or skirmish with the first, which was to be the prelude to the battle; and from these, when well warmed, they advanced to the second at the sound of the trumpets, with which they fought naked. Then they were said *vertere arma*. The terms of striking were *petere et repetere*; of avoiding a blow, *exire*; and

and when one of the combatants received a remarkable wound, his adversary or the people cried out, *Habet*, or *Hoc habet*. The first part of the engagement was called *ventilare, præludere;* and the second, *dimicare ad certum*, or *versis armis pugnare:* and some authors think, with much probability, that it is to these two kinds of combat that St Paul alludes in the passage 1 Cor. ix. 26, 27. "I fight, not as one that beateth the air; but I keep my body, and bring it into subjection."

If the vanquished surrendered his arms, it was not in the victor's power to grant him life; it was the people during the time of the republic, and the prince or people during the time of the empire, that were alone empowered to grant the boon. The reward of the conqueror was a branch of palm tree, and a sum of money, probably collected among the spectators: sometimes they gave him his congé, or dismissed him by putting one of the wooden foils or *rudes* in his hand; and sometimes they even gave him his freedom, putting the pilæus on his head. The sign or indication, whereby the spectators showed that they granted the favour, was *premere pollicem*, which M. Dacier takes to be a clenching of the fingers of both hands between one another, and so holding the two thumbs upright close together; and, when they would have the combat finished and the vanquished slain, *verterunt pollicem*, they bent back the thumb; which we learn from Juvenal, Sat. iii. ver. 36. The gladiators challenged or defied each other, by showing the little finger; and, by extending this, or some other, during the combat, they owned themselves vanquished, and begged mercy from the people: *Victi ostensam digiti veniam à populo postulabant*, says the old scholiast on Persius.

There were various kinds of gladiators, distinguished by their weapons, manner, and time of fighting, &c. as, The *andabatæ*, mentioned under ANDABATÆ. The *catervarii*, who always fought in troops or companies, number against number; or, according to others, who fought promiscuously, without any certain order. The *dimachæ*, who fought armed with two poniards or swords, or with sword and dagger. The *essedarii*, who fought in cars. The *fiscales*, or *Cæsariani*, who belonged to the emperor's company; and who, being more robust and dexterous than the rest, were frequently called for, and therefore named also *postulatitii*. Several other kinds are mentioned in the ancient authors.

GLADIATORS *War* (*bellum Gladiatorium* or *Spartacum*), called also the *servile war*, was a war which the Romans sustained about the year of their city 680. Spartacus, Crinus, and Oenomaus, having escaped, with other gladiators to the number of seventy-four, out of the place where they had been kept at Capua, gathered together a body of slaves, put themselves at their head, rendered themselves masters of all Campania, and gained several victories over the Roman prætors. At length they were defeated in the year 682, at the extremity of Italy; having, in vain, attempted to pass over into Sicily.

This war proved very formidable to the Romans. Crassus was not able to finish it: the great Pompey was forced to be sent as general.

The Dying GLADIATOR, a most valuable monument of ancient sculpture, which is now preserved in the palace of Chighi. This man, when he had received the mortal stroke, is particularly careful *ut procumbat honestè*, "that he might fall honourably." He is seated in a reclining posture on the ground, and has just strength sufficient to support himself on his right arm: and in his expiring moments it is plainly seen, that he does not abandon himself to grief and dejection; but is solicitous to maintain that firmness of aspect which the gladiators valued themselves on preserving in this season of distress, and that attitude which they had learnt of the masters of defence. He fears not death, nor seems to betray any tokens of fear by his countenance, nor to shed one tear: *quis mediocris gladiator ingemuit, quis vultum mutavit unquam, quis non modo stetit, verum etiam decubit turpiter*, says Cicero, in that part of his Tusculan where he is describing the astonishing firmness of those persons. We see, in this instance, notwithstanding his remaining strength, that he has but a moment to live; and we view him with attention, that we may see him expire and fall: thus the ancients knew how to animate marble, and to give it almost every expression of life.

GLADIOLUS, CORN FLAG, a genus of plants belonging to the triandria class, and in the natural method ranking under the sixth order *Ensatæ*. See BOTANY *Index*.

GLAIR of eggs, is the same as the white of eggs, and is used as a varnish for preserving paintings. For this purpose it is beat to an unctuous consistence, and commonly mixed with a little brandy or spirit of wine, to make it work more freely, and with a lump of sugar to give it body and prevent its cracking: and then spread over the picture or painting with a brush.

GLAMORGANSHIRE, a county of South Wales, said to have derived its name from a contraction of the Welsh words *Gwald Morgan*, or "the county of Morgan," and supposed to have been thus called from a prince of this part of the country, said to have been killed 800 years before the birth of our Saviour: but some other writers derive the name from the word *Mor*, which in the British tongue signifies the *sea;* this being a maritime county. It is bounded on the south, and part of the west, by Bristol channel; on the north-west, by Caermarthenshire; on the north, by Brecknockshire; and on the east, by Monmouthshire. It extends 48 miles in length from east to west, 27 in breadth from north to south, and is 116 in circumference. It it divided into 10 hundreds, in which are one city, 7 market towns, 118 parishes, about 10,000 houses, and 58,000 inhabitants. It is in the diocese of Llandaff. This county, in the time of the Romans, was part of the district inhabited by the Silures, and had several Roman stations. Thus Boverton, a few miles to the south of Cowbridge, is supposed to be the Bovium of Antoninus: Neath to be his Nidum; and Loghor, to the west of Swansey, to be his Leucarum. The principal rivers of this county are the Rhymny, the Taff, the Ogmore, the Avon, the Cledaugh, and the Tave. The air, in the south part, towards the sea, is temperate and healthful; but the northern part, which is mountainous, is cold and piercing, full of thick woods, extremely barren, and thin of inhabitants. The mountains, however, serve to feed herds of cattle, and send forth streams which add greatly to the fertility of the other parts of the county:

county: they have likewife coal and lead ore. The fouth part is fo remarkably fertile, pleafant, and populous, that it is generally ftyled the garden of Wales; but it has no manufacture. This county was formerly full of caftles, moft of which are now fallen to decay. It has many fmall harbours on the coaft for exporting coals and provifions. Of the former it fends large quantities both to England and Ireland; but of the latter, to England almoft folely, efpecially butter. It fends two members to parliament, one for the fhire, and one for the borough of Cardiff the capital.

GLAMOUR, or GLAMER, an old term of popular fuperftition in Scotland, denoting a kind of magical mift believed to be raifed by forcerers, and which deluded their fpectators with vifions of things which had no real exiftence, altered the appearance of thofe which really did exift, &c.—The eaftern nations have a fimilar fuperftition, as we may learn from the Arabian Nights Entertainments and other works of oriental fiction.

GLAND, in *Anatomy*. See ANATOMY *Index*.

GLANDERS. See FARRIERY *Index*.

GLANDORE, a town of Ireland, fituated in the county of Cork and province of Munfter, near the harbour of that name.

GLANDORE *Harbour*, fituated two leagues weft of the Galley-head in the county of Cork, province of Munfter, N. Lat. 51. 22. W. Long. 8. 56. Between this harbour and Rofs the coaft continues high and bold, with only two fmall coves; that to the eaft called *Millcove*, and that to the weft *Cowcove*. This harbour lies three miles weft of Rofs; and though fmall, is an exceeding good one; near it is a caftle of the fame name, and on the upper end is a deep and dangerous glin, called the *Leap*. Glandore gives title of earl to the family of Crofbie.

GLANDULÆ RENALES. See ANATOMY *Index*.

GLANS, in *Anatomy*, the tip or button of the penis, or that part covered with the prepuce, called alfo *balanus*. See ANATOMY *Index*.

GLANS is alfo ufed to denote the tip or extremity of the clitoris, from its refemblance, both in form and ufe, to that of the penis. See ANATOMY *Index*.

GLANVIL, JOSEPH, a learned and ingenious, but fanciful and credulous, writer in the 17th century, was born at Plymouth in 1636, and bred at Oxford. He became a great admirer of Mr Baxter, and a zealous perfon for a commonwealth. After the Reftoration, he publifhed The Vanity of Dogmatizing; was chofen a fellow of the Royal Society; and, taking orders in 1662, was prefented to the vicarage of Frome-Selwood in Somerfetfhire. The fame year he publifhed his *Lux Orientalis*: in 1665, his *Scepfis Scientifica*; and in the year following, Some Philofophical Confiderations touching the being of Witches and Witchcraft, and other pieces on the fame fubject. In 1660, he publifhed *Plus ultra*; or, The Progrefs and Advancement of Knowledge fince the Days of Ariftotle. He likewife publifhed A feafonable Recommendation and Defence of Reafon; and *Philofophia Pia*, or A Difcourfe of the Religious Temper and Tendencies of the Experimental Philofophy. In 1678 he was made a prebendary of Worcefter, and died in 1680.

GLARIS, one of the cantons of Swifferland, is bounded on the eaft, partly by the Grifons, and partly by the territory of Sargans; on the north, by the bailiwick of Gafter, and by the lake Wahleftatt; on the eaft, by the canton of Schwits; and on the fouth, by part of the canton of Uri, and part of the league of the Grifons. It is a mountainous country, being entirely within the Alps.

GLARIS, a town of Swifferland, capital of the canton of the fame name, is feated in a plain, at the foot of high craggy mountains. The ftreets are large, and the houfes kept in good repair. It has fome public buildings; among which are two churches, one in the middle of the town, and the other without upon an eminence. In this eminence there is a cavern, with grotefque figures formed by the water that drops therein. The general affemblies of the country were formerly held on the firft Sundays in May, where all the males above the age of fixteen were obliged to appear. Both the Calvinifts and the Roman Catholics are tolerated in this town, and they have divine fervice by turns in the fame church. It is feated on the river Lint, E. Long. 9. 13. N. Lat. 47. 6.

GLASGOW, a large city of Lanerkfhire or Clydefdale in Scotland, fituated in W. Long. 4. 30. N. Lat. 55. 50.

Concerning the foundation of this city we have no authentic records. The word in the Gaelic language fignifies a *gray fmith*; from whence it has been inferred, that fome fpot in the moft ancient part of the city was originally the refidence of fome blackfmith who had become eminent in his profeffion, fo that the place went by his name.

1 Bifhopric of Glafgow, when founded.

In the year 560, a bifhopric is faid to have been founded here by Saint Mungo, or Kentigern, fuppofed to be the fon of Thamates, daughter of Loth king of the Picts; but in what ftate the town at that time was, is altogether uncertain. Moft probably the priefts and difciples who attended St Kentigern would contribute confiderably towards its advancement; the aged and infirm, who were unfit for the purpofes of war, or fuch as were religioufly inclined, would come and fettle round the habitation of the holy man, in order to have the benefit of his prayers; and as a number of miracles were faid to have been wrought at his tomb, the fame caufes would ftill contribute to the increafe of the town.

Hiftory has not informed us of the name of the prince who founded and endowed the bifhopric of Glafgow in favour of St Kentigern. But from an abftract of the life of Kentigern (contained in Mr Innes's Critical Effay on the Ancient Inhabitants of Scotland), which was written in the 12th century, we learn, that the faint being ill ufed by Marken or Marcus, one of the kings of the Britons, retired into Wales. On the invitation of Roderic, however, one of Marken's fucceffors, he returned to Glafgow, and enjoyed the fee till 601, when he died. He was buried in the church of Glafgow, where his monument is ftill to be feen; and we find him marked among the faints in the Roman kalendar, January 13. 577.

The immediate fucceffors of Kentigern were Baldrede and Conwal. The firft eftablifhed a religious houfe at Inchinnan; the fecond went into Lothian to preach to the Saxons; and both of them are ranked as faints in the Roman kalendar, Baldrede on the 6th of March

Glasgow. March 608, and Conwal on the 18th of May 612. From this time, however, till the 1115, we have no distinct accounts concerning the city or bishopric of Glasgow. We find then, that David I. king of Scotland made an attempt to retrieve the people from a state of gross barbarity into which they were fallen, and restored to the church those lands of which she had been robbed. The only account we have of the transactions with regard to Glasgow, during that period, is in the inquisition made by David concerning the church lands of Glasgow, and is as follows.—"This church, by the divine appointment, admitted St Kentigern into the bishopric, who furnished large draughts of knowledge to those thirsting after heavenly things, &c. But a fraudulent destroyer, employing his common wiles, brought in, after a long series of time, unaccountable scandals into the Cumbrian church. For after St Kentigern and many of his successors were removed to heaven, various disturbances everywhere arising, not only destroyed the church and her possessions, but, wasting the whole country, drove the inhabitants into exile. These good men being destroyed, various tribes of different nations flocking in from several quarters, possessed the foresaid deserted country; but being of different origins, and varying from each other in their language and customs, and not easily agreeing among themselves, they followed the manners of the Gentiles, rather than those of the true faith. The inhabitants of which unhappy and abandoned country, though living like brutes, the Lord, who chooses that none should perish, vouchsafed to visit in mercy," &c.

2 Barbarity of the people in the time of David I.

From the year 1116 to the Reformation, the records of the bishopric are tolerably complete. The most remarkable particulars furnished by them are the following.

In 1136, John Achaius, chosen bishop of Glasgow by David I. built and adorned a part of the cathedral, which he solemnly consecrated on the 9th of July. The king was present at the ceremony; and bestowed on the church the lands of Perdeyk, now Patrick. This prelate also divided the diocese into the two archdeanries of Glasgow and Teviotdale; and established the offices of dean, subdean, chancellor, treasurer, sacrist, chantor, and successor; and settled a prebendary upon each of them, out of the donatives he received from the king.

In 1174, Joceline, abbot of Melrose, was elected bishop, and consecrated by Eskilus, bishop of Lunden in Denmark, the pope's legate for that kingdom, on the 1st of June 1175. He rebuilt the cathedral, or rather made an addition to the church already built by John Achaius. He also procured a charter from William king of Scotland, erecting Glasgow into a royal borough, and likewise a charter for a fair to be held there annually for eight days.

3 Glasgow erected into a royal borough.

In 1335, John Lindsay, bishop of Glasgow, was killed in an engagement at sea with the English, as he was returning home from Flanders. His successor, William Rae, built the stone bridge over the Clyde. In the time of Matthew Glendoning, who was elected bishop in 1387, the great spire of the church, which had been built only of wood, was consumed by lightning. The bishop intended to have built another of stone: but was prevented by death, in 1408, from accomplishing his purpose. His successor, William Lauder, laid the foundation of the vestry of the cathedral, and built the great tower of stone as far as the first battlement. The great tower of the episcopal palace was founded about the year 1437, on which Bishop Cameron expended a great deal of money.

In 1447, William Turnbull, a son of the family of Bedrule in Roxburghshire, was chosen bishop. He obtained from King James II. in 1450, a charter erecting the town and the patrimony of the bishops into a regality. He also procured a bull from Pope Nicholas V. for erecting an university within the city, which he endowed, and on which he also bestowed many privileges. He died in 1454, leaving behind him a most excellent character. The establishment of the college contributed more than any thing that had been formerly done towards the enlargement of the town. Before this time the town seems to have been inconsiderable. Mr Gibson * is of opinion, that the number of its inhabitants did not exceed 1500. But though the establishment of the university greatly increased the number of inhabitants, it in fact destroyed the freedom of the town. Bishop Turnbull seems to have made a point of it with King James II. that the city of Glasgow, with the bishop's forest, should be erected into a regality in his favour; which was accordingly done at the time above mentioned; and this at once took away all power from the citizens, and transferred it to the bishop. As the powers of the bishop, however, were reckoned by Turnbull insufficient to convey to the members of the university all that freedom which he wished to bestow upon them, he therefore obtained from the king a great many privileges for them; and afterwards he himself, with the consent of his chapter, granted them many more.

4 Glasgow erected into a regality, and the university founded.

* *Hist. of Glasgow*, p. 74.

5 Which destroys the freedom of the city.

The good effects of the establishment of the college were very soon obvious in Glasgow. The number of inhabitants increased exceedingly; the high street, from the convent of the Black Friars, to where the cross is now placed, was very soon filled up; the ancient road which led to the common being too far distant for the conveniency of the new inhabitants, the Gallows-gate began to be built. Soon after, the collegiate church of the blessed Mary (now the Tron church) being founded by the citizens, occasioned the Trongate street to be carried to the westward as far as the church. The rest of the city increased gradually towards the bridge, by the building of the Saltmarket street. The borough roads, and the cattle that grazed on the commons, were now found insufficient to maintain the increased number of inhabitants; for which reason a greater degree of attention than formerly was paid to the fishing in the river. Many poor people subsisted themselves by this occupation; they were incorporated into a society; and in order that they might be at hand to prosecute their business, they built a considerable part of the street now called the *Bridge-gate*, but at that time *Fishers-gate*.

6 Population of Glasgow increased by the university.

Notwithstanding all this, however, the city of Glasgow did not for a long time attain the rank among the other towns of Scotland which it holds at present. In 1556, it held only the 11th place among them, as appears by Queen Mary's taxation. The introduction of the reformed religion proved for some time prejudicial to the opulence of the city. The money which had

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had formerly been expended among the citizens by the bishop and his clergy, was now diverted into other channels: the advantages resulting from the university were also for a time lost; for as the reformers generally despised human learning, the college was in a manner deserted.

7
Great part of the town destroyed by a fire.

In the time of the civil wars, Glasgow suffered severely. To the mischief attending intestine discord, were added a pestilence and famine; and to complete their misfortunes, a violent fire broke out in June 1652, which destroyed the greatest part of the Saltmarket, Trongate, and High street. The fronts of the houses at that time were mostly of wood, so that they became an easy prey to the flames. The fire continued with great violence for the space of 18 hours; by which a great many of the inhabitants were ruined, the habitations of almost 1000 families being totally destroyed. On this account collections were made through different parts of the country; and to prevent such accidents for the future, the fronts were built with freestone, which abounds in the neighbourhood.

By the charter given to Bishop Turnbull in 1450, the citizens had been deprived of the power of electing their own magistrates, which was thenceforth exercised by the bishop; which, however, was not done without some resistance on the part of the inhabitants. After the Reformation was introduced into Scotland, we find this power exercised by the citizens, the bishop, the earl of Lennox, and others. The idea that the town was a bishop's borough, and not a royal free borough, gave occasion to this unsettled manner of appointing the magistracy; and though, in 1633, they were declared to be a royal free borough by the parliament, yet their freedom of election was afterwards disturbed by the privy council, by Cromwell, and the duke of York.

8
Glasgow declared free by William and Mary.

But on the 4th of June 1690, the town was declared free by a charter of William and Mary; and in confirmation of this charter it was inserted in the act of parliament, dated June 14th the same year, that they should have power to elect their own magistrates as fully and freely, in all respects, as the city of Edinburgh or any other royal borough within the kingdom; which freedom of election still continues.

By the assessment of the boroughs in 1695, we find the city of Glasgow reckoned the second in Scotland in point of wealth, which place it still continues to hold.

9
Great increase of its wealth.

To account for this great increase of wealth, we must observe, that for a long time, even before the restoration of Charles II. the inhabitants of Glasgow had been in possession of the sale both of raw and refined sugars for the greatest part of Scotland; they had a privilege of distilling spirits from their molasses, free of all duty and excise; the herring fishery was also carried on to what was at that time thought a very considerable extent; they were the only people in Scotland who made soap; and they sent annually some hides, linen, &c. to Bristol, from whence they brought back in exchange, a little tobacco, sugar, and goods, of the manufacture of England, with which they supplied a considerable part of the kingdom. From the year 1707, however, in which the union betwixt Scotland and England took place, we may date the prosperity of Glasgow. By the union, the American trade was laid open to the inhabitants: and so sensible were they of their advantageous situation, that they began almost instantly to prosecute that commerce; an assiduous application to which, ever since, hath greatly contributed to raise the city to the pitch of affluence and splendor which it at present enjoys. The city was now greatly enlarged; and as the community were sensible of the inconvenience that attended the want of a sufficiency of water in the river for carrying on their commerce, they resolved to have a port of their own nigher the mouth of the river. At first, they thought of making their harbour at Dumbarton: but as this is a royal borough, the magistrates opposed it; because they thought that the influx of sailors and others, occasioned by the harbour, would be so great, that a scarcity of provisions would be occasioned. The magistrates and town council of Glasgow, therefore, purchased some lands on the south side of the river Clyde for this purpose; and so expeditious were they in making their harbour, and rearing their town, that in 1710 a bailie was appointed for the government of Port-Glasgow. It is now a very considerable parish, and lies 21 miles nigher the mouth of Clyde than Glasgow.

10
Erection of Port Glasgow.

In 1725, Mr Campbell, the member of parliament for Glasgow, having given his vote for having the malt tax extended over Scotland, a riot ensued among the lower class of people. In this disturbance, Mr Campbell's furniture was destroyed, and some excisemen were maltreated for attempting to take an account of the malt. General Wade, who commanded the forces in Scotland, had sent two companies of soldiers, under the command of Captain Bushel, to prevent any disturbance of this kind. Captain Bushel drew up his men in the street, where the multitude pelted them with stones. He first endeavoured to disperse the mob by firing with powder only: but this expedient failing, he ordered his men to load their pieces with ball; and, without the sanction of the civil authority, commanded them to fire four different ways at once. By this discharge about 20 persons were killed and wounded; which enraged the multitude to such a degree, that having procured some arms, they pursued Bushel and his men to the castle of Dumbarton, about 14 miles distant. General Wade being informed of this transaction, assembled a body of forces, and being accompanied by Duncan Forbes, lord advocate, took possession of the town: the magistrates were apprehended and carried prisoners to Edinburgh; but on an examination before the lords, their innocence clearly appeared, upon which they were immediately dismissed. Bushel was tried for murder, convicted, and condemned; but, instead of suffering the penalties of law, he was indulged with a pardon, and promoted in the service. Mr Campbell petitioned the house of commons for an indemnification of his losses: a bill was passed in his favour; and this, together with some other expences incurred in the affair, cost the town 9000l. sterling.

11
Disturbance about the excise bill.

During the time of the rebellion in 1745; the citizens of Glasgow gave proof of their attachment to revolution principles, by raising two battalions of 600 men each, for the service of government. This piece of loyalty, however, had like to have cost them dear. The rebels, in their journey south, took a resolution to plunder and burn the city: which would probably have been done, had not Mr Cameron of Lochiel threatened, in that case, to withdraw his clan. A heavy contribution, Glafgow. tribution, however, was laid on. The city was compelled to pay 5000l. in money, and 500l. in goods; and on the return of the rebels from England, they were obliged to furnifh them with 12,000 linen fhirts, 6000 cloth coats, 6000 pairs of fhoes, 6000 pairs of hofe, and 6000 bonnets. Thefe goods, with the money formerly paid them, the expence of raifing and fubfifting the two city battalions, and the charge of maintaining the rebel army in free quarters for ten days, coft the community about 14,000l. fterling; 10,000l. of which they recovered in 1749, by an application to parliament.

12 Change of manners and method of living.

About the year 1750, a very confiderable change took place in the manner of living among the inhabitants of Glafgow. Till this time, an attentive induftry, and a frugality bordering upon parfimony, had been their general characteriftic; the feverity of the ancient manners prevailed in its full vigour: But now, when an extenfive commerce and increafed manufactures had produced wealth, the ideas of the people were enlarged, and fchemes of trade and improvement were adopted which people would formerly have been denominated madmen if they had undertaken; a new ftyle was introduced in living, drefs, building, and furniture; wheel carriages were fet up, public places of entertainment were frequented, and an affembly-room, ball-room, and playhoufe, were built by fubfcription; and from this time we may date all the improvements that have taken place, not only in Glafgow, but all over the weft of Scotland. The beft method, however, of eftimating the growing improvement of any town, is by the frequency of their applications for affiftance to parliament; we fhall therefore enumerate the acts of parliament which have been paffed in favour of the city of Glafgow fince the year 1750. In 1753, an act paffed for repairing feveral roads leading into the city of Glafgow. In 1756, an act for erecting and fupporting a lighthoufe in the ifland of Little Cumray, at the mouth of the Clyde, and for rendering the navigation of the frith and river more fafe and commodious.—In 1759, an act for improving the navigation of the river Clyde to the city of Glafgow, and for building a new bridge acrofs the river.—In 1767, the people of Glafgow having propofed to make a fmall cut or canal from the frith of Forth to that of Clyde, for the conveniency of their trade to the eaftern fide of the ifland, feveral gentlemen at Edinburgh, and throughout different parts of the kingdom, propofed that this canal fhould be executed upon a much larger fcale than what had been originally projected. An act was accordingly obtained, and and the canal executed in the manner defcribed under the article CANAL.—In 1770, another act was obtained for improving the navigation of the river, building the bridge, &c. being an amendment of the former act for thefe purpofes. In 1771, an act for making and widening a paffage from the Saltmarket to St Andrew's church; for enlarging and completing the churchyard of that church, and likewife for building a convenient exchange or fquare in the city; alfo for amending and explaining the former act relative to the navigation of the Clyde. An act for making and maintaining a navigable canal and waggon way from the collieries in the parifhes of Old and New Monkland, to the city of

13 Acts of parliament in favour of the city.

Glafgow. This laft canal, which was undertaken with a view to reduce the price of coals, has not been attended with the defired effect; but the other improvements have been productive of very great advantages.

14 Defcription of the city.

The moft ancient part of the city ftands on a rifing ground. The foundation of the cathedral is 104 feet higher than the bed of the river; and the defcent from the high ground reaches to about 100 yards below the college. The reft of the city is built chiefly upon a plain, bounded fouthward by the Clyde, and northward by a gentle ridge of hills lying in a parallel direction with that river. Thefe grounds, till lately, confifted of gardens and fields; but are now covered with buildings, in confequence of the increafing wealth and population of the city. The ftreets are all clean and well paved; and feveral of them interfecting one another at right angles, produce a very agreeable effect. The four principal ftreets, croffing one another in that manner, divide the city nearly into four equal parts; and the different views of them from the crofs, or centre of interfection, have an air of great magnificence. The houfes, confifting of four or five floors in height, are built of hewn ftone, generally in an exceeding good tafte, and many of them elegant. The moft remarkable public buildings are,

15 Of the cathedral.

1. *The Cathedral*, or *High Church*, is a magnificent building, and its fituation greatly to its advantage, as it ftands higher than any part of the city. It has been intended to form a crofs, though the traverfe part has never been finifhed. The great tower is founded upon four large maffy pillars, each of them about 30 feet in circumference. The tower itfelf is 25½ feet fquare within; and is furrounded by a balluftrade, within which rifes an octangular fpire terminated by a vane. The tower upon the weft end is upon the fame level, but appears not to have been finifhed, though it is covered over with lead. In this tower is a very large bell 11 feet four inches in diameter. The principal entry was from the weft; the gate 11 feet broad at the bafe, and 17 feet in height. The weft end of the choir is now appropriated for a place of divine worfhip; and is divided from the remaining part by a ftone partition, which is enclofed by another ftone wall parting it from the nave. It is impoffible to form an adequate idea of the awful folemnity of the place occafioned by the loftinefs of the roof and the range of pillars by which the whole is fupported.

The nave of the church rifes four fteps higher than the choir; and on the weft fide ftood the organ loft, formerly ornamented with a variety of figures, but now defaced. The pillars here are done in a better tafte than thofe in the choir, and their capitals are ornamented with fruits. The arched roof of the altar is fupported by five pillars, over which was a fine terrace walk, and above it a large window of curious workmanfhip, but now fhut up. On the north fide of the altar is the veftry, being a cube of 28 feet, the roof arched and vaulted at top, and fupported by one pillar in the centre of the houfe. Arched pillars from every angle terminate in the grand pillar, which is 19 feet high. The lower part of the fouth crofs is made ufe of as a burying place for the clergy of the city; and is by much the fineft piece of workmanfhip in the whole building. It is 55 feet long, 28 broad, and

15

Glasgow. 15 high; arched and vaulted at top, and supported by a middle range of pillars, with their capitals highly ornamented; correspsonding to which are columns adjoining to the walls, which, as they rise, spring into semi-arches, and are everywhere met at acute angles by their opposites, and are ornamented with carvings at the closing and crossing of the lines. At the east end of the choir you descend by flights of steps upon each side into passages which, in former times, were the principal entries to the burying vault which is immediately under the nave. It is now made use of as a parish church for the barony of Glasgow; and is full of pillars, some of them very massy, which support the arched roof: but it is a very uncomfortable place for devotion. The space under the altar and vestry, though now made use of as a burying place by the heritors of the barony, was formerly, according to tradition, employed for keeping of the relicks; and indeed, from the beautiful manner in which this place is finished, one would imagine that it had not been destined for common use. Here is shown the monument of St Mungo, or Kentigern, with his figure lying in a cumbent posture.

The whole length of the cathedral within the walls is 284 feet, its breadth 65; the height of the choir, from the floor to the canopy, 90 feet; the height of the nave, 85 feet; the height of the middle tower, 220 feet. This fabric was begun by John Achaius in 1123, and consecrated in 1136: and continued by succeeding bishops till such time as it was finished in the manner in which it stands at present. The wealth of the see of Glasgow, however, was not sufficient for so great an undertaking, so that they were obliged to have recourse to all the churches of Scotland for assistance in it.

This venerable edifice was in danger of falling a victim to the frenzy of fanaticism in 1579; and owed its preservation to the spirit and good sense of the tradesmen, who, upon hearing the beat of drum for collecting the workmen appointed to demolish it, flew to arms, and declared that the first man who pulled down a single stone should that moment be buried under it.

Near the cathedral are the ruins of the bishop's palace or castle, enclosed with a wall of hewn stone by Archbishop James Beaton; the great tower built by Archbishop Cameron in 1426.

16 St Andrew's church.

2. *St Andrew's Church* was begun by the community in 1739, and finished in 1756. It is the finest piece of modern architecture in the city; and is built after the model of St Martin's in the Fields, London, whose architect was the famous Gibbs. The length of the church is 104 feet, and its breadth 66. It has a fine arched roof, well ornamented with figures in stucco, and sustained by stone columns of the Corinthian order. Correspondent to the model, it has a place for the altar on the east, in which is a very ancient Venetian window; but the altar place being seated, makes this end appear to no great advantage. The fronts of the galleries and the pulpit are done in mahogany in a very elegant manner. The spire by no means corresponds with the rest of the building; and, instead of being an ornament, disgraces this beautiful fabric. Its height is 170 feet.

Besides the cathedral (which contains three congregations) and St Andrew's church, there is a number of others, as the College church, Ram's-horn, Tron, Wynd, &c. together with an English chapel, Highland church, several seceding meeting-houses, and others for sectaries of various denominations.

17 The college.

3. *The College.*—The front of this building extends along the east side of the high street, and is upwards of 330 feet long. The gate at the entrance is decorated with rustics, and over it are the king's arms. The building consists of two principal courts or squares. The first is 88 feet long and 44 broad. The west side is elevated upon stone pillars, on which are placed pilasters supporting the Doric entablature, and ornamented with arches forming a piazza. Above these is the public hall; the ascent to which is by a double flight of steps enclosed by a handsome stone ballustrade, upon the right of which is placed a lion, and on the left an unicorn, cut in freestone. The spire stands on the east side, is 135 feet high, and has a very good clock. Under this is the gateway into the inner and largest court, which is 103 feet long and 79 broad. Over the entry, in a niche, is a statue of Mr Zacharias Boyd, who was a benefactor to the university. On the east side of the court is a narrow passage leading into a handsome terrace walk, gravelled, 122 feet long by 64 feet broad. This walk is enclosed to the east by an iron pallisade, in the centre of which is a gate leading into the garden. This last consists of seven acres of ground, laid out in walks for the recreation of the students; and there is also a botanic garden. On the south side of the walk stands the library; a very neat edifice, well constructed for the purpose intended, and containing a very valuable collection of books. Underneath are preserved in cases all the Roman inscriptions found on Graham's Dike, together with altars and other antiquities collected from different parts of Scotland.—Adjoining there is an observatory, well furnished with astronomical instruments. The college also possesses, by bequest, the late Dr Hunter's famous anatomical preparations, library, and museum. A building is now (1806) preparing for its reception.

18 Town-house, &c.

4. *The Tolbooth*, or *Town-House*, is a magnificent and extremely elegant building. The front is adorned with a range of Ionic pilasters; and is elevated on strong rusticated pillars with arches, forming a piazza for merchants and others to shelter themselves from the weather when met upon business. One of the apartments was the assembly hall; a neat room, 47 feet long, and 24 in breadth and height, finished in a good taste, though too small for the city. The town hall is a very spacious and lofty apartment, 52 feet long by 27 broad, and 24 in height. It is finished in a very grand manner; the ceiling is divided into different compartments well ornamented. In it are full length portraits of King James VI. and VII. Charles I. and II. William and Mary, Queen Anne, King George I. II. and III. and Archibald duke of Argyll in his justiciary robes. The two last are by Ramsay. Opposite to the front of this building is the exchange walk, which is well paved with freestone, and enclosed from the street by stone pillars. In the middle of this area is an equestrian statue of King William III. placed upon a lofty pedestal, and surrounded with an iron rail.—In 1781, the exchange under the piazzas was greatly enlarged, by taking down the lower part of the town hall and assembly room;

Glaſgow. room; and at the ſame time, by a tontine ſcheme entered into by the inhabitants, a moſt elegant coffee room was added, with a ſuite of buildings adjoining for the purpoſes of a tavern and hotel, aſſembly room, and offices for notaries and underwriters. The aſſembly room, however, being found to be ſtill too ſmall, a ſubſcription of above 5000l. has been raiſed by a ſimilar plan of a tontine for building a new one, which is propoſed to be erected in the north corner of one of the new ſtreets which join Ingram ſtreet to Argyll ſtreet.

19 Guild hall. 5. *The Guild Hall* or *Merchants Houſe.* This building is ſituated upon the ſouth ſide of Bridgegate ſtreet; and is in length 82 feet, in breadth 31. The great hall, which is the whole length and breadth of the building, is ſo capacious, that it is better adapted for the reception of great and numerous aſſemblies than any other in the city. This houſe is adorned with a very elegant ſpire 200 feet high.

20 Town's hoſpital. 6. *The Town's Hoſpital* is a very neat building, conſiſting of two wings and a large front: the length 156 feet, the breadth of the centre 30 feet, and the depth of the wings 68 feet. Behind the building is an infirmary 127 feet long by 25 feet broad, the aſcent to which is by a flight of ſteps. The lower part of this building is appointed for the reception of lunatics. The area between the buildings is large, which, with the agreeable open ſituation of the hoſpital on the river, muſt conduce to the health of the inhabitants.

21 Grammar ſchool. 7. *The Grammar School* is ſituated in the new part of the town, to the north-weſt, and was built in 1787. It is a very handſome building, containing a large hall, and ſix airy commodious teaching rooms. In this ſchool there are four claſſes, the courſe being four years: each claſs is carried on the whole four years by the ſame maſter; ſo that, there being no rector, each maſter is head of the ſchool one year in rotation. It is under the direction of a committee of the town council; who, aſſiſted by the profeſſors, clergy, and other perſons of learning, frequently viſit it during the ſeſſion; and at an annual examination, prizes of books are diſtributed to the ſcholars according to their reſpective merits. The number of ſcholars is above 300.—The building is not yet entirely finiſhed; and the rooms which are not occupied by the Latin claſſes are intended for teaching writing, arithmetic, drawing, &c.

22 New Bridge. 8. *The New Bridge* is built in an elegant manner. It is 32 feet wide; with a commodious footway for paſſengers, five feet broad, on each ſide, raiſed above the road made for carriages, and paved with freeſtone. This bridge is about 500 feet in length; and conſiſts of ſeven arches, the faces of which are wrought in ruſtic, with a ſtrong block cornice above. The arches ſpring but a little way above low water mark; which, though it renders the bridge ſtronger than if they ſprung from taller piers, diminiſhes its beauty. Between every arch there is a ſmall circular one: theſe break the force of the water when the river riſes to a flood, and add to the ſtrength of the whole. The parapet wall or breaſtwork is cut out in the Chineſe taſte: and the two ends are finiſhed off with a ſweep. This bridge was begun in 1768, and finiſhed in 1772.

23 Markets, &c. 9. *The Markets in King's Street* are juſtly admired, as being the completeſt of their kind in Britain. They are placed on both ſides of the ſtreet. That on the eaſt ſide, appropriated entirely for butcher meat, is 112 feet in length, and 67 in breadth. In the centre is a ſpacious gateway, decorated on each ſide with coupled Ionic columns, ſet upon their pedeſtals, and ſupporting an angular pediment. At the north end is a very neat hall belonging to the incorporation of butchers, the front ornamented with ruſtics and a pediment. The markets upon the weſt ſide of the ſtreet conſiſt of three courts, ſet apart for fiſh, mutton, and cheeſe. The whole of the front is 173 feet, the breadth 46 feet; in the centre of which, as on the oppoſite ſide, is a very ſpacious gateway of the Doric order, ſupporting a pediment. This is the entry to the mutton market. Each of the other two has a well proportioned arch faced with ruſtics for the entrance. All theſe markets are well paved with freeſtone; have walks all round them; and are covered over for ſhelter by roofs ſtanding upon ſtone piers, under which the different commodities are expoſed to ſale. They have likewiſe pump wells within, for cleanſing away all the filth; which render the markets always ſweet and agreeable. Theſe markets were erected in 1754.

10. *The Herb Market* is neat and commodious; and the principal entry is decorated with columns. It is ſituated in the Candleriggs, and is laid out in the ſame manner with the markets in King's Street.

11. *The Guard Houſe* is a very handſome building, 24 Guard houſe. with a piazza formed by arches, and columns of the Ionic order ſet upon their pedeſtals. It was originally ſituated on the High ſtreet, at the corner of the Candleriggs ſtreet: but has lately been carried near half way up the Candleriggs, where it occupies the ground on which the weigh-houſe formerly ſtood, and is made larger and more commodious than it was before. An excellent new weigh-houſe has been erected at the head of the Candleriggs: And at the foot of the Candleriggs, or corner next the High ſtreet, where the guard-houſe was formerly ſituated, a ſuperb new hotel has been built, containing 75 fire rooms,

The moſt remarkable public charities in Glaſgow are,

1. *Muirhead's* or *St Nicholas's Hoſpital.* This was 25 Public charities. originally appointed to ſubſiſt 12 old men and a chaplain: but its revenues have, from ſome unknown cauſes, been loſt; ſo that no more of them now remains than the paltry ſum of 139l. 2s. 5d. Scots money, 128l. of which is annually divided among four old men, at the rate of 2l. 13s. 4d. ſterling each.

2. *Hutcheſon's Hoſpital,* was founded and endowed in 1639 by George Hutcheſon of Lamb-hill, notary public, and Mr Thomas Hutcheſon his brother, who was bred a preacher, for the maintenance of old men and orphans. The funds of this hoſpital were increaſed by James Blair merchant in Glaſgow in 1710, and by ſubſequent donations. From the ſale of ſome of their lands which lay convenient for building, and the riſe of the reſt, the income is now above 1400l. which is diſtributed in penſions to old people from 3l. to 20l. and in educating about 50 children.

3. *The Merchant's Houſe* likewiſe diſtributes in penſions and other charities about 800l. yearly.

4. *The Town's Hoſpital,* above deſcribed, was opened for the reception of the poor on the 15th of November 1733. The funds whence this hoſpital is ſubſiſted are, the general ſeſſion, the town council, the trades houſe

Glasgow. house and merchants house, the interest of money belonging to their funds, which are sums that have been mortified for the use of the house. These supplies, however, are found insufficient to defray the expences of the house; for which reason an assessment is annually made upon the inhabitants in the following manner. The magistrates nominate 12, 14, or sometimes more gentlemen of known integrity and character, who have a list laid before them of all the inhabitants in town. This list they divide into 16 or 18 columns. Each of these columns contains the names of such inhabitants as carry on trade to a certain extent, or are supposed to be well able to pay the sum affixed to the particular column in which their names are inserted. If it is necessary to raise 500l. for instance, then each name, in every separate column, is valued at as much as the fortunes of the persons in each particular column are supposed to be. If 1000l. or more is to be raised, it is only continuing a proportional increase through the whole of the columns. The highest sum that ever was thus raised, was 12s. 6d. upon every thousand pounds that each person was supposed to be worth. The number of people maintained in this hospital are about 620.

5. *Wilson's Charity* for the education of boys, was founded by George Wilson, who in 1778 left 3000l. for that purpose. This fund is now considerably increased, and gives education and clothing to 48 boys, who each continues four years, so that 12 are admitted annually.

Besides these, there are many public schools for the education of children; as well as many institutions of private societies for the purpose of relieving the indigent and instructing youth, such as *Graham's Society*, *Buchanan's Society*, the *Highland Society*, &c. These last put annually 20 boys apprentices to trades, and during the first three years give them clothing and education.

26 Members of the university.

The university of Glasgow owes its origin, as we have already observed, to Bishop Turnbull. The institution consisted at first of a rector, a dean of faculty, a principal who taught theology, and three professors of philosophy; and, soon after this, the civil and canon laws were taught by some clergymen. From the time of its establishment in 1450 to the Reformation in 1560, the college was chiefly frequented by those who were intended for the church; its members were all ecclesiastics, and its principal support was derived from the church. The Reformation brought the university to the verge of destruction: masters, students, and servants, all forsook it. The magistrates were so sensible of the loss which the community had sustained by this desertion, that they endeavoured to restore it in 1572, by bestowing upon it considerable funds, and prescribing a set of regulations for its management. These, however, proved insufficient; for which reason King James VI. erected it anew, by a charter called the *Nova Erectio*, 1577, and bestowed upon it the teinds of the parish of Govan. The persons who were to compose the new university were, a principal, three professors of philosophy, four students bursars, one œconomus, a principal's servant, a janitor, and cook.

Since the year 1577, the funds of the university have been considerably increased by the bounty of kings and the donations of private persons. The professors have therefore also been increased: so that at present the university of Glasgow consists of a chancellor, rector, dean of faculty, principal, and 14 professors (six of them in the gift of the crown), together with bursars, &c. The archbishop of Glasgow was formerly chancellor of the university *ex officio*; at present, the chancellor is chosen by the rector, dean of faculty, principal, and masters.

The chancellor, as being the head of the university, is the fountain of honour, and in his name are all academical degrees bestowed. The office of rector is to exercise that academical jurisdiction in disputes among the students themselves, or between the students and citizens, which is bestowed upon the greater part of the universities in Europe. He is chosen annually in the *comitia*; that is, in a meeting in which all the students, as well as the other members of the university, have a voice. Immediately after his admission, he has been in use to choose certain persons as his assessors; and counsellors in his capacity of judge; and, in former periods, it was customary to name the ministers of Glasgow, or any other gentlemen who had no connexion with the university; but, for a great while past, the rector has constantly named the dean of faculty, the principal, and masters, for his assessors; and he has always been, and still is, in the daily practice of judging in the causes belonging to him, with the advice of his assessors. Besides these powers as judge, the rector summons and presides in the meetings of the university for the election of his successor; and he is likewise in use to call meetings of the professors for drawing up addresses to the king, electing a member to the general assembly, and other business of the like kind.

The dean of faculty has, for his province, the giving direction with regard to the course of studies; the judging, together with the rector, principal, and professors, of the qualifications of those who desire to be created masters of arts, doctors of divinity, &c.; and he presides in meetings which are called by him for these purposes. He is chosen annually by the rector, principal, and masters.

The principal and masters, independent of the rector and dean, compose a meeting in which the principal presides; and as they are the persons for whose behoof chiefly the revenue of the college was established, the administration of that revenue is therefore committed to them. The revenue arises from the teinds of the parish of Govan, granted by King James VI. in 1557; from the teinds of the parishes of Renfrew and Kilbride, granted by the same monarch in 1617, and confirmed by King Charles I. on the 28th of June 1630; from the teinds of the parishes of Calder, Old and New Monkland, conveyed to them by a charter from Charles II. in 1670; from a tack of the archbishopric; and from several donations conferred by private persons.

The college of Glasgow, for a very considerable time after its erection, followed the mode of public teaching which is common even to this day in Oxford and Cambridge, and in many other universities throughout Europe; that is, each professor gave a few lectures every year, *gratis*, upon the particular science which he professed: but, in place of this, the professors have, for a great while past, adopted the mode of private teaching: that is, they lecture and examine two hours every

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every day during the feffion, viz. from the 10th of October to the 10th of June; a method which comes much cheaper to the ftudent, as he has it in his power, if he is attentive, to acquire his education without being under the neceffity of employing a tutor. They have alfo private claffes, in which they teach one hour per day. The number of ftudents who have attended this college for feveral years paft, has been upwards of 500 each feafon.

27
History of the trade of Glafgow.

The trade of Glafgow is faid to have been firft promoted by one Mr William Elphinftone in 1420. This trade was moft probably the curing and exporting of falmon; but the firft authentic document concerning Glafgow as a trading city is in 1546. Complaints having been made by Henry VIII. king of England, that feveral Englifh fhips had been taken and robbed by veffels belonging to Scotland, an order of council was iffued, difcharging fuch captures for the future; and among other places made mention of in this order is the city of Glafgow. The trade which at that time they carried on could not be great. It probably confifted of a few fmall veffels to France loaded with pickled falmon; as this fifhery was, even then, carried on to a confiderable extent, by Glafgow, Renfrew, and Dumbarton. Between the years 1630 and 1660, a very great degree of attention feems to have been paid to inland commerce by the inhabitants of Glafgow. Principal Baillie informs us, that the increafe of Glafgow arifing from this commerce was exceedingly great. The exportation of falmon and of herrings was alfo continued and increafed. In the war between Britain and Holland during the reign of Charles II. a privateer was fitted out in Clyde to cruife againft the Dutch. She was called the *Lion of Glafgow*, Robert M'Allan commander; and carried five pieces of cannon, and 60 hands.

A fpirit of commerce appears to have arifen among the inhabitants of Glafgow between the years 1660 and 1707. The citizens who diftinguifhed themfelves moft during this period were Walter Gibfon and John Anderfon. Gibfon cured and packed in one year 300 lafts of herrings, which he fent to St Martin's in France on board of a Dutch veffel called the *St Agate* of 450 tons burden; his returns were brandy and falt. He was the firft who imported iron from Stockholm into Clyde. Anderfon is faid to have been the firft who imported white wines.

Whatever their trade was at this time, it could not be confiderable: the ports to which they were obliged to trade lay all to the eaftward: the circumnavigation of the ifland would therefore prove an almoft unfurmountable bar to the commerce of Glafgow; and of confequence the people on the eaft coaft would be poffeffed of almoft all the commerce of Scotland. The union with England opened a field for commerce for which the fituation of Glafgow, fo convenient in refpect to the Atlantic, was highly advantageous. Since that time the commerce of the eaft coaft has declined, and that of the weft increafed to an amazing degree. No fooner was the treaty of union figned, than the inhabitants of Glafgow began to profecute the trade to Virginia and Maryland; they chartered veffels from Whitehaven, fent out cargoes of goods, and brought back tobacco in return. The method in which they at firft proceeded in this trade was certainly a very prudent one. A fupercargo went out with every veffel. He bartered his goods for tobacco, until fuch time as he had either fold off his goods, or procured as much tobacco as was fufficient to load his veffel. He then immediately fet out on his return; and if any of his goods remained unfold, he brought them home with him. While they continued to trade in this way, they were of great advantage to the country, by the quantity of manufactures which they exported; their own wealth began to increafe; they purchafed fhips of their own; and, in 1718, the firft veffel of the property of Glafgow croffed the Atlantic. Their imports of tobacco were now confiderable, and Glafgow began to be looked upon as a confiderable port; the tobacco trade at the ports of Briftol, Liverpool, and Whitehaven, was obferved to dwindle away; the people of Glafgow began to fend tobacco to thefe places, and to underfell the Englifh even in their own ports. Thus the jealoufy of the latter was foon excited, and they took every method in their power to deftroy the trade of Glafgow. The people of Briftol prefented remonftrances to the commiffioners of the cuftoms at London againft the trade of Glafgow, in 1717. To thefe remonftrances the merchants of Glafgow fent fuch anfwers to the commiffioners, as convinced them that the complaints of the Briftol merchants were without foundation. But in 1721, a moft formidable confederacy was entered into by almoft all the tobacco merchants in South Britain againft the trade of Glafgow. Thofe of London, Liverpool, and Whitehaven, prefented feverally to the lords of the treafury, petitions, arraigning the Glafgow merchants of frauds in the tobacco trade. To thefe petitions the Glafgow people gave in replies; and the lords of the treafury, after a full and impartial hearing, were pleafed to difmifs the caufe with the following fentence: "That the complaints of the merchants of London, Liverpool, and Whitehaven, were groundlefs; and that they proceeded from a fpirit of envy, and not from a regard to the intereft of trade, or of the king's revenue."

But the efforts of thefe gentlemen did not ftop here. They brought their complaints into the houfe of commons. Commiffioners were fent to Glafgow in 1722, who gave in their reports to the houfe in 1723. The merchants fent up diftinct and explicit anfwers to thefe reports; but fuch was the intereft of their adverfaries, that thefe anfwers were difregarded. New officers were appointed at the ports of Greenock and Port Glafgow, whofe private inftructions feem to have been to ruin the trade if poffible, by putting all imaginable hardfhips upon it. Hence it languifhed till the year 1735; but after that time it began to revive, though even after its revival it was carried on but flowly for a confiderable fpace of time.

At laft, however, the active and enterprifing fpirit of the merchants, feconding the natural advantages of their fituation, prevailed over all oppofition; and the American trade continued to flourifh and increafe until the year 1775, infomuch that the importation of tobacco into Clyde that year from the provinces of Virginia, Maryland, and Carolina, amounted to 57,143 hogfheads. But fince the breach with America, this trade has now greatly fallen off, and very large fums are faid to remain due to the merchants from that quarter of the world.

With

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28 Manufactures of Glafgow.

With regard to the manufactures of Glafgow, Mr Gibfon is of opinion that the commerce to America firft fuggefted the idea of introducing them, in any confiderable degree at leaft. The firft attempts in this way were about the year 1725, and their increafe for fome time was very flow, nor did they begin to be confiderable till great encouragement was given by the legiflature to the linen manufacture in Scotland. The firft caufes of the fuccefs of this manufacture were the act of parliament in 1748, whereby the wearing of French cambrics was prohibited under fevere penalties; that of 1751, allowing weavers in flax or hemp to fettle and exercife their trades anywhere in Scotland free from all corporation dues; and the bounty of three halfpence per yard on all linens exported at and under 18d. per yard. Since that time a fpirit of manufacture has been excited among the inhabitants of Glafgow; and great variety of goods, and in very great quantity, have been manufactured. Checks, linen, and linen and cotton, are manufactured to a great extent. Printed linens and cottons were begun to be manufactured in 1738; but they only made garments till 1754, when handkerchiefs were firft printed.

Incles were firft made here about the year 1732.—The engine looms ufed at that time were fo inconvenient, and took up fo much time in making the goods, that the Dutch, who were the only people poffeffed of the large incle looms, were almoft folely in poffeffion of this manufacture. Mr Hervey, who began this branch in Glafgow, was fo fenfible of the difadvantages under which it laboured, that he went over to Holland; and in fpite of the care and attention which the Dutch took to conceal their methods of manufacturing, he brought over with him from Haerlem two of their looms, and one of their workmen. This Dutchman remained fome years in Glafgow; but on fome difguft he went to Manchefter, and inftructed the people there in the method of carrying on the manufacture.

In 1757, carpets were begun to be made, and are now carried on to a confiderable extent. Hunters cloths, blankets, and other goods of the fame kind, are alfo made.

Befides thefe, a great variety of articles are manufactured at Glafgow, of which our limits will not permit us to enter into a detail, fuch as foap, refining of fugar, ironmongery, brafs, jewellery, glafs both common and white, pottery, &c. Types for printing are made in this city by Dr Wilfon and Sons, equal, if not fuperior, in beauty to any others in Britain. Printing of books was firft begun here by George Anderfon about the year 1638. But there was no good printing in Glafgow till the year 1735, when Robert Urie printed feveral books in a very elegant manner. The higheft perfection, however, to which printing hath yet been carried in this place, or perhaps in any other, was by the late Robert and Andrew Foulis, (who began in the year 1740); as the many correct and fplendid editions of books printed by them in different languages fufficiently teftify. Some of their claffics, it is faid, are held in fuch high efteem abroad, as to fell nearly at the price of ancient MSS. The fame gentlemen alfo eftablifhed an academy of painting; but the wealth of Scotland being unequal to the undertaking, it has been fince given up.

Since the ftagnation of the American trade, already noticed, the merchants of Glafgow have turned their attention more to manufactures, which have of late, efpecially that of cottons and muflins, increafed in a very rapid degree, and bid fair for putting the city in a more flourifhing condition than ever it was before. The manufacturing houfes, the influx of people for carrying on the manufactures, the means and encouragement which thefe afford to population, and the wealth thence derived by individuals as well as accruing to the community, have all tended lately to increafe, and are daily increafing, the extent of the city, and the elegance of the buildings. Befides various improvements in the old ftreets, feveral handfome new ones as well as new fquares have been added. The fite of thefe new buildings is the tract of rifing ground already mentioned as the north boundary of the town previous to its late extenfion. The weftern part of it, which is perfectly level, is occupied by a fpacious fquare, denominated *George's Square;* two fides of which are built and inhabited, and a third begun. The grafs plot in the middle is enclofed with a handfome iron railing. The fquare is deficient in regularity; the houfes on the weft fide being a ftory higher than thofe of the eaft; but in other refpects it is very neat. To the eaft of this fquare are feveral new ftreets laid out and paved, and fome of them almoft completely built on. The principal, though as yet the moft incomplete of thofe ftreets, is Ingram Street, which runs from eaft to weft. From this the others begin; fome of them being carried northward up the hill, others going fouthward and joining the main ftreet of the town. One of the fineft of thefe crofs ftreets is Hutchefon Street.

The fouth boundary of the city was mentioned to be the Clyde. Over this river there are two bridges. 29 The river, &c.
One of them, the Old Bridge, built about 400 years ago by Archbifhop Rae, but fince repaired and partly rebuilt, confifts of eight arches; and connects the fuburb of Gorbals, fituated on the oppofite fide of the river, with the city. The other is the New Bridge, defcribed above.—On the banks of the river, eaftward, is the Green, a fpot appropriated to the ufe of the inhabitants, with conveniences for wafhing and drying linens, and with agreeable and extenfive walks for recreation.

On the fame or fouth fide of the town, weftward, is the Broomielaw, where the quay is fituated. Till within thefe few years, the river here and for feveral miles diftance, was fo fhallow and fo obftructed by fhoals, as to admit only of fmall craft from Greenock, Port Glafgow, and the Highlands; but of late it has been cleared and deepened fo as to admit veffels of confiderable burden; and it is intended to make the depth as nearly equal as poffible to that of the canal, in order that the veffels from Ireland and the weft coaft may not be induced exclufively to afcend the weft end of the canal and deliver their goods at Canal bafon, but may come up Clyde and unload at the Broomielaw.

The government of the city of Glafgow is vefted in 30 Government, revenue, &c. of the city.
a provoft and three bailies, a dean of guild, deacon conveener, and a treafurer, with a common council of 13 merchants and 12 mechanics. The provoft and two of the bailies muft, by the fet of the borough, be elected from the merchant rank, and the other bailie from

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from the trades rank, i. e. the mechanics. The provost is, from courtesy and custom, styled *lord provost.* He is properly lord of the police of the city, president of the community, and is *ex officio* a justice of the peace for both the borough and county.

Many of the inhabitants of Glasgow were convinced of the necessity of a new system of police, a number of years before the sanction of parliament was obtained for that purpose, which was granted in the year 1800. The act vested the management of the police in the lord provost, bailies, dean of guild, deacon conveener, and 24 commissioners, one being chosen out of each ward into which the city is divided. The object of the bill was to procure an extension of the royalty, to pave, light, and clean the streets, for regulating the police, and nominating officers and watchmen, appointing commissioners, raising funds, and granting certain powers to the magistrates and council, town and dean of guild courts, and for several other purposes.

In the framing of this system of police, it has been wisely provided that the commissioners shall not enjoy the office for life; nor even for a long period, but upon the supposition of being re-elected, and that every person properly qualified may have a chance for the office, and by consequence be entitled to a voice in the management of the funds, and in the direction of every thing which respects the institution.

In order to raise funds for defraying the expence of the police establishment, the lord provost, magistrates and commissioners, on the first Monday of September, annually assess all occupiers, renters, or possessors of dwelling houses, cellars, shops, warehouses, and other buildings within the royalty, in proportion to the rent of the different subjects, of which the following table gives an accurate statement.

On the yearly rent of subjects valued at		
4l. and under 6l. sterling annually,	4d.	per pound.
At 6l. and under 10l.	6d.	do.
At 10l. and under 15l.	9d.	do.
At 15l. and upwards,	10d.	do.

As soon as the act passed, those gentlemen who were appointed to carry it into execution, began the discharge of their duty according to the spirit of said act, and the following office-bearers were nominated for that purpose; a master of police, a clerk of ditto, collector, treasurer, surveyor, together with other 15 officers of police, and 74 watchmen. These have power to bring to justice persons guilty of street robberies, house-breakings, assaults, thefts, shop-lifting, picking pockets, frequenters of disorderly houses; to suppress mobs and riots; to assist in extinguishing fires, in guarding and watching the streets, and in assisting the magistrates in every thing which relates to the police, peace, and good order of the city. These officers have hitherto given general satisfaction in the discharge of their duty, by seeing that the streets are kept clean, well lighted and guarded. In a word, property and personal safety are put beyond the reach of danger, and the institution promises to be of the most unspeakable advantage to the inhabitants at large.

Many whole and elegant streets have of late years been added to it, so that its rapid extension, increasing population, and flourishing commerce, justly entitle it to rank with some of the first cities in Scotland, or perhaps in the British empire.

Glasgow.

The revenue of the town arises from a duty upon all grain and meal brought into the city (which tax is denominated *the ladles*); from the rents of lands and houses the property of the community; from an impost of two pennies Scots upon every Scots pint of ale or beer brewed, inbrought, or sold within the city; from certain duties payable out of the markets; from the rents of the seats in churches; from the dues of cranage at the quay, at the weigh-house, &c. As to the tonnage on the river, the pontage of the bridge, and statute work; these, making no part of the city revenue, are kept separate and distinct under the management of commissioners appointed by act of parliament.

31 Number of inhabitants.

About the time of the Union, the number of inhabitants in Glasgow was reckoned about 14,000. In 1765, when a new division of the parishes took place, they were estimated at 28,000. In 1785, when an accurate survey was made, the number was about 36,000; besides the suburbs, containing the Calton, Gorbals, and Anderston, reckoned about 1000. Since that time new buildings, as above noticed, have been erected, and the city has become considerably more populous, but no exact estimate has been made; though it is generally thought that the number of inhabitants cannot at present (1806) be computed at much less than 86,630, and accordingly they are more than doubled since 1791, at which time they only amounted to 41,777.

The climate of Glasgow, similar to that of most other parts of the island, is variable; but there are some circumstances peculiar to its local situation which tend to affect it more than that of some other places nearer the middle of the country. That part of the county in which Glasgow is situated, is almost in the narrowest part of the isthmus betwixt the Forth and Clyde, from which position the air is frequently refreshed by temperate breezes from the sea. The wind is south-west and west for nearly two-thirds of the year, which is saturated with vapour in its passage across the Atlantic; and the sky being frequently clouded with it, the heats of summer are not so intense as in some other places. Fogs are not so common as in the neighbourhood of Edinburgh, and severe frosts are seldom of long continuance, nor are snows either very deep, nor do they lie long. Thunder and lightning are rare about Glasgow, and seldom destructive.

The soil in the vicinity is partly a rich clay and partly a light sand. The grain raised round the city is not sufficient for the consumpt of the inhabitants, but vast quantities are brought from Ireland, Ayrshire, and the east country. While digging the foundation for the Tontine buildings in the midst of the city, a piece of a boat was found several feet below the surface of the ground, imbedded in sand and gravel, from which it would appear that the channel of the river had once run in that direction. In August 1801, while repairing a division of the cathedral, below the pavement opposite to the pulpit, about two feet deep, part of a human skeleton was found, and a gold chain about 30 inches long lying above the bones of the leg. The date on the stone was 1599, but the inscription in the Saxon character was wholly effaced.

The

Glafs.

The general character of the people is that of induftry and attention to bufinefs, by which many of them have arifen to a ftate of independence. They were formerly faid to be remarkable for feverity and apparent fanctity of manners; but at prefent they are not more diftinguifhed in this refpect than any of their neighbours. The crimes of robbery and houfe-breaking were much more frequent at a former period than they are now; but as thefe were for the moft part committed by ftrangers, it would be uncandid on that account to attach blame to the inhabitants: the recent regulations, however, refpecting the internal police of the city, have nearly put a ftop to fuch depredations.

GLASS, a tranfparent, brittle, factitious body, produced from fand melted in a ftrong fire with fixed alkaline falts, lead, flags, &c. till the whole becomes perfectly clear and fine. The word is formed of the Latin *glaftum*, a plant called by the Greeks *ifatis*, by the Romans *vitrum;* by the ancient Britons *guadum*, and by the Englifh *woad.* We find frequent mention of this plant in ancient writers, particularly Cæfar, Vitruvius, Pliny, &c. who relate, that the ancient Britons painted or dyed their bodies with glaftum, guadum, vitrum, &c. i. e. with the blue colour procured from this plant. And hence, the factitious matter we are fpeaking of came to be called *glafs;* as having always fomewhat of this bluifhnefs in it.

1 History of glafs-making.

At what time the art of glafs-making was firft invented, is altogether uncertain. Some imagine it to have been invented before the flood: but of this we have no direct proof, though there is no improbability in the fuppofition; for we know, that it is almoft impoffible to excite a very violent fire, fuch as is neceffary in metallurgic operations, without vitrifying part of the bricks or ftones wherewith the furnace is built. This indeed might furnifh the firft hints of glafs-making; though it is alfo very probable, that fuch imperfect vitrifications would be obferved a long time before people thought of making any ufe of them.

Neri traces the antiquity of glafs as far back as the time of Job. That writer, fpeaking of the value of wifdom (chap. xxviii. verfe 17.), fays, that gold and *cryftal* cannot equal it. But this word, which Neri will have to fignify factitious glafs, is capable of a great many different interpretations, and properly fignifies only whatever is beautiful or tranfparent. Dr Merret will have the art to be as ancient as that of pottery or the making of bricks, for the reafons already given, viz. that by all vehement heat fome imperfect vitrifications are produced. Of this kind undoubtedly was the foffil glafs mentioned by Ferant. Imperator. to have been found under ground where great fires had been. But it is evident, that fuch imperfect vitrifications might have paffed unnoticed for ages; and confequently we have no reafon to conclude from thence, that the art of glafs-making is of fuch high antiquity.

The Egyptians boaft, that this art was taught them by their great Hermes. Ariftophanes, Ariftotle, Alexander Aphrodifeus, Lucretius, and St John the divine, put it out of all doubt that glafs was ufed in their days. Pliny relates, that it was firft difcovered accidentally in Syria, at the mouth of the river Belus, by certain merchants driven thither by a ftorm at fea; who being obliged to continue there, and drefs their victuals by making a fire on the ground, where there was great plenty of the herb kali; that plant, burning to afhes, its falts mixed and incorporated with the fand, or ftones fit for vitrification, and thus produced glafs; and that, this accident being known, the people of Sidon in that neighbourhood effayed the work, and brought glafs into ufe; fince which time the art has been continually improving. Be this as it will, however, the firft glafs-houfes mentioned in hiftory were erected in the city of Tyre, and here was the only ftaple of the manufacture for many ages. The fand which lay on the fhore for about half a mile round the mouth of the river Belus was peculiarly adapted to the making of glafs, as being neat and glittering; and the wide range of the Tyrian commerce gave an ample vent for the productions of the furnace.

Mr Nixon, in his obfervations on a plate of glafs found at Herculaneum, which was deftroyed A. D. 80, on which occafion Pliny loft his life, offers feveral probable conjectures as to the ufes to which fuch plates might be applied. Such plates, he fuppofes, might ferve for *fpecula* or looking glaffes; for Pliny, in fpeaking of Sidon, adds, *fiquidem etiam fpecula excogitaverat:* the reflection of images from thefe ancient fpecula being effected by befmearing them behind, or tinging them through with fome dark colour. Another ufe in which they might be employed, was for adorning the walls of their apartments, by way of wainfcot, to which Pliny is fuppofed to refer by his *vitreæ cameræ*, lib. xxxvi. cap. 25. § 64. Mr Nixon farther conjectures, that thefe glafs plates might be ufed for windows, as well as the lamina of *lapis fpecularis* and *phengites*, which were improvements in luxury mentioned by Seneca and introduced in his time, Ep. xc. However, there is no pofititive authority relating to the ufage of glafs windows earlier than the clofe of the third century: *Manifeftius eft* (fays Lactantius*), *mentem effe, quæ per oculos ea quæ funt oppofita, tranfpiciat, quafi per feneftras lucente vitro aut fpeculari lapide obductas.*

* *De opif. Dei*, cap. 5.

The firft time we hear of glafs made among the Romans was in the reign of Tiberius, when Pliny relates that an artift had his houfe demolifhed for making glafs malleable, or rather flexible; though Petronius Arbiter, and fome others, affure us, that the emperor ordered the artift to be beheaded for his invention.

It appears, however, that before the conqueft of Britain by the Romans, glafs-houfes had been erected in this ifland, as well as in Gaul, Spain, and Italy.—Hence, in many parts of the country are to be found annulets of glafs, having a narrow perforation and thick rim, denominated by the remaining Britons *gleineu naidreedh*, or *glafs adders*, and which were probably in former times ufed as amulets by the druids †. It can fcarcely be queftioned that the Britons were fufficiently well verfed in the manufacture of glafs, to form out of it many more ufeful inftruments than the glafs beads. Hiftory indeed affures us, that they did manufacture a confiderable quantity of glafs veffels. Thefe, like their annulets, were moft probably green, blue, yellow, or black, and many of them curioufly ftreaked with other colours. The procefs in the manufacture would be nearly the fame with that of the Gauls or Spaniards. The fand of their fhores being reduced to a fufficient degree of finenefs by art, was mixed with three-fourths of

† See *Anguinum Ovum.*

Glass.

of its weight of their nitre (much the ſame with our kelp), and both were melted together. The metal was then poured into other veſſels, where it was left to harden into a maſs, and afterwards replaced in the furnace, where it became tranſparent in the boiling, and was afterwards figured by blowing, or modelling in the lath, into ſuch veſſels as they wanted.

It is not probable that the arrival of the Romans would improve the glaſs manufacture among the Britons. The taſte of the Romans at that time was juſt the reverſe of that of the inhabitants of this iſland. The former preferred ſilver and gold to glaſs for the compoſition of their drinking veſſels. They made indeed great improvements in their own at Rome, during the government of Nero. The veſſels then formed of this metal rivalled the bowls of porcelain in their dearneſs, and equalled the cups of cryſtal in their tranſparency. But theſe were by far too coſtly for common uſe; and therefore, in all probability, were never attempted in Britain. The glaſs commonly made uſe of by the Romans was of a quality greatly inferior; and, from the fragments which have been diſcovered at the ſtations or towns of either, appear to have conſiſted of a thick, ſometimes white, but moſtly blue green, metal.

According to venerable Bede, artificers ſkilled in making glaſs for windows were brought over into England in the year 674, by Abbot Benedict, who were employed in glazing the church and monaſtery of Weremouth. According to others, they were firſt brought over by Wilfrid, biſhop of Worceſter, about the ſame time. Till this time the art of making ſuch glaſs was unknown in Britain; though glaſs windows did not begin to be common before the year 1180; till this period they were very ſcarce in private houſes, and conſidered as a kind of luxury, and as marks of great magnificence. Italy had them firſt, next France, from whence they came into England.

Venice, for many years, excelled all Europe in the fineneſs of its glaſſes; and in the thirteenth century, the Venetians were the only people that had the ſecret of making cryſtal looking glaſſes. The great glaſs works were at Muran, or Murano, a village near the city, which furniſhed all Europe with the fineſt and largeſt glaſſes.

The glaſs manufacture was firſt begun in England in 1557: the finer ſort was made in the place called Crutched Friars, in London; the fine flint glaſs, little inferior to that of Venice, was firſt made in the Savoy houſe, in the Strand, London. This manufacture appears to have been much improved in 1635, when it was carried on with ſea coal or pit coal inſtead of wood, and a monopoly was granted to Sir Robert Manſell, who was allowed to import the fine Venetian flint glaſſes for drinking, the art of making which was not brought to perfection before the reign of William III. But the firſt glaſs plates, for looking glaſſes and coach windows, were made, 1673, at Lambeth, by the encouragement of the duke of Buckingham; who, in 1670, introduced the manufacture of fine glaſs into England, by means of Venetian artiſts, with amazing ſucceſs. So that within a century paſt, the French and Engliſh have not only come up to, but even ſurpaſſed the Venetians, and we are now no longer ſupplied from abroad.

The French made a conſiderable improvement in the art of glaſs, by the invention of a method to caſt very large plates, till then unknown, and ſcarce practiſed yet by any but themſelves and the Engliſh. That court applied itſelf with a laudable induſtry to cultivate and improve the glaſs manufacture. A company of glaſsmen was eſtabliſhed by letters patent; and it was provided by an arret, not only that the working in glaſs ſhould not derogate any thing from nobility, but even that none but nobles ſhould be allowed to work therein.

An extenſive manufactory of this elegant and valuable branch of commerce was firſt eſtabliſhed in Lancaſhire, about the year 1773, through the ſpirited exertions of a very reſpectable body of proprietors, who were incorporated by an act of parliament. From thoſe various difficulties conſtantly attendant upon new undertakings, when they have to contend with powerful foreign eſtabliſhments, it was for ſome time conſiderably embarraſſed; but government, of late, having taken off ſome reſtrictions that bore hard upon it, and made ſome judicious regulations relative to the mode of levying the exciſe duty, it now bids fair to rival, if not ſurpaſs, the moſt celebrated continental manufactures, both with reſpect to the quality, brilliancy, and ſize of its productions.

2
Theory of vitrification uncertain.

With regard to the theory of vitrification, we are almoſt totally in the dark. In general, it ſeems to be that ſtate in which ſolid bodies are, by the vehement action of fire, fitted for being diſſipated or carried off in vapour. In all vitrifications there is a plentiful evaporation: and if any ſolid ſubſtance is carried off in vapour by the intenſe heat of a burning ſpeculum, a vitrification is always obſerved previouſly to take place. The difference, then, between the ſtate of fuſion and vitrification of a ſolid body we may conceive to be, that in the former the element of fire acts upon the parts of the ſolid in ſuch a manner as only to disjoin them, and render the ſubſtance fluid; but in vitrification the fire not only disjoins the particles, but combines with them in a latent ſtate into a third ſubſtance; which, having now as much fire as it can contain, can receive no further change from that element except being carried off in vapour.

But though we are unable to effect this change upon ſolid bodies without a very violent heat, it is otherwiſe in the natural proceſſes. By what we call *cryſtallization*, nature produces more perfect glaſſes than we can make with our furnaces. Theſe are called *precious ſtones*; but in all trials they diſcover the eſſential properties of glaſs, and not of ſtones. The moſt diſtinguiſhing property of glaſs is its reſiſting the force of fire, ſo that this element cannot calcine or change it as it does other bodies, but can only melt it, and then carry it off in vapours. To this laſt all the precious ſtones are ſubject. The diamond (the hardeſt of them all) may be diſſipated in a leſs degree of heat than what would diſſipate common glaſs. Nor can it be any objection to this idea, that ſome kinds of glaſs are capable of being converted into a kind of porcelain by a long-continued cementation with certain materials. This change happens only to thoſe kinds of glaſs which are made of alkaline ſalt and ſand; and Dr Lewis hath ſhown that this change is produced by the diſſipation of the ſaline principle, which is the leaſt fixed of the two. Glaſs, therefore, we may ſtill conſider as a ſubſtance upon which the fire has

Glafs. has no other effect than either to melt or diffipate it in vapour.

The other properties of glafs are very remarkable, fome of which follow :

3 Remarkable properties of glafs.

1. It is one of the moft elaftic bodies in nature. If the force with which glafs balls ftrike each other be reckoned 16, that wherewith they recede by virtue of their elafticity will be nearly 15.

2. When glafs is fuddenly cooled, it becomes exceedingly brittle; and this brittlenefs is fometimes attended with very furprifing phenomena. Hollow balls made of unannealed glafs, with a fmall hole in them, will fly to pieces by the heat of the hand only, if the hole by which the internal and external air communicate be ftopped with a finger. Some veffels, however, made of fuch unannealed glafs have been difcovered, which have the remarkable property of refifting very hard ftrokes given from without, though they fhiver to pieces by the fhocks received from the fall of very light and minute bodies dropped into their cavities. Thefe glaffes may be made of any fhape: all that needs be obferved in making them is, that their bottom be thicker than their fides. The thicker the bottom is, the eafier do the glaffes break. One whofe bottom is three fingers breadth in thicknefs flies with as much eafe at leaft as the thinneft glafs. Some of thefe veffels have been tried with ftrokes of a mallet fufficient to drive a nail into wood tolerably hard, and have held good without breaking. They have alfo refifted the fhock of feveral heavy bodies, let fall into their cavities, from the height of two or three feet; as mufket balls, pieces of iron, or other metal pyrites, jafper, wood, bone, &c. But this is not furprifing, as other glaffes of the fame fhape and fize will do the fame: but the wonder is, that taking a fhiver of flint of the fize of a fmall pea, and letting it fall into the glafs only from the height of three inches, in about two feconds the glafs flies, and fometimes at the very moment of the fhock; nay, a bit of flint no larger than a grain, dropped into feveral glaffes fucceffively, though it did not immediately break them, yet when fet by, they all flew in lefs than three quarters of an hour. Some other bodies produce the fame effect with flint; as fapphire, diamond, porcelain, hard tempered fteel; alfo marbles fuch as boys play with, and likewife pearls.

4 Surprifing fragility of unannealed glafs.

Thefe experiments were made before the Royal Society; and fucceeded equally when the glaffes were held in the hand, when they were refted on a pillow, put in water, or filled with water. It is alfo remarkable, that the glaffes broke upon having their bottoms flightly rubbed with the finger, though fome of them did not fly till half an hour after the rubbing. If the glaffes are everywhere extremely thin, they do not break in thefe circumftances.

5 Attempts to account for it.

Some have pretended to account for thefe phenomena, by faying, that the bodies dropped into the veffels caufe a concuffion which is ftronger than the cohefive force of the glafs, and confequently that a rupture muft enfue. But why does not a ball of iron, gold, filver, or copper, which are perhaps a thoufand times heavier than the flint, produce the fame effect? It is becaufe they are not elaftic. But furely iron is more elaftic than the end of one's finger. Mr Euler has endeavoured to account for thefe appearances from his principles of percuffion. He thinks that this experiment entirely overthrows the opinion of thofe who meafure the force of percuffion by the *vis viva*, or abfolute apparent ftrength of the ftroke. According to his principles, the great hardnefs and angular figure of the flint, which makes the fpace of contact with the glafs extremely fmall, ought to caufe an impreffion on the glafs vaftly greater than lead, or any other metal; and this may account for the flint's breaking the veffel, though the bullet, even falling from a confiderable height, does no damage. Hollow cups made of green bottle glafs, fome of them three inches thick at the bottom, were inftantly broken by a fhiver of flint weighing about two grains, though they had refifted the fhock of a mufket ball from the height of three feet.

That Mr Euler's theory cannot be conclufive more than the other, muft appear evident from a very flight confideration. It is not by angular bodies alone that the glaffes are broken. The marbles with which children play are round, and yet they have the fame effect with the angular flint. Befides, if it was the mere force of percuffion which broke the glaffes, undoubtedly the fracture would always take place at the very inftant of the ftroke; but we have feen that this did not happen fometimes till a very confiderable fpace of time had elapfed. It is evident, therefore, that this effect is occafioned by the putting in motion fome fubtile fluid with which the fubftance of the glafs is filled; and that the motions of this fluid, when once excited in a particular part of the glafs, foon propagate themfelves through the whole or greateft part of it, by which means the cohefive power becomes at laft too weak to refift them. There can be little doubt that the fluid juft now mentioned is that of electricity. It is known to exift in glafs in very great quantity; and it alfo is known to be capable of breaking glaffes even when annealed with the greateft care, if put into too violent a motion. Probably the cooling of glafs haftily may make it more electric than is confiftent with its cohefive power, fo that it is broken by the leaft increafe of motion in the electric fluid by friction or otherwife. This is evidently the cafe when it is broken by rubbing with the finger; but why it fhould alfo break by the mere contact of flint and the other bodies above mentioned, has not yet been fatisfactorily accounted for.

6 Rotation of glafs tubes before a fire.

A moft remarkable phenomenon alfo is produced in glafs tubes placed in certain circumftances. When thefe are laid before a fire in a horizontal pofition, having their extremities properly fupported, they acquire a rotatory motion round their axis, and alfo a progreffive motion towards the fire, even when their fupports are declining from the fire, fo that the tubes will move a little way up hill towards the fire. When the progreffive motion of the tubes towards the fire is ftopped by any obftacle, their rotation ftill continues. When the tubes are placed in a nearly upright pofture, leaning to the right hand, the motion will be from eaft to weft; but if they lean to the left hand, their motion will be from weft to eaft; and the nearer they are placed to the perfectly upright pofture, the lefs will the motion be either way.

If the tube is placed horizontally on a glafs pane, the fragment, for inftance, of coach window-glafs, inftead ſtead of moving towards the fire, it will move from it, and about its axis in a contrary direction to what it had done before; nay, it will recede from the fire, and move a little up hill when the plane inclines towards the fire. Theſe experiments are recorded in the Philoſophical Tranſactions*. They ſucceeded beſt with tubes about 20 or 22 inches long, which had in each end a pretty ſtrong pin fixed in cork for an axis.

* N° 476. § 1.

7 Attempts to account for it.

The reaſon given for theſe phenomena, is the ſwelling of the tubes towards the fire by the heat, which is known to expand all bodies. For, ſay the adopters of this hypotheſis, granting the exiſtence of ſuch a ſwelling, gravity muſt pull the tube down when ſupported near its extremities; and a freſh part being expoſed to the fire, it muſt alſo ſwell out and fall down, and ſo on.—But without going farther in the explanation of this hypotheſis, it may be here remarked, that the fundamental principle on which it proceeds is falſe; for though fire indeed make bodies expand, it does not increaſe them in weight; and therefore the ſides of the tube, though one of them is expanded by the fire, muſt ſtill remain *in equilibrio;* and hence we muſt conclude, that the cauſes of theſe phenomena remain yet to be diſcovered.

4. Glaſs is leſs dilatable by heat than metalline ſubſtances, and ſolid glaſs ſticks are leſs dilatable than tubes. This was firſt diſcovered by Col. Roy, in making experiments in order to reduce barometers to a greater degree of exactneſs than hath hitherto been found practicable; and ſince his experiments were made, one of the tubes 18 inches long, being compared with a ſolid glaſs rod of the ſame length, the former was found by a pyrometer to expand four times as much as the other, in a heat approaching to that of boiling oil.—On account of the general quality which glaſs has of expanding leſs than metal, M. de Luc recommends it to be uſed in pendulums: and he ſays it has alſo this good quality, that its expanſions are always equable, and proportioned to the degrees of heat; a quality which is not to be found in any other ſubſtance yet known.

Phil. Tranſ. vol. lxvii. p. 663.

Ibid. vol. lxviii. p. 474.

5. Glaſs appears to be more fit for the condenſation of vapours than metallic ſubſtances. An open glaſs filled with water, in the ſummer time, will gather drops of water on the outſide, juſt as far as the water in the inſide reaches; and a perſon's breath blown on it manifeſtly moiſtens it. Glaſs alſo becomes moiſt with dew, when metals do not. See Dew.

6. A drinking glaſs partly filled with water, and rubbed on the brim with a wet finger, yields muſical notes, higher or lower as the glaſs is more or leſs full; and will make the liquor friſk and leap. See Harmonica.

7. Glaſs is poſſeſſed of very great electrical virtues. See Electricity, *paſſim.*

8 Materials for glaſs.

Materials for Making of Glass. The materials whereof glaſs is made, we have already mentioned to be ſalt and ſand or ſtones.

1. The ſalt here uſed is procured from a ſort of aſhes brought from the Levant, called *polverine,* or *rochetta;* which aſhes are thoſe of a ſort of water plant called *kali* †, cut down in the ſummer, dried in the ſun, and burnt in heaps, either on the ground or on iron grates; the aſhes falling into a pit, grow into a hard maſs, or ſtone, fit for uſe. It may alſo be procured from common kelp, or the aſhes of the *fucus veſiculoſus.* See Kelp.

† See *Salſola, Botany Index.*

To extract the ſalt, theſe aſhes, or polverine, are powdered and ſifted, then put into boiling water, and there kept till one third of the water be conſumed; the whole being ſtirred up from time to time, that the aſhes may incorporate with the fluid, and all its ſalts be extracted: then the veſſel is filled up with new water, and boiled over again, till one half be conſumed; what remains is a ſort of ley, ſtrongly impregnated with ſalt. This ley, boiled over again in freſh coppers, thickens in about 24 hours, and ſhoots its ſalt; which is to be ladled out, as it ſhoots, into earthen pans, and thence into wooden vats to drain and dry. This done, it is groſsly pounded, and thus put in a ſort of oven, called *calcar,* to dry. It may be added, that there are other plants, beſides kali and fucus, which yield a ſalt fit for glaſs: ſuch are the common way thiſtle, bramble, hops, wormwood, woad, tobacco, fern, and the whole leguminous tribe, as peaſe, beans, &c.

Pearl aſhes form a leading flux in the manufacture of glaſs, and moſtly ſupply the place of the Levant aſhes, the barillas of Spain, and many other kinds, which were formerly brought here for making both glaſs and ſoap.

There are other fluxes uſed for different kinds of glaſs, and for various purpoſes, as calcined lead, nitre, ſea ſalt, borax, arſenic, ſmiths clinkers, and wood-aſhes, containing the earth and lixiviate ſalts as produced by incineration. With regard to theſe ſeveral fluxes, we may obſerve, in general, that the more calx of lead, or other metallic earth, enters into the compoſition of any glaſs, ſo much the more fuſible, ſoft, coloured, and denſe this glaſs is, and reciprocally.

The colours given to glaſs by calces of lead, are ſhades of yellow: on the other hand, glaſſes that contain only ſaline fluxes partake of the properties of ſalts; they are leſs heavy, leſs denſe, harder, whiter, more brilliant, and more brittle than the former; and glaſſes containing both ſaline and metallic fluxes do alſo partake of the properties of both theſe ſubſtances. Glaſſes too ſaline are eaſily ſuſceptible of alteration by the action of air and water: eſpecially thoſe in which alkalies prevail; and theſe are alſo liable to be injured by acids. Thoſe that contain too much borax and arſenic, though at firſt they appear very beautiful, quickly tarniſh and become opake when expoſed to air. By attending to theſe properties of different fluxes, phlogiſtic or ſaline, the artiſt may know how to adjuſt the proportions of theſe to ſand, or powdered flints, for the various kinds of glaſs. See the article Vitrification.

2. The ſand or ſtone, called by the artiſts *tarſo,* is the ſecond ingredient in glaſs, and that which gives it the body and firmneſs. Theſe ſtones, Agricola obſerves, muſt be ſuch as will fuſe; and of theſe ſuch as are white and tranſparent are beſt; ſo that cryſtal challenges the precedency of all others.

At Venice they chiefly uſe a ſort of pebble, found in the river Teſino, reſembling white marble, and called *cuogolo.* Indeed Ant. Neri aſſures us, that all ſtones which will ſtrike fire with ſteel, are fit to vitrify; but Dr Morret ſhows, that there are ſome exceptions from this

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this rule. Flints are admirable; and when calcined, powdered, and fearced, make a pure white cryftalline metal: but the expence of preparing them makes the mafters of our glafs-houfes fparing of their ufe. Where proper ftones cannot be fo conveniently had, fand is ufed. The beft for this purpofe is that which is white, fmall, and fhining; examined by the microfcope, it appears to be fmall fragments of rock cryftal. For green glafs, that which is of a foft texture, and more gritty; it is to be well wafhed, which is all the preparation it needs. Our glafs-houfes are furnifhed with white fand for their cryftal glaffes from Lynn in Norfolk and Maidftone in Kent, and with the coarfer for green glafs from Woolwich.

Some mention a third ingredient in glafs, viz. manganefe, a kind of pfeudo loadftone, dug up in Germany, Italy, and even in Mendip hills in Somerfetfhire. But the proportion hereof to the reft is very inconfiderable; befide, that it is not ufed in all glafs. Its office is to purge off the natural greenifh colour, and give it fome other tincture required.

For this purpofe it fhould be chofen of a deep colour, and free from fpecks of metalline appearance, or a lighter caft; manganefe requires to be well calcined in a hot furnace, and then to undergo a thorough levigation. The effect of manganefe in deftroying the colours of glafs, and hence called the foap of glafs, is accounted for by M. Montamy, in his *Traité des Couleurs pour la Peinture en Email*, in the following manner: the manganefe deftroys the green, olive, and blue colours of glafs, by adding to them a purple tinge, and by the mixture producing a blackifh brown colour; and as blacknefs is caufed merely by an abforption of the rays of light, the blackifh tinge given to the glafs by the mixture of colours, prevents the reflection of fo many rays, and thus renders the glafs lefs coloured than before. But the black produced by this fubftance fuggefts an obvious reafon for ufing it very fparingly in thofe compofitions of glafs which are required to be very tranfparent. Nitre or faltpetre is alfo ufed with the fame intention; for by deftroying in a certain degree the phlogifton which gives a ftrong tinge of yellow to glafs prepared with lead as a flux, it ferves to free it from this coloured tinge; and in faline glaffes, nitre is requifite in a fmaller proportion to render them fufficiently tranfparent, as in the cafe of looking glafs and other kinds of plates.

Kinds of Glass. The manufactured glafs now in ufe may be divided into three general kinds; white tranfparent glafs, coloured glafs, and common green or bottle glafs. Of the firft kind there is a great variety; as the flint glafs, as it is called with us, and the German cryftal glafs, which are applied to the fame ufes; the glafs for plates, for mirrors, or looking glaffes; the glafs for windows and other lights; and the glafs for phials and fmall veffels. And thefe again differ in the fubftances employed as fluxes in forming them, as well as in the coarfenefs or finenefs of fuch as are ufed for their body. The flint and cryftal, mirror and beft window glafs, not only require fuch purity in the fluxes, as may render it practicable to free the glafs perfectly from all colour; but for the fame reafon likewife, either the white Lynn fand, calcined flints, or white pebbles, fhould be ufed. The others do not demand the fame nicety in the choice of the materials; though the fecond kind of window glafs, and the beft kind of phial, will not be fo clear as they ought, if either too brown fand or impure falts be fuffered to enter into their compofition.

Of coloured glafs there is a great variety of forts, differing in their colour or other properties according to the occafions for which they are wanted. The differences in the latter kind depend on the accidental preparation and management of the artifts by whom they are manufactured, as will be afterwards explained.

Furnaces for the Making of Glass. In this manufacture there are three forts of furnaces; one called *calcar* is for the frit; the fecond is for working the glafs; the third ferves to anneal the glafs, and is called the *leer*. See Plate CCXLVII.

The calcar refembles an oven ten feet long, feven feet broad, and two deep; the fuel, which in Britain is fea coal, is put into a trench on one fide of the furnace; and the flame reverberating from the roof upon the frit calcines it. The glafs furnace, or working furnace, is round, of three yards diameter, and two high: or thus proportioned. It is divided into three parts, each of which is vaulted. The lower part is properly called the *crown*, and is made in that form. Its ufe is to keep a brifk fire, which is never put out. The mouth is called the *bocca*. There are feveral holes in the arch of this crown, through which the flame paffes into the fecond vault or partition, and reverberates into the pots filled with the ingredients above mentioned. Round the infides are eight or more pots placed, and piling pots on them. The number of pots is always double that of the boccas or mouths, or of the number of workmen, that each may have one pot refined to work out of, and another for metal to refine in while he works out of the other. Through the working holes the metal is taken out of the pots, and the pots are put into the furnace; and thefe holes are ftopped with moveable covers made of lute and brick, to fcreen the workmen's eyes from the fcorching flames. On each fide of the bocca or mouth is a bocarella or little hole, out of which coloured glafs or finer metal is taken from the piling pot. Above this oven there is the third oven or *leer*, above five or fix yards long, where the veffels or glafs are annealed or cooled: this part confifts of a tower, befides the leer, into which the flame afcends from the furnace. The tower has two mouths, through which the glaffes are put in with a fork, and fet on the floor or bottom: but they are drawn out on iron pans called *fraches*, through the leer, to cool by degrees; fo that they are quite cold by the time they reach the mouth of the leer, which enters the farofel or room where the glaffes are to be ftowed.

But the green-glafs furnace is fquare; and at each angle it has an arch for annealing or cooling glaffes. The metal is wrought on two oppofite fides, and on the other two they have their colours, into which are made linnet holes for the fire to come from the furnace to bake the frit, and to difcharge the fmoke. Fires are made in the arches to anneal the work, fo that the whole procefs is done in one furnace.

Thefe furnaces muft not be of brick, but of hard fandy ftones. In France, they build the outfide of brick; and the inner part, to bear the fire, is made of a

fort

ſort of fullers earth, or tobacco-pipe clay, of which earth they alſo make their melting pots. In Britain the pots are made of Stourbridge clay.

Mr Blancourt obſerves, that the worſt and rougheſt work in this art is the changing the pots when they are worn out or cracked. In this caſe, the great working hole muſt be uncovered; the faulty pot muſt be taken out with iron hooks and forks, and a new one muſt be ſpeedily put in its place, through the flames, by the hands only. For this work, the man guards himſelf with a garment made of ſkins, in the ſhape of a pantaloon, that covers him all but his eyes, and is made as wet as poſſible; the eyes are defended with a proper ſort of glaſs.

Inſtruments for Making of GLASS. The inſtruments made uſe of in this work may be reduced to theſe that follow. A blowing pipe, made of iron, about two feet and a half long, with a wooden handle. An iron rod to take up the glaſs after it is blown, and to cut off the former. Sciſſars to cut the glaſs when it comes off from the firſt hollow iron. Shears to cut and ſhape great glaſſes, &c. An iron ladle, with the end of the handle caſed with wood, to take the metal out of the refining pot, to put it into the workmen's pots. A ſmall iron ladle caſed in the ſame manner, to ſkim the alkalic ſalt that ſwims at top. Shovels, one like a peel, to take up the great glaſſes; another like a fire-ſhovel, to feed the furnace with coals. A hooked iron fork, to ſtir the matter in the pots. An iron rake for the ſame purpoſe, and to ſtir the frit. An iron fork, to change or pull the pots out of the furnace, &c.

Compoſitions for White and Cryſtal GLASS. 1. To make *cryſtal glaſs*, take of the whiteſt tarſo, pounded ſmall, and ſearced as fine as flour, 200 pounds; of the ſalt of polverine 130 pounds; mix them together, and put them into the furnace called the *calcar*, firſt heating it. For an hour keep a moderate fire, and keep ſtirring the materials with a proper rake, that they may incorporate and calcine together; then increaſe the fire for five hours; after which take out the matter; which being now ſufficiently calcined, is called *frit*. From the calcar put the frit in a dry place, and cover it up from the duſt for three or four months. Now to make the glaſs or cryſtal: take of this cryſtal frit, called alſo *bollito*; ſet it in pots in the furnace, adding to it a due quantity of magneſia or manganeſe: when the two are fuſed, caſt the fluor into fair water, to clear it of the ſalt called *ſandiver*; which would otherwiſe make the cryſtal obſcure and cloudy. This lotion muſt be repeated again and again, as often as needful, till the cryſtal be fully purged; or this ſcum may be taken off by means of proper ladles. Then ſet it to boil four, five, or ſix days; which done, ſee whether it have manganeſe enough; and if it be yet greeniſh, add more manganeſe, at diſcretion, by little and little at a time, taking care not to overdoſe it, becauſe the manganeſe inclines it to a blackiſh hue. Then let the metal clarify, till it becomes of a clear and ſhining colour; which done, it is fit to be blown or formed into veſſels at pleaſure.

2. *Flint glaſs*, as it is called by us, is of the ſame general kind with that which in other places is called cryſtal glaſs. It has this name from being originally made with calcined flints, before the uſe of the white ſand was underſtood; and retains the name, though no flints are now uſed in the compoſition of it. This flint glaſs differs from the other, in having lead for its flux, and white ſand for its body; whereas the fluxes uſed for the cryſtal glaſs are ſalts or arſenic, and the body conſiſts of calcined flints or white river pebbles, tarſo, or ſuch ſtones. To the white ſand and lead a proper proportion of nitre is added, to burn away the phlogiſton of the lead, and alſo a ſmall quantity of magneſia; and in ſome works they uſe a proportional quantity of arſenic to aid the fluxing ingredients. The moſt perfect kind of flint glaſs may be made by fuſing with a very ſtrong fire 120 pounds of the white ſand, 50 pounds of red lead, 40 pounds of the beſt pearl aſhes, 20 pounds of nitre, and five ounces of magneſia. Another compoſition of flint glaſs, which is ſaid to come nearer to the kind now made, is the following: 120 pounds of ſand, 54 pounds of the beſt pearl aſhes, 36 pounds of red lead, 12 pounds of nitre, and 6 ounces of magneſia. To either of theſe a pound or two of arſenic may be added, to increaſe the flux of the compoſition. A cheaper compoſition of flint glaſs may be made with 120 pounds of white ſand, 35 pounds of the beſt pearl aſhes, 40 pounds of red lead, 13 pounds of nitre, 6 pounds of arſenic, and 4 ounces of magneſia; or inſtead of the arſenic may be ſubſtituted 15 pounds of common ſalt; but this will be more brittle than the other. The cheapeſt compoſition for the worſt kind of flint glaſs conſiſts of 120 pounds of white ſand, 30 pounds of red lead, 20 pounds of the beſt pearl aſhes, 10 pounds of nitre, 15 pounds of common ſalt, and ſix pounds of arſenic. The beſt German cryſtal glaſs is made of 120 pounds of calcined flints or white ſand, 70 pounds of the beſt pearl aſhes, 10 pounds of ſaltpetre, half a pound of arſenic, and five ounces of magneſia. And a cheaper compoſition is formed of 120 pounds of calcined flints or white ſand, 46 pounds of pearl aſhes, 7 pounds of nitre, 6 pounds of arſenic, and 5 ounces of magneſia.

A glaſs much harder than any prepared in the common way, may be made by means of borax in the following method: Take four ounces of borax, and an ounce of fine ſand; reduce both to a ſubtile powder, and melt them together in a large cloſe crucible ſet in a wind furnace, keeping up a ſtrong fire for half an hour; then take out the crucible, and when cold break it, and there will be found at the bottom a pure hard glaſs capable of cutting common glaſs like a diamond. This experiment, duly varied, ſays Dr Shaw, may lead to ſeveral uſeful improvements in the arts of glaſs, enamels, and factitious gems, and ſhows an expeditious method of making glaſs, without any fixed alkali, which has been generally thought an eſſential ingredient in glaſs, and it is not yet known whether calcined cryſtal or other ſubſtances being added to this ſalt inſtead of ſand, it might not make a glaſs approaching to the nature of a diamond.

There are three principal kinds of glaſſes, diſtinguiſhed by the form or manner of working them; viz. I. *Round glaſs*, as thoſe of our veſſels, phials, drinking glaſſes, &c. II. *Table* or *window glaſs*, of which there are divers kinds; viz. crown glaſs, jealous glaſs, &c. III. *Plate glaſs*, or *mirror glaſs*.

I. *Working or Blowing Round* GLASS. The working furnace, we have obſerved, is round, and has ſix boccas or or apertures: at one of thefe, called the *great bocca*, the furnace is heated, and the pots of frit are at this fet in the furnace; two other fmall holes, called *bocarellas*, ferve to lade or take out the melted metal, at the end of an iron, to work the glafs. At the other holes they put in pots of fufible ingredients, to be prepared, and at laft emptied into the lading pot.

There are fix pots in each furnace; all made of tobacco-pipe clay, proper to fuftain not only the heat of the fire, but alfo the effect of the polverine, which penetrates every thing elfe. There are only two of thefe pots that work: the reft ferve to prepare the matter for them. The fire of the furnace is made and kept up with dry hard wood, caft in without intermiffion at fix apertures.

When the matter contained in the two pots is fufficiently vitrified, they proceed to blow or fafhion it. For this purpofe the workman dips his blowing pipe into the melting pot; and by turning it about, the metal fticks to the iron more firmly than turpentine. This he repeats four times, at each time rolling the end of his inftrument, with the hot metal thereon, on a piece of plate iron; over which is a veffel of water which helps to cool, and fo to confolidate and to difpofe that matter to bind more firmly with what is to be taken next out of the melting pot. But after he has dipt a fourth time, and the workman perceives there is metal enough on the pipe, he claps his mouth immediately to the other end of it, and blows gently through the iron tube, till the metal lengthens like a bladder about a foot. Then he rolls it on a marble ftone a little while to polifh it; and blows a fecond time, by which he brings it to the fhape of a globe of about 18 or 20 inches diameter. Every time he blows into the pipe, he removes it quickly to his cheek; otherwife he would be in danger, by often blowing, of drawing the flame into his mouth: and this globe may be flattened by returning it to the fire; and brought into any form by ftamp irons, which are always ready. When the glafs is thus blown, it is cut off at the collet or neck; which is the narrow part that ftuck to the iron. The method of performing this is as follows: the pipe is refted on an iron bar, clofe by the collet; then a drop of cold water being laid on the collet, it will crack about a quarter of an inch, which, with a flight blow or cut of the fhears will immediately feparate the collet.

After this is done, the operator dips the iron rod into the melting pot, by which he extracts as much metal as ferves to attract the glafs he has made, to which he now fixes this rod at the bottom of his work, oppofite to the opening made by the breaking of the collet. In this pofition the glafs is carried to the great bocca or mouth of the oven, to be heated and fcalded; by which means it is again put into fuch a foft ftate, that, by the help of an iron inftrument, it can be pierced, opened, and widened, without breaking. But the veffel is not finifhed till it is returned to the great bocca; where being again heated thoroughly, and turned quickly about with a circular motion, it will open to any fize, by the means of the heat and motion.

If there remain any fuperfluities, they are cut off with the fhears; for till the glafs is cool, it remains in a foft flexible ftate. It is therefore taken from the bocca, and carried to an earthen bench, covered with brands, which are coals extinguifhed, keeping it turning; becaufe that motion prevents any fettling, and preferves an evennefs in the face of the glafs, where, as it cools, it comes to its confiftency; being firft cleared from the iron rod by a flight ftroke by the hand of the workman.

If the veffel conceived in the workman's mind, and whofe body is already made, requires a foot, or a handle, or any other member or decoration, he makes them feparately; and now effays to join them with the help of hot metal, which he takes out of the pots with his iron rod: but the glafs is not brought to its true hardnefs till it has paffed the leer or annealing oven, defcribed before.

II. *Working or blowing of Window or Table* GLASS. The method of working round glafs, or veffels of any fort, is in every particular applicable to the working of window or table glafs, till the blowing iron has been dipt the fourth time. But then inftead of rounding it, the workman blows, and fo manages the metal upon the iron plate, that it extends two or three feet in the form of a cylinder. This cylinder is put again to the fire, and blown a fecond time, and is thus repeated till it is extended to the dimenfions required, the fide to which the pipe is fixed diminifhing gradually till it ends in a pyramidal form; fo that, to bring both ends nearly to the fame diameter, while the glafs is thus flexible, he adds a little hot metal to the end oppofite the pipe, and draws it out with a pair of iron pincers, and immediately cuts off the fame end with the help of a little cold water as before.

The cylinder being now open at one end, is carried back to the bocca; and there, by the help of cold water, it is cut about eight or ten inches from the iron pipe or rod; and the whole length at another place, by which alfo it is cut off from the iron rod. Then it is heated gradually on an earthen table, by which it opens in length; while the workman, with an iron tool, alternately lowers and raifes the two halves of the cylinder; which at laft will open like a fheet of paper, and fall into the fame flat form in which it ferves for ufe; in which it is preferved by heating it over again, cooling it on a table of copper, and hardening it 24 hours in the annealing furnace, to which it is carried upon forks. In this furnace an hundred tables of glafs may lie at a time, without injury to each other, by feparating them into tents, with an iron fhiver between, which diminifhes the weight by dividing it, and keeps the tables flat and even.

Of window or table glafs there are various forts, made in different places, for the ufe of building. Thofe moft known among us are given us by the author of the Builder's Dictionary, as follows:

1. *Crown*, of which, fays Neri, there are two kinds, diftinguifhed by the places where they are wrought; viz. Ratcliff crown glafs, which is the beft and cleareft, and was firft made at the Bear garden, on the Bankfide, Southwark, but fince at Ratcliff: of this there are 24 tables to the cafe, the tables being of a circular form, about three feet fix inches in diameter. The other kind, or Lambeth crown glafs, is of a darker colour than the former, and more inclining to green.

The beft window or crown glafs is made of white fand 60 pounds, of purified pearl afhes 30 pounds, of

faltpetre

Glafs.

faltpetre 15 pounds, of borax one pound, and of arfenic half a pound. If the glafs fhould prove yellow, magnefia muft be added. A cheaper compofition for window glafs confifts of 60 pounds of white fand, 25 pounds of unpurified pearl afhes, 10 pounds of common falt, 5 pounds of nitre, 2 pounds of arfenic, and one ounce and a half of magnefia. The common or green window glafs is compofed of 60 pounds of white fand, 30 pounds of unpurified pearl afhes, 10 pounds of common falt, 2 pounds of arfenic, and 2 ounces of magnefia. But a cheaper compofition for this purpofe confifts of 120 pounds of the cheapeft white fand, 30 pounds of unpurified pearl afhes, 60 pounds of wood afhes, well burnt and fifted, 20 pounds of common falt, and 5 pounds of arfenic.

2. *French glafs*, called alfo *Normandy glafs*, and formerly *Lorraine glafs*, becaufe made in thofe provinces. At prefent it is made wholly in the nine glafs works; five whereof are in the foreft of Lyons, four in the county of Eu; the laft at Beaumont near Rouen. It is of a thinner kind than our crown glafs; and when laid on a piece of white paper, appears of a dirtyifh green colour. There are but 25 tables of this to the cafe.

3. *German glafs* is of two kinds, the *white* and the *green*: the firft is of a whitifh colour, but is fubject to thofe fmall curved ftreaks obferved in our Newcaftle glafs, though free from the fpots and blemifhes thereof. The green, befides its colour, is liable to the fame ftreaks as the white, but both them are ftraighter and lefs warped than our Newcaftle glafs.

4. *Dutch glafs* is not much unlike our Newcaftle glafs either in colour or price. It is frequently much warped like that, and the tables are but fmall.

5. *Newcaftle glafs* is that moft ufed in England. It is of an afh colour, and much fubject to fpecks, ftreaks, and other blemifhes; and befides is frequently warped. Leybourn fays, there are 45 tables to the cafe, each containing five fuperficial feet: fome fay there are but 35 tables, and fix feet in each table.

6. *Phial glafs* is a kind betwixt the flint glafs and the common bottle or green glafs. The beft kind may be prepared with 120 pounds of white fand, 50 pounds of unpurified pearl afhes, 10 pounds of common falt, 5 pounds of arfenic, and 5 ounces of magnefia. The compofition for green or common phial glafs confifts of 120 pounds of the cheapeft white fand, 80 pounds of wood afhes well burnt and fifted, 20 pounds of pearl afhes, 15 pounds of common falt, and 1 pound of arfenic.

The common bottle or green is formed of fand of any kind fluxed by the afhes of burnt wood, or of any parts of vegetables; to which may be added the *fcoriæ* or clinkers of forges. When the fofteft fand is ufed, 200 pounds of wood afhes will fuffice for 100 pounds of fand, which are to be ground and mixed together. The compofition with the clinkers confifts of 170 pounds of wood afhes, 100 pounds of fand, and 50 pounds of clinkers or *fcoriæ*, which are to be ground and mixed together. If the clinkers cannot be ground, they muft be broke into fmall pieces, and mixed with the other matter without any grinding.

III. *Working of Plate or Mirror* Glass. 1. The materials of which this glafs is made are much the fame as thofe of other works of glafs, viz. an alkali, falt and fand.

Glafs.

The falt, however, fhould not be that extracted from polverine or the afhes of the Syrian kali, but that from barilla, growing about Alicant in Spain. It is very rare that we can have the barilla pure; the Spaniards in burning the herb make a practice of mixing another herb along with it, which alters its quality; or of adding fand to it to increafe the weight, which is eafily difcovered if the addition be only made after the boiling of the afhes, but next to impoffible if made in the boiling. It is from this adulteration that thofe threads and other defects in plate glafs arife. To prepare the falt, they clean it well of all foreign matters; pound or grind it with a kind of mill, and finally fift it pretty fine.

Pearl afhes, properly purified, will furnifh the alkali falt requifite for this purpofe; but it will be neceffary to add borax or common falt, in order to facilitate the fufion, and prevent the glafs from ftiffening in that degree of heat in which it is to be wrought into plates. For purifying the pearl afhes, diffolve them in four times their weight of boiling water, in a pot of caft iron, always kept clean from ruft. Let the folution be removed into a clean tub, and remain there 24 hours or longer. Having decanted the clear part of the fluid from the dregs or fediment, put it again in the iron pot, and evaporate the water till the falts are left perfectly dry. Preferve them in ftone jars, well fecured from air and moifture.

Pearl afhes may alfo be purified in the higheft degree, fo as to be proper for the manufacture of the moft tranfparent glafs, by pulverizing three pounds of the beft pearl afhes with fix ounces of faltpetre in a glafs or marble mortar, till they are well mixed; and then putting part of the mixture into a large crucible, and expofing it in a furnace to a ftrong heat. When this is red hot, throw in the reft gradually; and when the whole is red hot, pour it out on a moiftened ftone or marble, and put it into an earthen or clean iron pot, with ten pints of water; heat it over the fire till the falts be entirely melted; let it then ftand to cool, and filter it through paper in a pewter cullender. When it is filtered, put the fluid again into the pot, and evaporate the falt to drynefs, which will then be as white as fnow; the nitre having burnt all the phlogiftic matter that remained in the pearl afhes after their former calcination.

As to the fand, it is to be fifted and wafhed till fuch time as the water come off very clear; and when it is well dried again, they mix it with the falt, paffing the mixture through another fieve. This done, they lay them in the annealing furnace for about two hours; in which time the matter becomes very light and white: in this ftate they are called *frit* or *fritta*; and are to be laid up in a dry clean place, to give them time to incorporate: they lie here for at leaft a year.

When they would employ this frit, they lay it for fome hours in the furnace, adding to fome the fragments or fhards of old and ill made glaffes; taking care firft to calcine the fhards by heating them red hot in the furnace, and thus cafting them into cold water. To the mixture muft likewife be added

Glaſs.

ed mangaheſe, to promote the fuſion and purification.

The beſt compoſition for looking glaſs plates conſiſts of 60 pounds of white ſand cleanſed, 25 pounds of purified pearl aſhes, 15 pounds of ſaltpetre, and 7 pounds of borax. If a yellow tinge ſhould affect the glaſs, a ſmall proportion of magneſia, mixed with an equal quantity of arſenic, ſhould be added. An ounce of the magneſia may be firſt tried; and if this proves inſufficient, the quantity ſhould be increaſed.

A cheaper compoſition for looking glaſs plate conſiſts of 60 pounds of the white ſand, 20 pounds of pearl aſhes, 10 pounds of common ſalt, 7 pounds of nitre, 2 pounds of arſenic, and 1 pound of borax. The matter of which the glaſſes are made at the famous manufacture of St Gobin in France, is a compoſition of ſolder and of a very white ſand, which are carefully cleaned of all heterogeneous bodies; afterwards waſhed for ſeveral times, and dried ſo as to be pulverized in a mill, conſiſting of many peſtles, which are moved by horſes. When this is done, the ſand is ſifted through ſilk ſieves and dried.

The matter thus far prepared is equally fit for plate glaſs, to be formed either for blowing or by caſting.

The largeſt glaſſes at St Gobin are run; the middle ſized and ſmall ones are blown.

2. *Blowing the plates.* The workhouſes, furnaces, &c. uſed in the making of this kind of plate glaſs, are the ſame, except that they are ſmaller, and that the carquaiſſes are diſpoſed in a large covered gallery, over againſt the furnace, as thoſe in the following article, to which the reader is referred.

After the materials are vitrified by the heat of the fire, and the glaſs is ſufficiently refined, the workman dips in his blowing iron, ſix feet long, and two inches in diameter, ſharpened at the end which is put in the mouth, and widened at the other, that the matter may adhere to it. By this means he takes up a ſmall ball of matter, which ſticks to the end of the tube by conſtantly turning it. He then blows into the tube, that the air may ſwell the annexed ball; and carrying it over a bucket of water, which is placed on a ſupport at the height of about four feet, he ſprinkles the end of the tube to which the matter adheres, with water, ſtill turning it, that by this cooling the matter may coaleſce with the tube, and be fit for ſuſtaining a greater weight. He dips the tube again into the ſame pot, and proceeds as before; and dipping it into the pot a third time, he takes it out, loaded with matter, in the ſhape of a pear, about ten inches in diameter, and a foot long, and cools it at the bucket; at the ſame time blowing into the tube, and with the aſſiſtance of a labourer, giving it a balancing motion, he cauſes the matter to lengthen; which, by repeating this operation ſeveral times, aſſumes the form of a cylinder, terminating like a ball at the bottom, and in a point at the top. The aſſiſtant is then placed on a ſtool three feet and a half high; and on this ſtool there are two upright pieces of timber, with a croſs beam of the ſame, for ſupporting the glaſs and tube, which are kept in an oblique poſition by the aſſiſtant, that the maſter workman may with a puncheon ſet in a wooden handle, and with a mallet, make a hole in the maſs: this hole is drilled at the centre of the ball that terminates the cylinder, and is about an inch in diameter. When the glaſs is pierced, the defects of it are perceived; if it is tolerably perfect, the workman lays the tube horizontally on a little iron treſſel, placed on the ſupport of the aperture of the furnace. Having expoſed it to the heat for about half a quarter of an hour, he takes it away, and with a pair of long and broad ſhears, extremely ſharp at the end, widens the glaſs, by inſinuating the ſhears into the hole made with the puncheon, whilſt the aſſiſtant, mounted on the ſtool, turns it round, till at laſt the opening is ſo large as to make a perfect cylinder at bottom. When this is done, the workman lays his glaſs upon the treſſels at the mouth of the furnace to heat it: he then gives it to his aſſiſtant on the ſtool, and with large ſhears cuts the maſs of matter up to half its height. There is at the mouth of the furnace an iron tool called *pontil*, which is now heating, that it may unite and coaleſce with the glaſs juſt cut, and perform the office which the tube did before it was ſeparated from the glaſs. This pontil is a piece of iron ſix feet long, and in the form of a cane or tube, having at the end of it a ſmall iron bar, a foot long, laid equally upon the long one, and making with it a T. This little bar is full of the matter of the glaſs, about four inches thick. This red hot pontil is preſented to the diameter of the glaſs, which coaleſces immediately with the matter round the pontil, ſo as to ſupport the glaſs for the following operation. When this is done, they ſeparate the tube from the glaſs, by ſtriking a few blows with a chiſſel upon the end of the tube which has been cooled; ſo that the glaſs breaks directly, and makes this ſeparation, the tube being diſcharged of the glaſs now adhering to the pontil. They next preſent to the furnace the pontil of the glaſs, laying it on the treſſel to heat, and redden the end of the glaſs, that the workman may open it with his ſhears, as he has already opened one end of it, to complete the cylinder; the aſſiſtant holding it on his ſtool as before. For the laſt time, they put the pontil on the treſſel, that the glaſs may become red hot, and the workman cuts it quite open with his ſhears, right over againſt the forementioned cut; this he does as before, taking care that both cuts are in the ſame line. In the mean time, the man who looks after the carquaiſſes comes to receive the glaſs upon an iron ſhovel two feet and a half long without the handle, and two feet wide, with a ſmall border of an inch and a half to the right and left, and towards the handle of the ſhovel. Upon this the glaſs is laid, flattening it a little with a ſmall ſtick a foot and a half long, ſo that the cut of the glaſs is turned upwards. They ſeparate the glaſs from the pontil, by ſtriking a few gentle blows between the two with a chiſſel. The glaſs is then removed to the mouth of the hot carquaiſſe, where it becomes red hot gradually; the workman, with an iron tool ſix feet long, and widened at the end in form of a club at cards four inches long, and two inches wide on each ſide, very flat, and not half an inch thick, gradually lifts up the cut part of the glaſs to unfold it out of its form of a flattened cylinder, and render it ſmooth, by turning it down upon the hearth of the carquaiſſe. The tool already deſcribed being inſinuated within the cylinder, performs this operation by being puſhed hard againſt all the parts of the glaſs. When the glaſs is thus made quite ſmooth, it is puſhed to the bottom of the carquaiſſe

Glafs.

carquaiffe or annealing furnace with a fmall iron raker, and ranged there with a little iron hook. When the carquaiffe is full, it is ftopped and cemented as in the cafe of run glaffes, and the glafs remains there for a fortnight to be annealed; after which time they are taken out to be polifhed. A workman can make but one glafs in an hour, and he works and refts for fix hours alternately.

Such was the method formerly made ufe of for blowing plate glafs, looking glaffes, &c.; but the workmen, by this method, could never exceed 50 inches in length, and a proportional breadth, becaufe what were larger were always found to warp, which prevented them from reflecting the objects regularly, and wanted fubftance to bear the neceffary grinding. Thefe imperfections have been remedied by the following invention of the Sieur Abraham Thevart, in France, about the year 1688.

3. *Cafting or Running of Large Mirror Glass Plates.* The furnace is of a very large dimenfion, environed with feveral ovens, or annealing furnaces, called *carquaiffes*, befides others for making of frit and calcining old pieces of glafs. This furnace, before it is fit to run glafs, cofts 3500l. It feldom lafts above three years, and even in that time it muft be refitted every fix months. It takes fix months to rebuild it, and three months to refit it. The melting pots are as big as large hogfheads, and contain about 2000 weight of metal. If one of them burfts in the furnace, the lofs of the matter a... time amounts to 250l. The materials in thefe pots are the fame as defcribed before. When the furnace is red hot, thefe materials are put in at three different times, becaufe that helps the fufion; and in 24 hours they are vitrified, refined, fettled, and fit for cafting. A is the bocca, or mouth of the furnace; B is the ciftern that conveys the liquid glafs it receives out of the melting pots in the furnace to the cafting table. Thefe cifterns are filled in the furnace, and remain therein fix hours after they are filled; and then are hooked out by the means of a large iron chain, guided by a pulley, placed upon a carriage with four wheels marked C, by two men. This carriage has no middle piece; fo that when it has brought the ciftern to the cafting table D, they flip off the bottom of the ciftern, and out rufhes a torrent of flaming matter upon the table: this matter is confined to certain dimenfions by the iron rulers EE, which are moveable, retain the fluid matter, and determine the width of the glafs; while a man, with the roller F refting on the edge of the iron rulers, reduceth it as it cools to an equal thicknefs, which is done in the fpace of a minute. This table is fupported on a wooden frame, with truftles for the convenience of moving to the annealing furnace; into which, ftrewed with fand, the new plate is fhoved, where it will harden in about 10 days.

Plate CCXLVII.

What is moft furprifing throughout the whole of this operation, is the quicknefs and addrefs wherewith fuch maffy cifterns, filled with a flaming matter, are taken out of the furnace, conveyed to the table, and poured therein, the glafs fpread, &c. The whole is inconceivable to fuch as have not been eye witneffes of that furprifing manufacture.

As faft as the cifterns are emptied, they carry them back to the furnace and take frefh ones, which they empty as before. Thus they continue to do fo long as there are any full cifterns; laying as many plates in each carquaiffe as it will hold, and ftopping them up with doors of baked earth, and every chink with cement, as foon as they are full, to let them anneal, and cool again, which requires about 14 days.

The firft running being difpatched, they prepare another, by filling the cifterns anew from the matter in the pots; and after the fecond, a third; and even a fourth time, till the melting pots are quite empty.

The cifterns at each running fhould remain at leaft fix hours in the furnace to whiten; and when the firft annealing furnace is full, the cafting table is to be carried to another. It need not here be obferved, that the carquaiffes, or annealing furnaces, muft firft have been heated to the degree proper for them. It may be obferved, that the oven full, or the quantity of matter commonly prepared, fupplies the running of 18 glaffes, which is performed in 18 hours, being an hour for each glafs. The workmen work fix hours, and are then relieved by others.

When the pots are emptied, they take them out, as well as the cifterns, to fcrape off what glafs remains, which otherwife would grow green by continuance of fire, and fpoil the glaffes. They are not filled again in lefs than 36 hours; fo that they put the matter into the furnace, and begin to run it every 54 hours.

The manner of heating the large furnaces is very fingular; the two tifors, or perfons employed for that purpofe, in their fhirts, run fwiftly round the furnace without making the leaft ftop: as they run along, they take two billets, or pieces of wood, which are cut for the purpofe: thefe they throw into the firft tiffart; and continuing their courfe, do the fame for the fecond. This they hold without interruption for fix hours fucceffively; after which they are relieved by others, &c. It is furprifing that two fuch fmall pieces of wood, and which are confumed in an inftant, fhould keep the furnace to the proper degree of heat; which is fuch, that a large bar of iron, laid at one of the mouths of the furnace, becomes red hot in lefs than half a minute.

The glafs, when taken out of the melting furnace, needs nothing farther but to be ground, polifhed, and foliated.

4. *Grinding and Polifhing of Plate Glass.* Glafs is made tranfparent by fire; but it receives its luftre by the fkill and labour of the grinder and polifher; the former of whom takes it rough out of the hands of the maker.

In order to grind plate glafs, they lay it horizontally upon a flat ftone table made of a very fine grained freeftone; and for its greater fecurity they plafter it down with lime or ftucco; for otherwife the force of the workmen, or the motion of the wheel with which they grind it, would move it about.

This ftone table is fupported by a ftrong frame A, made of wood, with a ledge quite round its edges, rifing about two inches higher than the glafs. Upon this glafs to be ground is laid another rough glafs not above half fo big, and fo loofe as to flide upon it; but cemented to a wooden plank, to guard it from the injury it muft otherwife receive from the fcraping of the wheel to which this plank is faftened, and from the weights laid upon it to promote the grinding or triture of the glaffes. The whole is covered with a wheel B, made

Plate CCXLVII.

Fig. 1. Blowing.

Fig. 2. Casting.

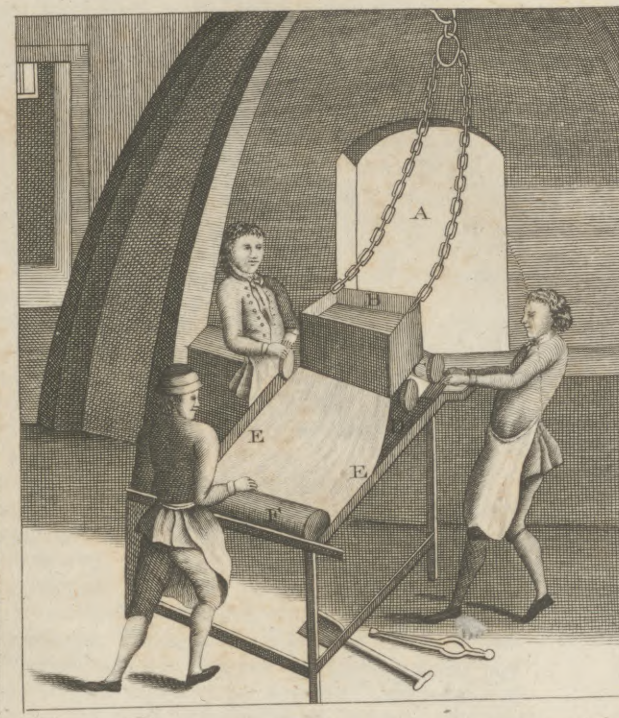


Fig. 3. Polishing.

Furnace for Artificial GEMS.

Fig. 7.

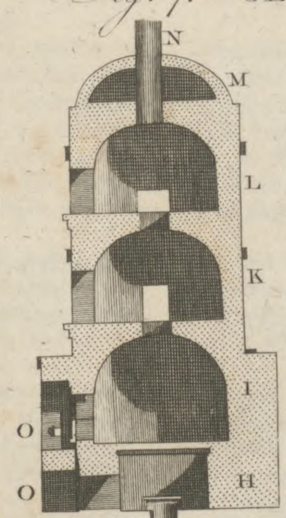


Fig. 6.

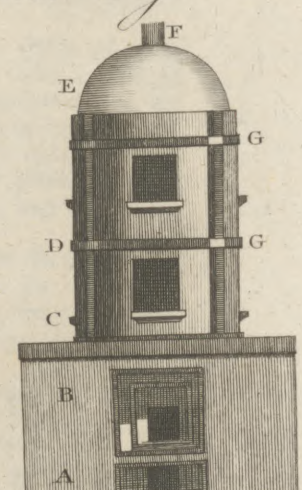
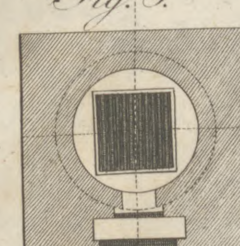


Fig. 4.

Fig. 5.



A. Bell Prin. Wal. Sculptor fecit.

made of hard light wood, about fix inches in diameter, by pulling of which backwards and forwards alternately, and fometimes turning it round, the workmen, who always ftand oppofite to each other, produce a conftant attrition between the two glaffes, and bring them to what degree of fmoothnefs they pleafe, by firft pouring in water and coarfe fand; after that, a finer fort of fand, as the work advanceth, till at laft they muft pour in the powder of fmalt. As the upper or incumbent glafs polifhes and grows fmoother, it muft be taken away, and another from time to time put in its place.

This engine is called a *mill* by the artifts, and is ufed only in the largeft fized glaffes; for in the grinding of the leffer glaffes, they are content to work without a wheel, and to have only four wooden handles faftened to the four corners of the ftone which loads the upper plank, by which they work it about.

When the grinder has done his part, who finds it very difficult to bring the glafs to an exact plainnefs, it is turned over to the polifher; who, with the fine powder of tripoli ftone or emery, brings it to a perfect evennefs and luftre. The inftrument made ufe of in this branch is a board, *cc*, furnifhed with a felt, and a fmall roller, which the workman moves by means of a double handle at both ends. The artift, in working this roller, is affifted with a wooden hoop or fpring, to the end of which it is fixed: for the fpring, by conftantly bringing the roller back to the fame points, facilitates the action of the workman's arm.

Colouring of Glass. That the colours given to glafs may have their full beauty, it muft be obferved, that every pot when new, and firft ufed, leaves a foulnefs in the glafs from its own earthy parts; fo that a coloured glafs made in a new pot can never be bright or perfectly fine. For this reafon, the larger of thefe, when new, may be glazed with white glafs; but the fecond time of ufing the pots lofe this foulnefs. The glazing may be done by reducing the glafs to powder, and moiftening the infide of the pot with water; while it is yet moift, put in fome of the powdered glafs, and fhake it about, till the whole inner furface of the pot be covered by as much as will adhere to it, in confequence of the moifture. Throw out the redundant part of the powdered glafs; and the pot being dry, fet it in a furnace fufficiently hot to vitrify the glafs adhering to it, and let it continue there fome time; after which, care muft be taken to let it cool gradually. Thofe pots which have ferved for one colour muft not be ufed for another; for the remainder of the old matter will fpoil the colour of the new. The colours muft be very carefully calcined to a proper degree; for if they are calcined either too much or too little, they never do well; the proper proportion, as to quantity, muft alfo carefully be regarded, and the furnaces muft be fed with dry hard wood. And all the proceffes fucceed much the better if the colour be ufed dividedly, that is, a part of it in the frit, and the reft in the melted metal.

A hard glafs, proper for receiving colours, may be prepared by pulverizing 12 pounds of the beft fand, cleanfed by wafhing in a glafs or flint mortar, and mixing feven pounds of pearl afhes or any fixed alkaline falt purified with nitre, one pound of faltpetre, and half a pound of borax, and pounding them together. A glafs lefs hard may be prepared of twelve pounds of white fand cleanfed, feven pounds of pearl afhes purified with faltpetre, one pound of nitre, half a pound of borax, and four ounces of arfenic prepared as before.

Amethyft colour. See *Purple* below, and the article Amethyst.

Balas colour. Put into a pot cryftal frit, thrice wafhed in water; tinge this with manganefe, prepared into a clear purple; to this add *alumen cativum*, fifted fine, in fmall quantities, and at feveral times: this will make the glafs grow yellowifh, and a little reddifh, but not blackifh, and always diffipates the manganefe. The laft time you add manganefe give no more of the *alumen cativum*, unlefs the colour be too full. Thus will the glafs be exactly of the colour of the balas ruby. See *Ruby Glass*.

The common black colour. The glafsmakers take old broken glafs of different colours, grind it to powder, and add to it, by different parcels, a fufficient quantity of a mixture of two parts zaffer and one part manganefe: when well purified, they work it into veffels, &c.

Glafs beads are coloured with manganefe only.

Black velvet colour. To give this deep and fine colour to glafs, take of cryftalline and pulverine frit, of each 20 pounds; of calx of lead and tin, four pounds; fet all together in a pot in the furnace, well heated; when the glafs is formed and pure, take fteel well calcined and powdered, fcales of iron that fly off from the fmith's anvil, of each an equal quantity; powder and mix them well; then put fix ounces of this powder to the above defcribed metal while in fufion: mix the whole thoroughly together, and let them all boil ftrongly together; then let it ftand in fufion 12 hours to purify, and after this work it. It will be a moft elegant velvet black.

There is another way of doing this, which alfo produces a very fair black. It is this: take a hundred weight of rochetta frit, add to this two pounds of tartar and fix pounds of manganefe, both in fine powder; mix them well; and put them to the metal while in fufion, at different times, in feveral parcels; let it ftand in fufion after this for four days, and then work it.

A glafs perfectly black may alfo be formed to ten pounds of either of the compofitions for hard glafs above defcribed, one ounce of zaffer, fix drachms of manganefe, and an equal quantity of iron ftrongly calcined.

Blue colour. A full blue may be made by adding fix drachms of zaffer and two drachms of manganefe to ten pounds of either of the compofitions for hard glafs, defcribed above. For a very cool or pure blue glafs, half an ounce of calcined copper may be ufed inftead of the manganefe, and the proportion of zaffer diminifhed by one half. Glafs refembling fapphire may be made with ten pounds of either of the compofitions for hard glafs, three drachms and one fcruple of zaffer, and one drachm of the *calx caffii* or precipitation of gold by tin; or, inftead of this latter ingredient, two drachms and two fcruples of manganefe. Or a fapphire-coloured glafs may be made by mixing with any quantity of the hard glafs one eighth of its weight of fmalt. A beautiful blue glafs is alfo produced from the oxide of cobalt.

Venetian brown, with gold fpangles, commonly called the

the *philofopher's ftone*, may be prepared in the following manner: take of the fecond compofition for hard glafs above defcribed, and of the compofition for pafte, of each five pounds, and of highly calcined iron an ounce; mix them well, and fufe them till the iron be perfectly vitrified, and has tinged the glafs of a deep tranfparent yellow brown colour. Powder this glafs, and add to it two pounds of powdered glafs of antimony; grind them together, and thus mix them well. Take part of this mixture, and rub into it 80 or 100 leaves of the counterfeit leaf gold called *Dutch gold;* and when the parts of the gold feem fufficiently divided, mix the powder containing it with the other part of the glafs. Fufe the whole with a moderate heat till the powder run into a vitreous mafs, fit to be wrought into any of the figures or veffels into which it is ufually formed; but avoid a perfect liquefaction, becaufe that in a fhort time deftroys the equal diffufion of the fpangles, and vitrifies, at leaft in part, the matter of which they are compofed; converting the whole into a kind of tranfparent olive coloured glafs. This kind of glafs is ufed for a great variety of toys and ornaments with us, who at prefent procure it from the Venetians.

Chalcedony. A mixture of feveral ingredients with the common matter of glafs, will make it reprefent the femi-opake gems, the jafpers, agates, chalcedonies, &c. The way of making thefe feems to be the fame with the method of making marbled paper, by feveral colours diffolved in feveral liquors, which are fuch as will not readily mix with one another when put into water, before they are caft upon the paper which is to be coloured. There are feveral ways of making thefe varioufly coloured glaffes, but the beft is the following.

Diffolve four ounces of fine leaf filver in a glafs veffel in ftrong aquafortis; ftop up the veffel, and fet it afide.—In another veffel, diffolve five ounces of quickfilver in a pound of aquafortis, and fet this afide.—In another glafs veffel, diffolve in a pound of aquafortis three ounces of fine filver, firft calcined in this manner: amalgamate the filver with mercury, mix the amalgam with twice its weight of common falt well purified; put the mixture in an open fire in a crucible, that the mercury may fly off, and the filver be left in form of powder. Mix this powder with an equal quantity of common falt well purified, and calcine this for fix hours in a ftrong fire; when cold, wafh off the falt by repeated boilings in common water, and then put the filver into the aquafortis. Set this folution alfo afide.—In another veffel, diffolve in a pound of aquafortis three ounces of fal ammoniac; pour off the folution and diffolve in it a quarter of an ounce of gold. Set this alfo afide.—In another veffel, diffolve three ounces of fal ammoniac in a pound of aquafortis; then put into the folution cinnabar, crocus martis, ultramarine, and ferretto of Spain, of each half an ounce. Set this alfo afide.—In another veffel, diffolve in a pound of aquafortis three ounces of fal ammoniac; then put into it crocus martis made with vinegar, calcined tin, zaffer, and cinnabar, of each half an ounce; let each of thefe be powdered very fine, and put gently into the aquafortis. Set this alfo afide.—In another veffel, diffolve three ounces of fal ammoniac in a pound of aquafortis, and add to it brafs calcined with brimftone, brafs thrice calcined, manganefe, and fcales of iron which fall from the fmith's anvil, of each half an ounce; let each be well powdered, and put gently into the veffel. Then fet this alfo afide.—In another veffel, diffolve two ounces of fal ammoniac in a pound of aquafortis, and put to it verdigrife an ounce, red lead, crude antimony, and the caput mortuum of vitriol, of each half an ounce; put thefe well powdered leifurely into the veffel, and fet this alfo afide.—In another veffel, diffolve two ounces of fal ammoniac in a pound of aquafortis, and add orpiment, white arfenic, painters lake, of each half an ounce.

Keep the above nine veffels in a moderate heat for 15 days, fhaking them well at times. After this pour all the matters from thefe veffels into one large veffel, well luted at its bottom; let this ftand fix days, fhaking it at times; and then fet it in a very gentle heat, and evaporate all the liquor, and there will remain a powder of a purplifh green.

When this is to be wrought, put into a pot very clear metal, made of broken cryftalline and white glafs that has been ufed; for with the virgin frit, or fuch as has never been wrought, the chalcedony can never be made, as the colours do not ftick to it, but are confumed by the frit. To every pot of 20 pounds of this metal put two or three ounces of this powder at three feveral times; incorporate the powder well with the glafs; and let it remain an hour between each time of putting in the powders. After all are in, let it ftand 24 hours; then let the glafs be well mixed, and take an affay of it, which will be found of a yellowifh blue; return this many times into the furnace; when it begins to grow cold, it will fhow many waves of different colours very beautifully. Then take tartar eight ounces, foot of the chimney two ounces, crocus martis made with brimftone, half an ounce; let thefe be well powdered and mixed, and put them by degrees into the glafs at fix times, waiting a little while between each putting in. When the whole is put in, let the glafs boil and fettle for 24 hours; then make a little glafs body of it; which put in the furnace many times, and fee if the glafs be enough, and whether it have on the outfide veins of blue, green, red, yellow, and other colours, and have, befide thefe veins, waves like thofe of the chalcedonies, jafpers, and oriental agates, and if the body kept within looks as red as fire.

When it is found to anfwer this, it is perfect, and may be worked into toys and veffels, which will always be beautifully variegated: thefe muft be well annealed, which adds much to the beauty of their veins. Maffes of this may be polifhed at the lapidary's wheel as natural ftones, and appear very beautiful. If in the working the matter grow tranfparent, the work muft be ftopped, and more tartar, foot, and crocus martis, muft be put to it, which will give it again the neceffary body and opacity, without which it does not fhow the colours well.

Chryfolite colour may be made of ten pounds of either of the compofitions for hard glafs defcribed above, and fix drachms of calcined iron.

Red cornelian colour may be formed by adding one pound of glafs of antimony, two ounces of the calcined vitriol called *fcarlet ochre*, and one drachm of manganefe or magnefia, to two pounds of either of the compofitions

pofitions for hard glafs. The glafs of antimony and magnefia are firft fufed with the other glafs, and then powdered and ground with the fcarlet ochre: the whole mixture is afterwards fufed with a gentle heat till all the ingredients are incorporated. A glafs refembling the white cornelian may be made of two pounds of either of the compofitions for hard glafs, and two drachms of yellow ochre well wafhed, and one ounce of calcined bones: grind them together, and fufe them with a gentle heat.

Emerald colour. See *Green* below.

Garnet colour. To give this colour to glafs, the workmen take the following method. They take equal quantities of cryftal and rochetta frit, and to every hundred weight of this mixture they add a pound of manganefe and an ounce of prepared zaffer: thefe are to be powdered feparately, then mixed and added by degrees to the frit while in the furnace. Great care is to be taken to mix the manganefe and zaffer very perfectly; and when the matter has ftood 24 hours in fufion, it may be worked.

Glafs of this kind may be made by adding one pound of glafs of antimony, one drachm of manganefe, and the fame quantity of the precipitate of gold by tin, to two pounds of either of the compofitions for hard glafs; or the precipitate of gold may be omitted, if the quantities of the glafs of antimony and manganefe be doubled.

Gold colour. This colour may be produced by taking ten pounds of either of the compofitions for hard glafs, omitting the faltpetre; and for every pound adding an ounce of calcined borax, or, if this quantity doth not render the glafs fufficiently fufible, two ounces; ten ounces of red tartar of the deepeft colour; two ounces of magnefia; and two drachms of charcoal of fallow, or any other foft kind. Precipitates of filver baked on glafs will ftain it yellow, and likewife give a yellow colour on being mixed and melted with 40 or 50 times their weight of vitreous compofitions; the precipitate from aquafortis by fixed alkali feems to anfwer beft. Yellow glaffes may alfo be obtained with certain preparations of iron, particularly with Pruffian blue. But Dr Lewis obferves, that the colour does not conftantly fucceed, nor approach to the high colour of gold, with filver or with iron. The neareft imitations of gold which he has been able to produce have been effected with antimony and lead. Equal parts of the glafs of antimony, of flint calcined and powdered, and of minium, formed a glafs of a high yellow; and with two parts of glafs of antimony, two of minium, and three of powdered flint, the colour approached ftill more to that of gold. The laft compofition exhibited a multitude of fmall fparkles interfperfed throughout its whole fubftance, which gave it a beautiful appearance in the mafs, but were really imperfections, owing to air bubbles.

Neri directs, for a gold yellow colour, one part of red tartar and the fame quantity of manganefe, to be mixed with a hundred parts of frit. But Kunckel obferves, that thefe proportions are faulty; that one part, or one and a quarter, of manganefe, is fufficient for a hundred of frit; but that fix parts of tartar are hardly enough, unlefs the tartar is of a dark red colour, almoft blackifh; and that he found it expedient to add to the tartar about a fourth of its weight of powdered charcoal. He adds, that the glafs fwells up very much in melting, and that it muft be left unftirred, and worked as it ftands in fufion. Mr Samuel More, in repeating and varying this procefs in order to render the colour more perfect, found that the manganefe is entirely uneffential to the gold colour; and that the tartar is no otherwife of ufe than in virtue of the coaly matter to which it is in part reduced by the fire, the phlogifton or inflammable part of the coal appearing in feveral experiments to be the direct tinging fubftance. Mr Pott alfo obferves, that common coals give a yellow colour to glafs; that different coaly matters differ in their tinging power; that caput mortuum of foot and lamp black anfwer better than common charcoal; and that the fparkling coal, which remains in the retort after the rectification of the thick empyreumatic animal oils, is one of the moft active of thefe preparations. This preparation, he fays, powdered, and then burnt again a little in a clofe veffel, is excellent for tinging glafs, and gives yellow, brown, reddifh, or blackifh colours, according to its quantity; but the frit muft not be very hard of fufion, for in this cafe the ftrong fire will deftroy the colouring fubftance before the glafs melts: and he has found the following compofition to be nearly the beft; viz. fand two parts, alkali three parts; or fand two, alkali three, calcined borax one; or fand two, alkali two, calcined borax one: and though faltpetre is hardly ufed at all, or very fparingly, for yellow glaffes, as it too much volatilizes the colouring fubftance; yet here for the moft part a certain proportion of it, eafily determined by trial, is very neceffary; for without it the concentrated colouring matter is apt to make the glafs too dark, and even of an opake pitchy blacknefs. It does not certainly appear that there is any material diverfity in the effects of different coals, the difference being probably owing to the different quantities of the inflammable matter which they contain; fo that a little more fhall be required of one kind than of another for producing the fame degree of colour in the glafs. Nor does the foftnefs or fufibility of the frit appear to be in any refpect neceffary.

Gold-coloured fpangles may be diffufed through the fubftance of glafs, by mixing the yellow talcs with powdered glafs, and bringing the mixture into fufion.

Green. This colour may be imparted to glafs by adding three ounces of copper precipitated from aquafortis, and two drachms of precipitated iron to nine pounds of either of the compofitions for hard glafs. The fineft method of giving this beautiful colour to glafs is this: Take five pounds of cryftalline metal that has been paffed feveral times through water, and the fame quantity of the common white metal of polverine, four pounds of common polverine frit, and three pounds of red lead; mix the red lead well with the frit, and then put all into a pot in a furnace. In a few hours the whole mafs will be well purified: then caft the whole into water, and feparate and take out the lead; then return the metal into the pot, and let it ftand a day longer in fufion; then put in the powder of the refiduum of the vitriol of copper, and a very little crocus martis, there will be produced a moft lively and elegant green, fcarce inferior to that of the oriental emerald. There are many ways of giving a green to glafs, but all are greatly inferior to this.—To make a *fea green*, the fineft cryftalline glafs only muft be ufed, and no manganefe muft

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muft be added at firft to the metal. The cryftal frit muft be melted thus alone; and the falt, which fwims like oil on its top, muft be taken off with an iron ladle very carefully. Then to a pot of twenty pounds of this metal add fix ounces of calcined brafs, and a fourth part of the quantity of powdered zaffer: this powder muft be well mixed, and put into the glafs at three times; it will make the metal fwell at firft, and all muft be thoroughly mixed in the pot. After it has ftood in fufion three hours, take out a little for a proof: if it be too pale, add more of the powder. Twenty-four hours after the mixing the powder the whole will be ready to work; but muft be well ftirred together from the bottom, left the colour fhould be deepeft there, and the metal at the top lefs coloured, or even quite colourlefs. Some ufe for this purpofe half cryftal frit and half rochetta frit, but the colour is much the fineft when all cryftal frit is ufed.

Lapis lazuli colour. See *Lapis* LAZULI.

Opal colour. See OPAL.

Purple of a deep and bright colour may be produced by adding to ten pounds of either of the compofitions for hard glafs, above defcribed, fix drachms of zaffer and one drachm of gold precipitated by tin; or to the fame quantity of either compofition one ounce of manganefe and half an ounce of zaffer. The colour of amethyft may be imitated in this way.

Red. A blood red glafs may be made in the following manner: Put fix pounds of glafs of lead, and ten pounds of common glafs, into a pot glazed with white glafs. When the whole is boiled and refined, add by fmall quantities, and at fmall diftances of time, copper calcined to a rednefs as much as on repeated proofs is found fufficient: then add tartar in powder by fmall quantities at a time, till the glafs is become as red as blood; and continue adding one or other of the ingredients till the colour is quite perfect.

Ruby. The way to give the true fine red of the ruby, with a fair tranfparence, to glafs, is as follows: Calcine in earthen veffels gold diffolved in aqua regia; the menftruum being evaporated by diftillation, more aqua regia added, and the abftraction repeated five or fix times, till it becomes a red powder. This operation will require many days in a hot furnace. When the powder is of a proper colour, take it out: and when it is to be ufed, melt the fineft cryftal glafs, and purify it by often cafting it into water; and then add, by fmall quantities, enough of this red powder to give it the true colour of a ruby, with an elegant and perfect tranfparence.

The procefs of tinging glafs and enamels by preparations of gold was firft attempted about the beginning of the laft century. Libavius, in one of his tracts entitled *Alchymia*, printed in 1606, conjectures that the colour of the ruby proceeds from gold, and that gold diffolved and brought to rednefs might be made to communicate a like colour to factitious gems and glafs. On this principle Neri, in his Art of Glafs, dated in 1611, gives the procefs above recited. Glauber in 1648 publifhed a method of producing a red colour by gold, in a matter which is of the vitreous kind, though not perfect glafs. For this purpofe he ground powdered flint or fand with four times its weight of fixed alkaline falt: this mixture melts in a moderately ftrong fire, and when cool looks like glafs, but expofed to the air runs into a liquid ftate. On adding this liquor to folution of gold in aqua-regia, the gold and flint precipitate together in form of a yellow powder, which by calcination becomes purple. By mixing this powder with three or four times its weight of the alkaline folution of flint, drying the mixture, and melting it in a ftrong fire for an hour, a mafs is obtained of a tranfparent ruby colour and of a vitreous appearance; which neverthelefs is foluble in water, or by the moifture of the air, on account of the redundance of the falt. The Honourable Mr Boyle, in a work publifhed in 1680, mentions an experiment in which a like colour was introduced into glafs without fufion; for having kept a mixture of gold and mercury in digeftion for fome months, the fire was at laft immoderately increafed, fo that the glafs burft with a violent explofion; and the lower part of the glafs was found tinged throughout of a tranfparent red colour, hardly to be equalled by that of rubies.

About the fame time Caffius is faid to have difcovered the precipitation of gold by tin, and that glafs might be tinged of a ruby colour by melting it with this precipitate; though he does not appear, fays Dr Lewis, from his treatife *De Auro*, to have been the difcoverer of either. He defcribes the preparation of the precipitate and its ufe; but gives no account of the manner of employing it, only that he fays one drachm of gold duly prepared will tinge ten pounds of glafs.

Commerce of Arts, p. 171. 621. &c.

This procefs was foon after brought to perfection by Kunckel; who fays, that one part of the precipitate is fufficient to give a ruby colour to 1280 parts of glafs, and a fenfible rednefs to upwards of 1900 parts; but that the fuccefs is by no means conftant. Kunckel alfo mentions a purple gold powder, refembling that of Neri; which he obtained by infpiffating folution of gold to drynefs; abftracting from it frefh aqua-regia three or four times, till the matter appears like oil; then precipitating with ftrong alkaline ley, and wafhing the precipitate with water. By diffolving this powder in fpirit of falt and precipitating again, it becomes, he fays, extremely fair; and in this ftate he directs it to be mixed with a due proportion of Venice glafs.

Orfchal, in a treatife entitled *Sol fine Vefte*, gives the following procefs for producing a very fine ruby. He directs the purple precipitate made by tin to be ground with fix times its quantity of Venice glafs into a very fine powder, and this compound to be very carefully mingled with the frit or vitreous compofition to be tinged. His frit confifts of equal parts of borax, nitre, and fixed alkaline falt, and four times as much calcined flint as of each of the falts; but he gives no directions as to the proportion of the gold precipitate or mode of fufion. Hellot defcribes a preparation, which, mixed with Venice glafs, was found to give a beautiful purple enamel. This preparation confifts of equal parts of folution of gold and of folution of zinc in aqua-regia mixed together, with the addition of a volatile falt prepared from fal ammoniac by quicklime, in fufficient quantity to precipitate the two metals. The precipitate is then gradually heated till it acquires a violet colour. However, though a purple or red colour, approaching to that of ruby, may, by the methods above recited, be baked on glafs or enamels, and introduced into the mafs by fufion, the way of equally diffufing fuch ſuch a colour through a quantity of fluid glaſs is ſtill, ſays Dr Lewis, a ſecret. The following proceſs for making the ruby glaſs was communicated to Dr Lewis by an artiſt, who aſcribed it to Kunckel. The gold is directed to be diſſolved in a mixture of one part of ſpirit of ſalt and three of aquafortis, and the tin in a mixture of one part of the former of theſe acids with two of the latter. The ſolution of gold being properly diluted with water, the ſolution of tin is added, and the mixture left to ſtand till the purple matter has ſettled to the bottom. The colourleſs liquor is then poured off, and the purple ſediment, while moiſt and not very thick, is thoroughly mixed with powdered flint or ſand. This mixture is well ground with powdered nitre, tartar, borax, and arſenic, and the compound melted with a ſuitable fire. The proportions of the ingredients are 2560 parts of ſand, 384 of nitre, 240 of tartar, 240 of borax, 28 of arſenic, five of tin, and five of gold.

Topaz Colour. Glaſs reſembling this ſtone may be made by pulverizing ten pounds of either of the compoſitions for hard glaſſes with an equal quantity of the gold-coloured glaſs, and fuſing them together.

White opake and *ſemitranſparent* glaſs may be made of ten pounds of either of the compoſitions for hard glaſs, and one pound of well calcined horn, ivory, or bone; or an opake whiteneſs may be given to glaſs by adding one pound of very white arſenic to ten pounds of flint glaſs. Let them be well powdered and mixed by grinding them together, and then fuſed with a moderate heat till they are thoroughly incorporated. A glaſs of this kind is made in large quantities at a manufactory near London; and uſed not only for different kinds of veſſels, but as a white ground for enamel in dial plates and ſnuff boxes, which do not require finiſhing with much fire, becauſe it becomes very white and fuſible with a moderate heat.

Yellow. See *Gold colour* above.

Painting in GLASS. The ancient manner of painting in glaſs was very ſimple: it conſiſted in the mere arrangement of pieces of glaſs of different colours in ſome ſort of ſymmetry, and conſtituted what is now called *moſaic work*. See MOASIC.

In proceſs of time they came to attempt more regular deſigns, and alſo to repreſent figures heightened with all their ſhades: yet they proceeded no farther than the contours of the figures in black with water colours, and hatching the draperies after the ſame manner on glaſſes of the colour of the object they deſigned to paint. For the carnation, they uſed glaſs of a bright red colour; and upon this they drew the principal lineament of the face, &c. with black.

At length, the taſte for this kind of painting improving conſiderably, and the art being found applicable to the adorning of churches, baſilics, &c. they found out means of incorporating the colours in the glaſs itſelf, by heating them in the fire to a proper degree; having firſt laid on the colours. A French painter at Marſeilles is ſaid to have given the firſt notion of this improvement, upon going to Rome under the pontificate of Julius II.; but Albert Durer and Lucas of Leyden were the firſt that carried it to any height.

This art, however, has frequently met with much interruption, and ſometimes been almoſt totally loſt; of which Mr Walpole gives us the following account, in his Anecdotes of Painting in England.

"The firſt interruption given to it was by the reformation, which baniſhed the art out of churches; yet it was in ſome meaſure kept up in the eſcutcheons of the nobility and gentry in the windows of their ſeats. Towards the end of Queen Elizabeth's reign it was omitted even there; yet the practice did not entirely ceaſe. The chapel of our Lady at Warwick was ornamented anew by Robert Dudley earl of Leiceſter, and his counteſs, and the cipher of the glaſs-painter's name yet remains, with the date 1574: and in ſome of the chapels at Oxford the art again appears, dating itſelf in 1622, by the hand of no contemptible maſter.

"I could ſupply even this gap of 48 years by many dates on Flemiſh glaſs; but no body ever ſuppoſed that the ſecret was loſt ſo early as the reign of James I. and that it has not periſhed ſince will be evident from the following ſeries, reaching to the preſent hour.

"The portraits in the windows of the library at All Souls, Oxford. In the chapel at Queen's College there are twelve windows dated 1518. P. C. a cipher on the painted glaſs in the chapel at Warwick, 1574. The windows at Wadham's College; the drawing pretty good, and the colours fine, by Bernard Van Linge, 1622. In the chapel at Lincoln's Inn, a window, with the name Bernard, 1623. This was probably the preceding Van Linge. In the church of St Leonard, Shoreditch, two windows by Baptiſta Sutton, 1634. The windows in the chapel at Univerſity College, Hen. Giles *pinxit*, 1687. At Chriſt Church, Iſaac Oliver, aged 84, 1700. Window in Merton Chapel, William Price 1700. Windows at Queen's New College, and Maunlin, by William Price, the ſon, now living, whoſe colours are fine, whoſe drawing is good, and whoſe taſte in ornaments and moſaic is far ſuperior to any of his predeceſſors; is equal to the antique, to the good Italian maſters, and only ſurpaſſed by his own ſingular modeſty.

"It may not be unwelcome to the curious reader to ſee ſome anecdotes of the revival of taſte for painted glaſs in England. Price, as we have ſaid, was the only painter in that ſtyle for many years in England. Afterwards one Rowell, a plumber at Reading did ſome things, particularly for the late Henry earl of Pembroke; but Rowell's colours ſoon vaniſhed. At laſt he found out a very durable and beautiful red; but he died in a year or two, and the ſecret with him. A man at Birmingham began the ſame art in 1756 or 1757, and fitted up a window for Lord Lyttleton, in the church of Hagley; but ſoon broke. A little after him, one Peckitt at York began the ſame buſineſs, and has made good proficiency. A few lovers of that art collected ſome diſperſed panes from ancient buildings, particularly the late Lord Cobham, who erected a Gothic temple at Stowe, and filled it with arms of the old nobility, &c. About the year 1753, one Aſciotti, an Italian, who had married a Flemiſh woman, brought a parcel of painted glaſs from Flanders, and ſold it for a few guineas to the Honourable Mr Batemen, of Old Windſor. Upon that I ſent Aſciotti again to Flanders, who brought me 450 pieces, for which, including the expence of his journey, I paid him thirty-ſix guineas. His wife made more journeys for the ſame purpoſe;

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poſe; and ſold her cargoes to one Palmer a glazier in St Martin's lane, who immediatedly raiſed the price to one, two, or five guineas for a ſingle piece, and fitted up entire windows with them, and with moſaics of plain glaſs of different colours. In 1761, Paterſon, an auctioneer at Eſſex houſe in the Strand, exhibited the two firſt auctions of painted glaſs, imported in like manner from Flanders. All this manufacture conſiſted in rounds of Scripture ſtories, ſtained in black and yellow, or in ſmall figures of black and white; birds and flowers in colours, and Flemiſh coats of arms.

The colours uſed in painting or ſtaining of glaſs are very different from thoſe uſed in painting either in water or oil colours.

For black, take ſcales of iron, one ounce; ſcales of copper, one ounce; jet, half an ounce: reduce them to powder, and mix them. For blue, take powder of blue, one pound; ſal nitre, half a pound: mix them and grind them well together. For carnation, take red chalk, eight ounces; iron ſcales, and litharge of ſilver, of each two ounces; gum arabic, half an ounce: diſſolve in water; grind all together for half an hour as ſtiff as you can; then put it in a glaſs and ſtir it well, and let it ſtand to ſettle 14 days. For green, take red lead one pound; ſcales of copper, one pound; and flint, five pounds: divide them into three parts; and add to them as much ſal nitre; put them into a crucible, and melt them with a ſtrong fire; and when it is cold, powder it, and grind it on a porphyry. For gold colour, take ſilver, an ounce; antimony, half an ounce: melt them in a crucible; then pound the maſs to powder, and grind it on a copper plate; add to it yellow ochre, or brick duſt calcined again, 15 ounces; and grind them well together with water. For purple, take minium, one pound; brown ſtone, one pound; white flint, five pounds: divide them into three parts, and add to them as much ſal nitre as one of the parts; calcine, melt, and grind it as you did the green. For red, take jet, four ounces; litharge of ſilver, two ounces; red chalk, one ounce: powder them fine, and mix them. For white, take jet, two parts; white flint, ground on a glaſs very fine, one part: mix them. For yellow, take Spaniſh brown, ten parts; leaf ſilver, one part; antimony, half a part: put all into a crucible, and calcine them well.

In the windows of ancient churches, &c. there are to be ſeen the moſt beautiful and vivid colours imaginable, which far exceed any of thoſe uſed by the moderns, not ſo much becauſe the ſecret of making thoſe colours is entirely loſt, as that the moderns will not go to the charge of them, nor be at the neceſſary pains, by reaſon that this ſort of painting is not now ſo much in eſteem as formerly. Thoſe beautiful works which were made in the glaſs houſes were of two kinds.

In ſome, the colour was diffuſed through the whole ſubſtance of the glaſs. In others, which were the more common, the colour was only on one ſide, ſcarce penetrating within the ſubſtance above one third of a line; though this was more or leſs according to the nature of the colour, the yellow being always found to enter the deepeſt. Theſe laſt, though not ſo ſtrong and beautiful as the former, were of more advantage to the workmen, by reaſon that on the ſame glaſs, though already coloured, they could ſhow other kinds of colours where there was occaſion to embroider draperies, enrich them with foliages, or repreſent other ornaments of gold, ſilver, &c.

In order to this, they made uſe of emery, grinding or wearing down the ſurface of the glaſs till ſuch time as they were got through the colour to the clear glaſs. This done, they applied the proper colours on the other ſide of the glaſs. By theſe means, the new colours were hindered from running and mixing with the former, when they expoſed the glaſſes to the fire, as will appear hereafter.

When indeed the ornaments were to appear white, the glaſs was only bared of its colour with emery, without tinging the place with any colour at all; and this was the manner by which they wrought their light and heightenings on all kinds of colour.

The firſt thing to be done, in order to paint or ſtain glaſs, in the modern way, is to deſign, and even colour, the whole ſubject on paper. Then they chooſe ſuch pieces of glaſs as are clear, even, and ſmooth, and proper to receive the ſeveral parts; and proceed to diſtribute the deſign itſelf, or papers it is drawn on, into pieces ſuitable to thoſe of the glaſs; always taking care that the glaſſes may join in the contours of the figures and the folds of the draperies; that the carnations, and other finer parts, may not be impaired by the lead with which the pieces are to be joined together. The diſtribution being made, they mark all the glaſſes as well as papers, that they may be known again: which done, applying every part of the deſign upon the glaſs intended for it, they copy or transfer the deſign upon this glaſs with the black colour diluted in gum water, by tracing and following all the lines and ſtrokes as they appear through the glaſs with the point of a pencil.

When theſe ſtrokes are well dried, which will happen in about two days, the work being only in black and white, they give a ſlight waſh over with urine, gum arabic, and a little black; and repeat it ſeveral times, according as the ſhades are deſired to be heightened; with this precaution, never to apply a new waſh till the former is ſufficiently dried.

This done, the lights and riſings are given by rubbing off the colour in their reſpective places with a wooden point, or the handle of the pencil.

As to the other colours above mentioned, they are uſed with gum water, much as in painting in miniature; taking care to apply them lightly, for fear of effacing the outlines of the deſign; or even, for the greater ſecurity, to apply them on the other ſide; eſpecially yellow, which is very pernicious to the other colours, by blending therewith. And here too, as in pieces of black and white, particular regard muſt always be had not to lay colour on colour, or lay on a new lay, till ſuch time as the former are well dried.

It may be added that the yellow is the only colour that penetrates through the glaſs, and incorporates therewith by the fire; the reſt, and particularly the blue, which is very difficult to uſe, remaining on the ſurface, or at leaſt entering very little. When the painting of all the pieces is finiſhed, they are carried to the furnace or oven to anneal or bake the colours.

The furnace here uſed is ſmall, built of brick, from 18 to 30 inches ſquare. At ſix inches from the bottom is an aperture to put in the fuel and maintain the fire.

fire. Over this aperture is a grate made of three square bars of iron, which traverse the furnace, and divide it into two parts. Two inches above this partition is another little aperture, through which they take out pieces to examine how the coction goes forward. On the grate is placed a square earthen pan, six or seven inches deep, and five or six inches less every way than the perimeter of the furnace. On the other side hereof is a little aperture, through which to make trials, placed directly opposite to that of the furnaces destined for the same end. In this pan are the pieces of glass to be placed in the following manner: First, The bottom of the pan is covered with three strata or layers of quicklime pulverized; those strata being separated by two others of old broken glass, the design whereof is to secure the painted glass from the too intense heat of the fire. This done, the glasses are laid horizontally on the last or uppermost layer of lime.

The first row of glass they cover over with a layer of the same powder an inch deep; and over this they lay another range of glasses, and thus alternately till the pan is quite full; taking care that the whole heap always end with a layer of the lime powder.

The pan being thus prepared, they cover up the furnace with tiles, on a square table of earthen ware, closely luted all round; only leaving five little apertures, one at each corner, and another in the middle, to serve as chimneys. Things thus disposed, there remains nothing but to give the fire to the work. The fire for the two first hours must be very moderate, and must be increased in proportion as the coction advances, for the space of ten or twelve hours; in which time it is usually completed. At last the fire, which at first was charcoal, is to be of dry wood, so that the flame covers the whole pan, and even issues out at the chimneys.

During the last hours, they make essays, from time to time, by taking out pieces laid for the purpose through the little aperture of the furnace and pan, to see whether the yellow be perfect, and the other colours in good order. When the annealing is thought sufficient, they proceed with great haste to extinguish the fire, which otherwise would soon burn the colours, and break the glasses.

Glass Balls, which are circular, or otherwise shaped hollow vessels of glass, may be coloured within, so as to imitate the semipellucid gems. The method of doing it is this: make a strong solution of ichthyocolla, or isinglass, in common water, by boiling; pour a quantity of this while warm into the hollow of a white glass vessel; shake it thoroughly about, that all the sides may be wetted, and then pour off the rest of the moisture. Immediately after this, throw in red lead, shake it and turn it about, throw it into many places with a tube, and the moisture will make it stick and run in waves and pretty figures. Then throw in some of the painters blue smalt, and make it run in waves in the ball as the red lead; then do the same with verdigrise, next with orpiment, then with red lake, all well ground; always casting in the colours in different places, and turning the glass, that the moisture within may run them into the waves. Then take fine plaster of Paris, and put a quantity of it into the ball; shake it also nimbly about; this will everywhere stick firmly to the glass, and give it a strong inner coat, keeping all the colours on very fairly and strongly. These are set on frames of carved wood, and much esteemed as ornaments in many places.

Glass Drop. See *Rupert's Drops*.

Engraving on Glass. Professor Beckmann has proved, that so early as the year 1670 the art of etching upon glass was discovered by Henry Schwanhard, son of George Schwanhard, who was a celebrated glass-cutter, patronized by the emperor Ferdinand III. about the middle of the last century. At the time of his death, 1667, the father practised his art at Prague and Ratisbon. Whether the son followed the same business at the same towns, or removed to Nuremberg, is not very evident; but in the year above mentioned, some *aqua regia* (nitro-muriatic acid) having accidentally fallen on his spectacles, he was surprised to find the glass corroded by it, and become quite soft. He thus, it is said, found himself in possession of a liquid by which he could etch writing and figures upon plates of glass.

But it is probable, as Beckmann seems to think, that he had discovered the fluoric acid itself; for in the year 1725 there appeared in a periodical work the following receipt for making a powerful acid, by which figures of every kind can be etched upon glass.

"When the *spiritus nitri per distillationem* has passed into the recipient, ply it with a strong fire, and when well dephlegmated, pour it, as it corrodes ordinary glass, into a Weldenburg flask. Then throw into it a pulverised green Bohemian emerald, otherwise called *hesphorus* (which, when reduced to powder, and heated, emits in the dark a green light), and place it in warm sand for 24 hours. Take a piece of glass well cleaned, and freed from all grease by means of a ley; put a border of wax round it, about an inch in height, and cover it all over with the above acid. The longer you let it stand so much the better; and at the end of some time the glass will be corroded, and the figures which have been traced out with sulphur and varnish will appear as if raised above the pane of glass."

That the Bohemian emerald or *hesphorus* mentioned in this receipt is green sparry fluor, cannot, says the professor, be doubted; and he seems to have as little doubt of the receipt itself having passed from Schwanhard and his scholars to the periodical work of 1725, from which it was inserted in the Œkonomische Encyclopedie of Krunitz. This supposition certainly acquires a considerable degree of probability from the similarity of Schwanhard's method of etching to that which is here recommended, and which is so different from what is now followed. At present, the glass is covered with a varnish either of isinglass dissolved in water, or of turpentine oil mixed with a little white lead, through which the figures to be etched are traced as on copper; but Schwanhard, when he had drawn his figures, covered them with varnish, and then by his liquid corroded the glass around them. His figures, therefore, when the varnish was removed, remained smooth and clear, appearing raised from a dim or dark ground; and M. Beckmann, who persuaded some ingenious artists to make trial of this ancient method of etching, declares, that such figures have a much better effect than those which are cut into the glass.

Foliating of Glass. See Foliating and *Looking-glass*.

Gilding of Glass. See Gilding.

Impreffions of antique Gems taken in Glass. See Gems.

Glass of Lead, a glafs made with the addition of a large quantity of lead, of great ufe in the art of making counterfeit gems. The method of making it is this: Put a large quantity of lead into a potter's kiln, and keep it in a ftate of fufion with a moderate fire, till it is calcined to a gray loofe powder; then fpread it in the kiln, and give it a greater heat, continually ftirring it to keep it from running into lumps; continue this feveral hours, till the powder become of a fair yellow; then take it out, and fift it fine: this is called *calcined lead*. Take of this calcined lead 15 pounds, and cryftalline or other frit 12 pounds; mix thefe as well as poffible together; put them into a pot, and fet them in the furnace for ten hours; then caft the whole, which will be now perfectly melted, into water; feparate the loofe lead from it, and return the metal into the pot; and after ftanding in fufion 12 hours more, it will be fit to work. It is very tender and brittle, and muft be worked with great care, taking it flowly out of the pot, and continually wetting the marble it is wrought upon.

It is well known that cerufe or white lead, minium, litharge, and all the other preparations and calces of lead, are eafily fufed by a moderate fire, and formed into a tranfparent glafs of a deep yellow colour. But this glafs is fo penetrating and powerful a flux, that it is neceffary to give it a greater confiftence, in order to render it fit for ufe. With this view, two parts of calx of lead, *e.g.* minium, and one part of fand or powdered flints, may be put into a crucible of refractory clay, and baked into a compact body. Let this crucible, well clofed with a luted lid, be placed in a melting furnace, and gradually heated for an hour or an hour and a half; and afterwards let the heat be increafed fo as to obtain a complete fufion, and continued in that ftate for the fame time: let the crucible remain to cool in the furnace; and when it is broken a very tranfparent yellow coloured glafs will be found in it. Some add nitre and common falt to the above mixture, becaufe thefe falts promote the fufion and the more equal diftribution of the fand. This glafs of lead has a confiderable fpecific gravity, and its loweft part is always the heavieft. It is an important flux in the affays of ores to facilitate their fcorification.

Glafs of lead is capable of all the colours of the gems in very great perfection. The methods of giving them are thefe: for green, take pulverine frit 20 pounds, lead calcined 16 pounds; fift both the powders very fine; then melt them into a glafs, feparating the unmixed lead, by plunging the mafs in water; after this return it into the pot, and add brafs thrice calcined fix ounces, and one pennyweight of crocus martis made with vinegar; put this in at fix different times, always carefully mixing it together, and take a proof of it; when the colour is right, let it ftand eight hours, and then work it. If inftead of the calcined brafs the fame quantity of the caput mortuum of the vitriolum veneris be ufed, the green is yet much finer.

For topaz colour, take cryftal frit 15 pounds, calcined lead 12 pounds; mix them well together, by fifting the powders through a fine fieve; then fet them in a furnace not too hot, and feparate the fuperfluous unmixed lead, by cafting the whole into water; repeat this twice: then add half gold yellow glafs, and let them incorporate and purify, and they will be of the true and exact colour of the oriental topazes.

For fea green, take cryftal frit 16 pounds, calcined lead 10 pounds; mix and fift them together, and fet them in a pot in a furnace; in 12 hours the whole will be melted; then caft it into water, and feparate it from the loofe lead; put them into the furnace again for eight hours; then feparate the loofe lead by wafhing a fecond time, and return it to the pot for eight hours more.

Mufcovy Glass. See Mica, Mineralogy *Index*.

Painting on Glass by means of Prints. See *Back-painting*.

Glass Porcelain, the name given by many to a modern invention of imitating the china ware with glafs. The method given by M. Reaumur, who was the firft that carried the attempt to any degree of perfection, is fhortly this: The glafs veffels to be converted into porcelain are to be put into a large earthen veffel, fuch as the common fine earthen difhes are baked in, or into fufficiently large crucibles; the veffels are to be filled with a mixture of fine white fand, and of fine gypfum or plafter ftone burnt into what is called plafter of Paris, and all the interftices are to be filled up with the fame powder, fo that the glafs veffels may nowhere touch either one another, or the fides of the veffel they are baked in. The veffel is to be then covered down and luted, and the fire does the reft of the work; for this is only to be put into a common potter's furnace, and when it has ftood there the ufual time of the baking the other veffels, it is to be taken out, and the whole contents will be found no longer glafs, but converted into a white opaque fubftance, which is a very elegant porcelain, and has almoft the properties of that of China.

The powder which has ferved once will do again as well as frefh, and that for a great many times: nay, it feems, ever fo often. The caufe of this transformation, fays Macquer, is probably that the vitriolic acid of the gypfum quits its bafis of calcareous earth, and unites with the alkaline falt and faline earth of the glafs, with which it forms a kind of falt, different from the calcareous felenite, by the interpofition of which matter the glafs acquires the qualities of porcelain.

Glass Pots, the veffels in the glafs trade ufed for melting the glafs. Thofe for the white glafs works are made of a tobacco pipe clay, brought from the ifle of Wight, which is firft well wafhed, then calcined, and afterwards ground to a fine powder in a mill; which being mixed with water, is then trod with the bare feet till it is of a proper confiftence to mould with the hands into the proper fhape of the veffels. When thefe are thus made, they are afterwards annealed over the furnace. Thofe for the green glafs work are made of the nonfuch, and another fort of clay from Staffordfhire; they make thefe fo large as to hold three or four hundred weight of metal. And befides thefe, they have a fmall fort called piling pots, which they fet upon the larger, and which contain a finer and more nice metal fit for the niceft works.

The clay that is ufed for this purpofe fhould be of the pureft and moft refractory kind, and well cleanfed from all fandy, ferruginous, and pyritous matters; and to

Glass.

to this it will be proper to add ground crucibles, white ſand, calcined flints duly levigated, or a certain proportion of the ſame clay baked, and pounded not very finely. The quantity of baked clay that ought to be mixed with the crude clay, to prevent the pots from cracking when dried, or expoſed to a great heat, is not abſolutely determined, but depends on the quality of the crude clay, which is more or leſs fat. M. D'Antic, in a memoir on this ſubject, propoſes the following method of aſcertaining it: The burnt and crude clay, being mixed in different proportions, ſhould be formed into cakes, one inch thick, and four inches long and wide. Let theſe cakes be ſlowly dried, and expoſed to a violent heat, till they become as hard and as much contracted as poſſible, and in this ſtate be examined; and the cake, he ſays, which has ſuffered a diminution of its bulk equal only to an eighteenth part, is made of the beſt proportions. He obſerves, in general, that moſt clays require that the proportion of the burnt ſhould be to the freſh as four to five.

Tin Glass, the ſame with Biſmuth. See Bismuth, Chemistry *Index*.

Glasses are diſtinguiſhed, with regard to their form, uſe, &c. into various kinds, as drinking glaſſes, optical glaſſes, looking glaſſes, burning glaſſes, &c.

Drinking Glasses, are ſimple veſſels of common glaſs or cryſtal, uſually made in form of an inverted cone.

Each glaſs conſiſts of three parts, viz. the bowl, the bottom, and the foot; which are all wrought or blown ſeparately.

Nothing can be more dexterous and expeditious than the manner of blowing theſe parts: two of them opened, and all three joined together. An idea is only to be had thereof, by ſeeing it actually done. For the method of gilding the edges of drinking glaſſes, ſee *Gilding on Enamel and Glaſs*.

Optical Glasses. See Optics.

The improvements hitherto made in teleſcopes by means of combining lenſes made of different kinds of glaſs, though very great, are yet by no means adequate to the expectations that might reaſonably be formed if opticians could fall on any method of obtaining pieces of glaſs ſufficiently large for purſuing the advantages of Mr Dollond's diſcovery. Unfortunately, however, though the board of longitude have offered a conſiderable reward for bringing this art to the requiſite perfection, no attempt of any conſequence has hitherto been made. Mr Keir is of opinion, that the accompliſhment of this is by no means an eaſy taſk; as it requires not only a competent knowledge of the properties of glaſs fitteſt for the purpoſe (the faults not being evident to common inſpection), but a conſiderable degree of chemical knowledge is alſo neceſſary in order to invent a compoſition by which theſe faults may be avoided; and laſtly, a kind of dexterity in the execution of the work, which can only be acquired by practice. Our author, however, thinks, that if the ſubject were more generally underſtood, and the difficulties more fully pointed out, for which purpoſe he makes the following remarks, the end may be more eaſily accompliſhed.

1. The rays of light paſſing through a glaſs lens or priſm, or through any other medium of unequal thickneſs, are refracted; but not in an equal manner, the blue, violet, &c. being more refracted than the red.

Glaſs.

2. Hence it happens, that the rays of light, when refracted by a common lens, do not all unite in one focus, but in reality form as many different foci as there are colours; and hence ariſe the priſmatic colours, or iriſes, which appear towards the borders of the image formed by the common convex lenſes, and which render the viſion extremely indiſtinct.

3. The indiſtinctneſs of viſion produced by this cauſe, which is ſenſible in teleſcopes of a ſmall aperture, increaſes in ſo great a proportion, viz. as the cubes of the diameters, that it ſeemed impoſſible to increaſe the power of dioptric teleſcopes greatly, without extending them to a very inconvenient length, unleſs this confuſion of colours could be corrected.

4. It was known that different tranſparent bodies poſſeſſed different degrees of refractive power; and until Mr Dollond diſcovered the contrary, it was ſuppoſed, that the refractions of the coloured rays were always in a determined ratio to one another. On this ſuppoſition it ſeemed impoſſible to correct the faults of refracting teleſcopes: for it was ſuppoſed, that if the diſperſion of light produced by a convex lens were counteracted by another lens or medium of a concave form, the refraction would be totally deſtroyed; and this indeed would be the caſe, if the two mediums were made of the ſame matter; and from ſome experiments made by Sir Iſaac Newton, this was ſuppoſed to be actually the caſe in all ſubſtances whatever.

5. From conſidering that the eyes of animals are formed of mediums of different colours, it occurred firſt to Mr David Gregory, the celebrated profeſſor of aſtronomy at Oxford, and then to Mr Euler, that, by a combination of mediums which had different refractive powers, it might be poſſible to remedy the imperfections of dioptric teleſcopes. It does not, however, appear, that either of theſe gentlemen underſtood the true principle on which theſe phenomena depend. Mr Euler executed his idea by forming a compound object lens from two glaſs lenſes with water interpoſed, but his attempt was not attended with ſucceſs. Mr Dollond, however, was led by ſome arguments adduced by Mr Klingenſtierna of Sweden, to repeat one of Sir Iſaac Newton's experiments, and which had induced even that great philoſopher himſelf to ſuppoſe that the improvement afterwards executed by Mr Dollond was impoſſible. This experiment was made by Sir Iſaac Newton, by placing a glaſs priſm within a priſmatic veſſel filled with water, in ſuch a manner that the rays of light which were refracted by the glaſs priſm ſhould paſs through and be refracted in a contrary direction by the water priſm. In this manner the refraction of the light was entirely deſtroyed. But when Mr Dollond repeated the experiment, he found, that, contrary to his own expectations, when the angles of the two priſms were ſo proportioned that they counteracted each other's mean refraction, then colours appeared; and on the other hand, when they were ſo proportioned that the diſperſion of the coloured rays was counteracted, the mean refraction ſtill ſubſiſted; which evidently proved, that the mean refractive and diſperſive powers of glaſs and water were not proportional to one another.

6. To apply this to the propoſed improvement, Mr Dollond examined ſeveral kinds of glaſs. Crown glaſs was found to poſſeſs the ſmalleſt diſperſive power in proportion to its refraction; while flint glaſs poſſeſſed the

the greateſt diſperſive power in proportion to its refraction, which was alſo very great. On comparing theſe two exactly together, he found, that a wedge of white flint glaſs whoſe angle was about 25 degrees, and another of crown glaſs whoſe angle was 29 degrees, refracted very nearly alike. He found alſo, that, when the wedges were ground to ſuch angles, the refraction produced by the flint glaſs was to that produced by the crown glaſs nearly as two or three; the refracted light was then free from colour. On meaſuring the general refracting powers of theſe two glaſſes, he found, that in flint glaſs, the ſine of incidence of the rays was to the ſine of mean refraction as 1 to 1.583; and that in crown glaſs, the ſine of incidence was to the ſine of mean refraction as 1 to 1.53.

The methods of determining the different refractive powers of glaſs are given under the article Optics. Here we ſhall only obſerve, that two kinds of glaſs are neceſſary for the conſtruction of achromatic teleſcopes; one of which ſhall poſſeſs as ſmall, and the other as great, diſperſive powers, relative to their mean refracting powers, as can be produced. The difference of glaſſes in this reſpect depends on the quality of the ingredients employed in their compoſition. Crown glaſs, which is compoſed of ſand melted by means of the aſhes of ſea weeds, barilla, or kelp, both which fluxes are known to conſiſt of vegetable earth, alkali, and neutral ſalt, is found to give the ſmalleſt diſperſive power. Plate glaſs, which conſiſts of ſand melted by means of fixed vegetable alkali, with little or no vegetable earth, gives a greater diſperſive power; but both theſe give much leſs than flint glaſs, which conſiſts of ſand melted by means of minium and fixed alkali. It appears, therefore, that the diſperſion of the rays is greateſt when minium, or probably other metallic calces, are made uſe of; and that alkalies give a greater power of diſperſion than vegetable or other earths. Mr Zieher of Peterſburgh, however, informs us, that he has made a kind of glaſs, much ſuperior in this reſpect to flint glaſs; but it does not as yet appear whether it be more fit for optical purpoſes than that commonly made uſe of. There ſeems no difficulty in augmenting the diſperſive power, as that is found to depend on the quantity of minium or other flux: but thus we unfortunately increaſe alſo the capital fault to which flint glaſs and all compoſitions of that kind are ſubject; namely, the being ſubject to veins or ſmall threads running through it. By theſe, even when ſo ſmall as to be imperceptible to the naked eye, the rays which fall on them are diverted from their proper direction, and thereby render the images confuſed. This is owing to the greater denſity of the veins, as appears by their image being received on white paper, when the glaſs is held between the paper and the ſun or a candle at a proper diſtance. The rays of light being then made to converge by the ſuperior denſity of the veins, their images will appear as bright lines bordered with obſcure edges on the paper. Flint glaſs is ſo much ſubject to this kind of imperfection, that it is with difficulty the opticians can pick out pieces of the ſize commonly uſed from a large quantity of the glaſs. It is farther to be regretted, that the minium which produces the greateſt diſperſive power, is likewiſe the very ſubſtance which renders flint glaſs much more ſubject to theſe imperfections than any other. The reaſon is, that the ſand and earthy matters mix uniformly in fuſion; and having not only a conſiderable degree of affinity towards each other, but alſo being not much different from each other, they are not apt to ſeparate. On the other hand, when ſuch a heavy ſubſtance as minium is added to theſe earthy ſubſtances, though it has a pretty ſtrong tendency to unite with the earthy ſubſtances, it has none with the fixed alkali, which is another ingredient in this glaſs. Hence ſome parts of the glaſs will contain more metallic matter than the reſt; particularly that near the bottom of the pot, which is ſo full of large veins as to be applied only to the making of wares of little value. The veins in this caſe are formed by the deſcent of the minium at the bottom, which in its paſſage forms threads or veins by dragging other parts of the glaſs along with them.

The correction of this fault appears therefore to be very difficult. M. Macquer informs us, that he had in vain tried to remove it by very long fuſion and a fierce fire; which indeed others have found by experience not to correct, but to augment the evil. Mr Keir is of opinion that ſome new compoſition muſt be diſcovered, which, along with a ſufficient refractive power, ſhould poſſeſs a greater uniformity of texture; but he is likewiſe of opinion, that ſcarce any alteration in this reſpect could be made without injuring the colour of the glaſs. For optical purpoſes, however, our author does not think that an alteration in the colour of the ingredients would be very detrimental. "I am convinced (ſays he), that glaſſes ſenſibly tinged with colour, might tranſmit as much or more light than the beſt flint glaſs. For the colourleſs appearance of flint glaſs is an optical deception. The minium gives it a conſiderable tinge of yellow, and the alkali inclines it to a bluiſh caſt, beſides the colour ariſing from a greater or leſs impurity of the materials; ſo that the glaſs would actually be very ſenſibly coloured, unleſs by the addition of mangaueſe, which is known to give a purpliſh red. Thus the other tinges are counteracted, but not effaced or deſtroyed as has been frequently imagined. By the mixture of the three principal colours, red, yellow, and blue, more or leſs exactly counterpoiſed, a certain dark ſhade is introduced, in which, as not any one of the colours predominates, no coloured tinge appears, but the effect is merely a diminution of the tranſparency of the glaſs, which, however, is too ſmall for ordinary obſervation." Mr Keir is even of opinion, that a certain tinge of yellow would in many caſes be of ſervice, becauſe it would exclude ſome of the blue rays, which being moſt refrangible are moſt injurious to the diſtinctneſs of viſion.

Very conſiderable difficulties, however, muſt ariſe in attempting improvements of this kind; as the experiments muſt all be tried on a very large ſcale. This is not only attended with a very heavy expence in itſelf on account of the quantity of materials employed, but from the heavy duty of exciſe which is rigorouſly exacted whether the glaſs be manufactured into ſaleable articles or not. It is obſerved in the manufacture of every kind of glaſs, that the glaſs in the middle of the area or tranſverſe ſection of a pot is much purer and freer from veins and other imperfections than the part which is near the ſides, and that the glaſs at the bottom is the worſt of all. Conſequently it is chiefly in large pots, ſuch as are uſed in manufactures, that there is a probability of ſuccefs. Very fine and beautiful glaſſes, called *paſte* and *artificial gems*, may be made in ſmaller pots or crucibles; but this glaſs is ſuffered to cool and ſubſide in the veſſel, by which means the contiguous parts are more uniform in their texture than can be expected in a piece of glaſs taken out of the pot while hot in the common way, by making it adhere and twiſt round an irod rod or pipe. But although the method of allowing the glaſs to cool in the pots is very advantageous for the purpoſes of the jeweller, it is by no means applicable to thoſe of the optician. Glaſs cooled in that gradual manner, ſuffers ſome degree of cryſtallization or peculiar arrangement of its parts; the conſequence of which is, that the rays of light undergo certain refractions independent on the form of the glaſs, which greatly affect the diſtinctneſs of viſion in teleſcopes.

Muſical GLASSES. See HARMONICA.

Looking GLASS. See *LOOKING Glaſs*, MIRROR, and FOLIATING.

Burning GLASS. See *BURNING Glaſs*.

Weather GLASS. See BAROMETER.

Cupping GLASS. See SURGERY.

Hour GLASS. See *HOUR Glaſs*.

Watch GLASS. See WATCH.

GLASS *Wort*. See SALSOLA, BOTANY *Index*.

GLASTONBURY, a town of Somerſetſhire in England; ſeated in W. Long. 2. 46. N. Lat. 51. 15. —It is noted for a famous abbey, ſome magnificent ruins of which ſtill remain. The curious ſtructure called *the Abbot's kitchen* is ſtill pretty entire. The monks pretend that it was the reſidence of Joſeph of Arimathea, and of St Patrick. The king of the Weſt Saxons erected a church here, which he and the ſucceeding kings enriched to ſuch a degree, that the abbot lived like a prince, had the title of *lord*, and ſat among the barons in parliament; and no perſon, not even a biſhop or prince, durſt ſet foot on the iſle of Avalon, in which the abbey ſtands, without his leave. The revenue of the abbey was above 40,000l. per ann. beſides ſeven parks well ſtocked with deer. The laſt abbot (Richard Whiting), who had 100 monks, and 300 domeſtics, was hanged in his pontificals, with two of his monks, on the Tor, a high hill in the neighbourhood, for refuſing to take the oath of ſupremacy to Henry VIII. and ſurrender his abbey when required. Edgar and many other Saxon kings were buried here; and, as ſome will have it, Arthur the Britiſh king. Every cottage here has part of a pillar, a door, or a window of this fabric; of which there ſtill remain the ruins of the choir, the middle tower and the chapels. The walls that remain of the abbey are overgrown with ivy, and the aſpect of the whole is both melancholy and venerable. Here are two pariſh churches. This town, while under the protection of its abbots, was a parliamentary borough, but it loſt that and its privilege of a corporation; the latter of which was, however, reſtored by Queen Anne, who granted it a new charter for a mayor and burgeſſes. The only manufactory here is ſtockings. At a little diſtance from the old church, and facing the monk's churchyard, are two remarkable pyramids, with inſcriptions, that are in characters unintelligible, and an image in biſhop's veſtments. The ſtory of the Glaſtonbury thorn, and of its budding upon Chriſtmas day, is well known. This is not correctly true; but if the winter is mild, it always buds about the latter end of December, but later if the weather is ſevere.

GLATZ, a ſtrong town of Bohemia, capital of a county of the ſame name, ſeated on the river Neiſſe; and well fortified with a caſtle. The county was ceded to the king of Pruſſia by the queen of Hungary in 1742; and is about 45 miles in length, and 25 in breadth. It has mines of pit coal, ſilver, and iron; good quarries, plenty of cattle, and fine ſprings of mineral water. The town is ſituated in E. Long. 15. 16. N. Lat. 50. 25.

GLAUBER, JOHN RHODOLPHUS, a celebrated German chemiſt, who flouriſhed about the year 1646. He wrote a great number of different treatiſes on chemiſtry, ſome of which have been tranſlated into Latin and French. All his works have been collected into one volume, entitled *Glauberus concentratus*, which was tranſlated into Engliſh, and printed at London, in folio, in 1689.

GLAUBER'S *Salts*, or *Sulphate of Soda*. See CHEMISTRY *Index*.

GLAUCOMA, in *Medicine* and *Surgery*, the name of a diſeaſe in the eye, wherein the cryſtalline humour is turned of a bluiſh or greeniſh colour, and its tranſparency hereby diminiſhed.—The word comes from γλαυκος, *cæſius*, " ſea green, ſky coloured, or grayiſh."

Thoſe in whom this diſorder is forming, diſcover it hence, that all objects appear to them as through a cloud or miſt; when entirely formed, the viſual rays are all intercepted, and nothing is ſeen at all.

It is reckoned incurable, when inveterate, and in aged perſons: and even under other circumſtances, is very difficult of cure, externals proving of little ſervice.

The internals beſt ſuited to it, are thoſe uſed in the gutta ſerena. Jul. Cæſar Claudinus, Conſul. 74. gives a remedy for the glaucoma.

The glaucoma is uſually diſtinguiſhed from the cataract or ſuffuſion, in this, that in the cataract the whiteneſs appears in the pupil, very near the corner; but it ſhows deeper in the glaucoma. See SURGERY *Index*.

GLAUCUS, a marine god, or deity of the ſea. There are a great many fabulous accounts of this divinity: but the poetical hiſtory of him is, that before his deification, he was a fiſherman of the town of Anthedon, who having one day taken a conſiderable number of fiſhes, which he laid upon the bank, on a ſudden perceived, that theſe fiſhes, having touched a kind of herb that grew on the ſhore, received new ſtrength, and leaped again into the ſea: upon the ſight of which extraordinary accident, he was tempted to taſte of the herb himſelf, and preſently leaped into the ſea after them, where he was metamorphoſed into a Triton, and became one of the ſea gods.

GLAUX, a genus of plants belonging to the pentandria claſs, and in the natural method ranking under the 17th order, *Calycanthemæ*. See BOTANY *Index*.

GLAZIER, an artificer who works in glaſs.—The principal part of a glazier's buſineſs conſiſts in fitting panes of glaſs to the ſaſhes and window frames of houſes, pictures, &c. and in cleaning the ſame.

GLAZING, the cruſting over earthen ware with a vitreous ſubſtance, the baſis of which is lead. See GLASS *of Lead*.

The workers of common earthen ware, however, are not at the trouble of thus previously making a pure glass of lead. Their usual composition for glazing their ware is formed of white sand 40 pounds, of red lead 20 pounds, of pearl ashes 20 pounds, and of common salt 12 pounds. Powder the sand by grinding it, and then add it to the other ingredients and grind them together: after which calcine them for some time with a moderate heat, and when the mixture is cold, pound it to powder; and when wanted for use temper it with water. The proportion of these ingredients may be occasionally varied. The ware after being turned on the wheel and dried in the open air, is covered over with the above composition by means of a brush; and when set in the furnace the violent heat soon reduces it to a perfect glass, covering the whole internal and external surface of the vessel.

We may observe, however, in general, that lead ought to be excluded from the composition of glazings, and other fluxes substituted in its stead. A transparent glazing may be prepared without lead, by calcining 40 pounds of white sand, 25 pounds of pearl ashes, and 15 pounds of common salt; and proceeding as before: and a more perfect transparent glazing may be made of sand 40 pounds, of wood ashes perfectly burnt 50 pounds, of pearl ashes 10 pounds, and of common salt 12 pounds. The following receipts are taken for the most part from Kunckel, who says, that they are the true glazings used at Delft and other Dutch manufactories.

Black is made of eight parts of red lead, iron filings three, copper ashes three, and zaffer two measures. This when melted will make a brown black; and if you want it blacker, add more zaffer to it.

Blue is thus prepared: Take lead ashes or red lead one pound, clear sand or powdered flints two pounds, common salt two pounds, white calcined tartar one pound, Venice or other glass half a pound, zaffer half a pound; mix them well together and melt them for several times, quenching them always in cold water. If you would have it fine and good, it will be proper to put the mixture into a glass furnace for a day or two.

Another blue glazing may be formed of one pound of tartar, a quarter of a pound of red lead, half an ounce of zaffer, and a quarter of a pound of powdered flints, which are to be fused and managed as in the last receipt. Or, take two pounds of calcined lead and tin, add five pounds of common salt, five pounds of powdered flints, and of zaffer, tartar, and Venetian glass, each one pound. Calcine and fuse the mixture as before. Or, again, take of red lead one part, of sand three parts, and of zaffer one part. For a violent blue glazing, take four ounces of tartar, two ounces of red lead, five ounces of powdered flints, and half a drachm of manganese.

Brown is made of red lead and flints of each 14 parts, and of manganese two parts fused; or of red lead 12 parts, and manganese one part fused. A brown glazing, to be laid on a white ground, may be made of manganese two parts, and of red lead and white glass of each one part, twice fused.

Flesh coloured is made of 12 parts of lead ashes, and one of white glass.

Gold coloured. Take of litharge three parts, of sand or calcined flint one part; pound and mix these very well together, then run them into a yellow glass with a strong fire. Pound this glass, and grind it into a subtile powder, which moisten with a well saturated solution of silver; make it into a paste, which put into a crucible, and cover it with a cover. Give at first a gentle degree of fire; then increase it, and continue it till you have a glass, which will be green. Pound this glass again, and grind it to a fine powder; moisten this powder with some beer, so that by means of a hair pencil you may apply it upon the vessels or any piece of earthen ware. The vessels that are painted or covered over with this glazing must be first well heated, then put under a muffle; and as soon as the glass runs, you must smoke them, by holding them over burning vegetables, and take out the vessels. Mr Heinsius of Petersburgh, who sent this receipt to the Royal Society, uses the words *afflare debes fumum*, which is rendered *smoke them*, in the Transactions. Phil. Trans. N° 465. § 6.

Kunckel gives several preparations for a gold coloured yellow glazing. This may be produced by fusing a mixture of three parts of red lead, two parts of antimony, and one part of saffron of Mars; by again melting the powdered mass, and repeating the operation four times, or by fusing four or five times a composition of red lead and antimony of each an ounce, and of scales of iron half an ounce: or by calcining and fusing together eight parts of red lead, six parts of flints, one part of yellow ochre, one part of antimony, and one part of white glass. A transparent gold-coloured glazing may be obtained by twice fusing red lead and white flints, of each 12 parts, and of filings of iron one part.

Green may be prepared of eight parts of litharge or red lead, eight parts of Venice glass, four parts of brass dust or filings of copper; or of ten parts of litharge, twelve of flint or pebble, and one of *æs ustum* or copper ashes.—A fine green glazing may be produced by fusing one part of the Bohemian granate, one part of filings of copper, one part of red lead, and one part of Venetian glass; or by fusing one part of white glass, the same quantity of red lead, and also of filings of copper; powdering the mass, and adding one part of Bohemian granate to two parts of this powder. A fine green may be obtained by mixing and grinding together any of the yellow glazings with equal quantities of the blue glazings; and all the shades and teints of green will be had by varying the proportion of the one to the other, and by the choice of the kind of yellow and blue.

Sea green is made of five pounds of lead ashes, one pound of tin ashes, three pounds of flint, three quarters of a pound of salt, half a pound of tartar, and half a pound of copper dust.

Iron colour is prepared of 15 parts of lead ashes or red lead, 15 of white sand or flints, and five of calcined copper. This mixture is to be calcined and fused.

Liver colour is prepared of 12 parts of litharge, eight of salt, six of pebble or flint, and one of manganese.

Purple brown consists of lead ashes 15 parts, clean sand or powdered flints 18 parts, manganese one part, and white glass 15 measures, to which some add one measure of zaffer.

Red

Red is made of antimony three pounds, litharge or red lead three, and ruſt of iron one : grind them to a fine powder. Or, take two pounds of antimony, three of red lead, and one of calcined ſaffron of Mars, and proceed as before.

White. The white glazing for common ware is made of 40 pounds of clear ſand, 75 pounds of litharge or lead aſhes, 26 of pot aſhes, and ten pounds of ſalt : theſe are three times melted into a cake, quenching it each time in clear cold water. Or it may be made of 50 pounds of clean ſand, 70 of lead aſhes, 30 of wood aſhes, and 12 of ſalt.

For a fine white : Take two pounds of lead and one of tin ; calcine them to aſhes : of this take two parts, calcined flint, white ſand, or broken white glaſs, one part, and ſalt one part ; mix them well together and melt them into a cake for uſe. The trouble of calcining the tin and lead may be prevented by procuring them in a proper ſtate.

A very fine white glazing may be obtained by calcining two parts of lead and one part of tin ; and taking one part of this maſs, and of flints and common ſalt of each one part, and fuſing the mixture.

A white glazing may be alſo prepared by mixing 100 pounds of maſticot, 60 pounds of red lead, 20 pounds of calcined tin or putty, and 10 pounds of common ſalt, and calcining and powdering the mixture ſeveral times.

Yellow is prepared of red lead three pounds ; calcined antimony and tin, of each two pounds ; or, according to ſome, of equal quantities of the three ingredients. Theſe muſt be melted into a cake, then ground fine ; and this operation repeated ſeveral times ; or it may be made of 15 parts of lead ore, three parts of litharge of ſilver, and 15 parts of ſand.—A fine yellow glazing may be procured by mixing five parts of red lead, two parts of powdered brick, one part of ſand, one part of the white glazings, and two parts of antimony, calcining the mixture and then fuſing it. Or, take four parts of white glaſs, one part of antimony, three parts of red lead, and one part of iron ſcales, and fuſe the mixture ; or fuſe 16 parts of flints, one part of iron filings, and 24 parts of litharge. A light yellow glazing may be produced with ten parts of red lead, three parts of antimony, and three of glaſs, and two parts of calcined tin. See *Gold colour*, above.—A *citron yellow* is made of ſix parts of red lead, ſeven parts of fine red brick duſt, and two parts of antimony. This mixture muſt be calcined day and night for the ſpace of four days, in the aſh hole of a glaſs-houſe furnace, and at laſt urged to fuſion.

For the glazing of Delft ware, Porcelain, Stoneware, &c. see the articles *Delft Ware*, Porcelain, and Pottery.

The Romans had a method of glazing their earthen veſſels, which in many reſpects appears to have been ſuperior to ours. The common brown glazing eaſily ſcales off, cracks, and in a ſhort time becomes diſagreeable to the eye. Beſides, it is very eaſily deſtroyed by acids ; nor can veſſels glazed in this manner be even employed to hold water, without part of it oozing through their pores. Lead is alſo very deſtructive to the human body ; and if acids are unwarily put into veſſels glazed with lead, the liquors will receive a very dangerous impregnation from the metal. The Roman glazing, which is yet to be ſeen upon urns dug up in ſeveral places, appears to have been made of ſome kind of varniſh ; and Pliny gives us a hint that it was made of bitumen. He tells us that it never loſt its beauty, and that at length it became cuſtomary to glaze over ſtatues in this manner. As this varniſh ſunk deep into the ſubſtance of the ware, it was not ſubject to thoſe cracks and flaws which disfigure our veſſels ; and as it was not liable to be corroded by acids, it could not be ſubject to any of the accidents which may enſue from the uſe of veſſels glazed with lead.

GLEAD, or Glade, a name uſed in the northern parts of the kingdom for the kite. See Falco, Ornithology *Index*.

GLEAM is popularly uſed for a ray or beam of light. Among falconers a hawk is ſaid to gleam when ſhe caſts or throws up filth from the gorge.

GLEANING, the act of gathering or picking up the ears of corn left behind after the field has been reaped and the crop carried home. By the cuſtoms of ſome countries, particularly thoſe of Melun and Eſtampes, all farmers and others are forbid, either by themſelves or ſervants, to put any cattle into the fields, or prevent the gleaning in any manner whatever for the ſpace of 24 hours after the carrying off the corn, under the penalty of confiſcation.

GLEBE, among miners, ſignifies a piece of earth in which is contained ſome mineral ore.

Glebe, in *Law*, the land belonging to a pariſh church beſides the tithes.

GLECHOMA, ground ivy, a genus of plants belonging to the didynamia claſs, and in the natural method ranking under the 42d order, *Verticillatæ*. See Botany *Index*.

GLEDITSIA, triple thorned acacia, or *Honey Locuſt*, a genus of plants belonging to the polygamia claſs, and in the natural method ranking under the 33d order, *Lomentaceæ*. See Botany *Index*.

GLEET, in *Medicine*, the flux of a thin limpid humour from the urethra. See Medicine *Index*.

GLENDALAGH, otherwiſe called *the Seven Churches*, anciently a celebrated town of Ireland, ſituated five miles north-weſt of Rathdrum, in the county of Wicklow, and province of Leinſter. The name ſignifies "the valley of the two lakes." In this valley, ſurrounded by high and almoſt inacceſſible mountains, St Kevin or Cavan, called alſo *St Coemgene*, about the middle of the 6th century, founded a monaſtery, which in a ſhort time from the ſanctity of its founder was much reſorted to, and at length became a biſhoprick and a religious city. St Kevin died 3d June 618, aged 120 ; and on that pay annually numbers of perſons flock to the Seven Churches to celebrate the feſtival of that venerated ſaint. During the middle ages the city of Glendalagh, called by Hovedon *Epiſcopatus Biſtagnienſis*, was held in great eſteem, and received ſeveral valuable donations and privileges, its epiſcopal juriſdiction extending to the walls of Dublin.—About the middle of the 12th century, on ſome account or other, it was much neglected by the clergy ; and became, inſtead of a holy city, a den of thieves, wherefore Cardinal Papiro, in 1214, united it to the ſee of Dublin, which union was confirmed by King John. The O'Tools, chiefs of of Firthual, however, by the assistance of the Pope, continued long after this period to elect bishops and abbots to Glendalagh, though they had neither revenues or authority, beyond the district of Tuathal, which was the western part of the county of Wicklow; in consequence of which the city was suffered to decay, and had become nearly a desert, in 1497, when Dennis White, the last titular bishop, surrendered his right in the cathedral church of St Patrick, Dublin. From the ruins of this ancient city still remaining, it appears to have been a place of consequence, and to have contained seven churches and religious houses; small indeed but built in a neat elegant style, in imitation of the Greek architecture: the cathedral, the walls of which are yet standing, was dedicated to St Peter and St Paul. South of the cathedral stands a small church roofed with stone, nearly entire; and in several parts of the valley are a number of stone crosses, some of which are curiously carved, but without any inscriptions. In the north-west corner of the cemetery belonging to the cathedral stands a round tower, 95 feet high, and 15 in diameter; and in the cemetery of a small church, on the south side of the river, near the great lake, called the *Rhefeart church*, are some tombs, with Irish inscriptions, belonging to the O'Tools. In a perpendicular projecting rock on the south side of the great lake, 30 yards above the surface of the water, is the celebrated bed of St Kevin, hewn out of the rock, exceedingly difficult of access and terrible of prospect. Amongst the ruins have been discovered a number of stones, curiously carved, and containing inscriptions in the Latin, Greek, and Irish languages. As this city was in a valley, surrounded on all sides, except the east, by high, barren, and inaccessible mountains, the artificial roads leading thereto are by no means the least curious part of the remains; the principal is that leading into the county of Kildare through Glendason. This road for near two miles is yet perfect, composed of stones placed on their edges, making a firm and durable pavement, about 10 feet broad. At a small distance from St Kevin's bed, on the same side of the mountain, are to be seen the ruins of a small stone building called *Saint Kevin's cell*.

GLENOIDES, the name of two cavities, or small depressions, in the inferior part of the first vertebra of the neck.

GLIMMER, or GLIST. See MICA, MINERALOGY *Index*.

GLINUS, in *Botany*, a genus of plants belonging to the decandria class; and in the natural method ranking under the 22d class, *Caryophylleæ*. See BOTANY *Index*.

GLIRES, the name of Linnæus's fourth order of mammalia. See MAMMALIA *Index*.

GLISSON, FRANCIS, a learned English physician in the 17th century, was educated at Cambridge, and was made regius professor of that university. In 1634 he was admitted a fellow of the College of Physicians in London. During the civil wars, he practised physic at Colchester, and afterwards settled in London. He greatly improved physic by his anatomical dissections and observations, and made several new discoveries of singular use towards establishing a rational practice. He wrote, 1. *De rachitide*, &c. 2. *De lymphæductis nuper repertis*: with the *Anatomica prolegomena*, *et Anatomia hepatis*. 3. *De naturæ substantia energitica; seu de via vitæ naturæ, ejusque tribus primis facultatibus*, &c. quarto. 4. *Tractatus de ventriculo et intestinis*, &c. The world is obliged to him for the *capsula communis*, or *vagina portæ*.

GLISTER, in *Surgery*. See CLYSTER.

GLOBBA, a genus of plants belonging to the monandria class. See BOTANY *Index*.

GLOBE, in *Geometry*, a round or spherical body, more usually called a *Sphere*. See SPHERE.

GLOBE is more particularly used for an artificial sphere of metal, plaster, paper, or other matter; on whose convex surface is drawn a map, or representation either of the earth or heavens, with the several circles conceived thereon. See GEOGRAPHY.

Globes are of two kinds, *terrestrial* and *celestial*; each of very considerable use, the one in astronomy, and the other in geography, for performing many of the operations thereof in an easy obvious manner, so as to be conceived without any knowledge of the mathematical grounds of those arts.

The fundamental parts, common to both globes, are an axis, representing that of the world; and a spherical shell, or cover, which makes the body of the globe, on the external surface of which the representation is drawn. See GEOGRAPHY *Index*.

Globes, we have observed, are made of different materials, viz. silver, brass, paper, plaster, &c. Those commonly used are of plaster and paper. For the construction of globes, see GEOGRAPHY *Index*.

For the uses, &c. of the globes, see GEOGRAPHY and ASTRONOMY.

GLOBE Animal. See ANIMALCULE.

GLOBE Fish. See OSTRACION, ICHTHYOLOGY *Index*.

GLOBULARIA, GLOBULAR BLUE DAISY; a genus of plants, belonging to the tetrandria class; and in the natural method ranking under the 48th order, *Aggregatæ*. See BOTANY *Index*.

GLOBULE, a diminutive of globe, frequently used by physicians in speaking of the red particles of the blood. See BLOOD.

GLOCESTER, the capital of Glocestershire in England, 101 miles from London. It is an ancient city; and by Antoninus is called *Clevum*, or *Glevum*, which Camden thinks was formed from the British *Caer-Glowe*, signifying "a fair city." It was one of the 28 cities built by the Britons before the arrival of the Romans, who made it one of their colonies, and in the eighth century it was esteemed one of the noblest cities in the kingdom. It has suffered considerably by fire at different periods. It stands upon a hill; and from the middle of the city, where the four principal streets meet, there is a descent every way, which makes it not only clean and healthy, but adds to the beauty of the place. Forging of iron seems to have been its manufacture so early as the time of William the Conqueror. King Henry VIII. made it the see of a bishop, with a dean and six prebends. Its castle which was erected in the time of William the Conqueror, is very much decayed; part of it is leased out by the crown; and the rest serves for a prison, one of the best in England. In its cathedral, which is an ancient but magnificent fabric, and has a tower reckoned one

Glocester.

one of the most curious pieces of architecture in England, are the tombs of Robert duke of Normandy, son to William the Conqueror, and of Edward II. and there is a whispering place like to that of St Paul's at London. In the chapter house lies Strongbow who conquered Ireland. There are 12 chapels in it, with the arms and monuments of many great persons. King John made it a borough to be governed by two bailiffs. Henry III. who was crowned here, made it a corporation. By its present charter from Charles I. it is governed by a steward, who is generally a nobleman; a mayor; a recorder; 12 aldermen, out of whom the mayor is chosen; a town clerk; two sheriffs, chosen yearly out of 26 common councilmen; a sword-bearer; and four serjeants at mace. Here are 12 incorporated trading companies, whose masters attend the mayor on all public occasions, &c. Besides the cathedral, there are five parish churches in this city; which is likewise well provided with hospitals, particularly an infirmary upon the plan of those at London, Winchester, Bath, &c. Here is a good stone bridge over the river Severn, with a quay, wharf, and customhouse; but most of its business is engrossed by Bristol. King Edward I. held a parliament here in 1272, wherein some good laws were made, now called the *Statutes of Glocester;* and he erected a gate on the south side of the abbey, still called by his name, though almost demolished in the civil wars. King Richard II. also held a parliament here: and King Richard III. in consideration of his having (before his accession to the crown) borne the title of *Duke of Glocester*, added the two adjacent hundreds of Dudston and King's Barton to it, gave it his sword and cap of maintenance, and made it a county of itself by the name of the *county of the city of Glocester*. But after the Restoration the hundreds were taken away by act of parliament, and the walls pulled down; because the city shut the gates against Charles I. when he besieged it in 1643; by which, though the siege was raised by the earl of Essex, it had suffered 20,000l. damage, having 241 houses destroyed, which reduced it so much that it has scarce recovered its former size and grandeur. Before that time it had 11 parish churches, but six of them were then demolished. Here are abundance of crosses, and statues of the English kings, some of whom kept their Christmas here; several market houses supported with pillars; and large remains of monasteries, which were once so numerous, that it gave occasion to the monkish proverb, *As sure as God is in Glocester*. Here is a barley market; and a hall for the assizes, called the *Booth Hall*. Its chief manufacture is pins. Under the bridge is a water engine to supply the town, and it is served with it also from Robin Hood's well, to which is a fine walk from the city. Camden says, that the famous Roman way, called *Ermin Street*, which begins at St David's in Pembrokeshire, and reaches to Southampton, passes through this city. Sudmead in the neighbourhood is noted for horse races. Here is a charity school for above 80 children, of whom above 70 are also clothed; and a well endowed blue coat school. The city sends two members to parliament.

GLOCESTER is also the name of two counties and of several towns in America; such as the county of Glocester in New Jersey, bounded on the north by Burlington, on the south by Salem and Cumberland, on the east by the Atlantic ocean, and on the west by the river Delaware. It contains 13,172 inhabitants, besides 191 slaves. Glocester in Virginia is a well cultivated and fruitful county, about 55 miles long and 30 broad, with a population of 13,498 souls, among whom are included 7063 slaves.

Glocestershire.

GLOCESTERSHIRE, a county of England, is bounded on the west by Monmouthshire and Herefordshire, on the north by Worcestershire, on the east by Oxfordshire and Warwickshire, and on the south by Wiltshire, and part of Somersetshire. It is sixty miles in length, twenty-six in breadth, and one hundred and sixty in circumference; containing 1,100,000 acres, 26,760 houses, 162,560 inhabitants, 290 parishes, 140 are impropriations, 1229 villages, 2 cities, and 28 market towns. It sends only 8 members to parliament, 6 for three towns, viz. Glocester, Tewkesbury, and Cirencester; and two for the county. Its manufactures are woollen cloths of various kinds, men's hats, leather, pens, paper, bar iron, edge tools, nails, wire, tinned plates, brass, &c.: and of the principal articles of commerce of the county, it exports cheese 8000 tons; bacon, grain, cyder, 5000l. worth; perry, fish, 4000l. worth, &c. It lies in the diocese that takes its name from the capital, and in the Oxford circuit. The air of the county is very wholesome, but the face of it is very different in different parts: for the eastern part is hilly, and is called *Cotteswold;* the western woody, and called the *Forest of Dean;* and the rest is a fruitful valley, through which runs the river Severn. This river is in some places between two and three miles broad; and its course through the country, including its windings, is not less than seventy miles. The tide of flood, called the *Boar*, rises very high, and is very impetuous. It is remarkable, that the greatest tides are one year at the full moon, and the other at the new; one year the night tides, and the next the day. This river affords a noble conveyance for goods and merchandise of all sorts to and from the county; but it is watered by several others, as the Wye, the Avon, the Isis, the Leyden, the Frome, the Stroud, and Windrush, besides lesser streams, all abounding with fish, the Severn in particular with salmon, conger eels, and lampreys. The soil is in general very fertile, though pretty much diversified, yielding plenty of corn, pasture, fruit, and wood. In the hilly part of the county, or Cotteswold, the air is sharper than in the lowlands; and the soil, though not so fit for grain, produces excellent pasture for sheep; so that of the four hundred thousand that are computed to be kept in the county, the greater part are fed here. Of these sheep the wool is exceeding fine; and hence it is that this shire is so eminent for its manufacture of cloth, of which fifty thousand pieces are said to have been made yearly, before the practice of clandestinely exporting English wool became so common. In the vale, or lower part of the county, through which the Severn passes, the air and soil are very different from those of the Cotteswold: for the former is much warmer, and the latter richer, yielding the most luxuriant pastures; in consequence of which, numerous herds of black cattle are kept, and great quantities of that excellent cheese, for which it is so much celebrated, made in it. The remaining part of the county, called the

Forest of Dean, was formerly almost entirely overrun with wood, and extended 20 miles in length, and 10 in breadth. It was then a nest of robbers, especially towards the Severn; but now it contains many towns and villages, consisting chiefly of miners, employed in the coal pits, or in digging for or forging iron ore, with both which the forest abounds. These miners have their particular laws, customs, courts, and judges: and the king, as in all royal forests, has a swain-mote for the preservation of the vert and venison. This forest was anciently, and is still noted for its oaks, which thrive here surprisingly; but as there is a prodigious consumption of wood in the forges, it is continually dwindling away. A navigable canal is made from Stroud to Framilode, forming a junction between the Severn and Thames. Its chalybeate springs are, St Anthony's well, in Abbenhall parish; at Barrow and Maredon, in Bodington parish; at Ash-church, near Tewkesbury; at Dumbleton, near Winchcomb; at Easington, near Dursley; and at Cheltenham. Its ancient fortifications, attributed to the Romans, Saxons, or Danes, are Abston and Wick, and at Dointon, Dixton, Addlesthorp, Knole, Over Upton, Hanham Bodington, and Bourton on the Water.

GLOCHIDON, a genus of plants, belonging to the monœcia class. See BOTANY *Index*.

GLOGAW, a strong town of Germany, in Silesia, and capital of a duchy of the same name. It is not very large, but is well fortified on the side of Poland. It has a handsome castle, with a tower, in which several counsellors were condemned by Duke John, in 1498, to perish with hunger. Besides the Papists, there are a great number of Protestants and Jews. It was taken by assault, by the king of Prussia, in 1741, and the garrison made prisoners. After the peace in 1742, the king of Prussia settled the supreme court of justice here, it being, next to Breslaw, the most populous place in Silesia. It is seated on the river Oder, in E. Long. 15. 13. N. Lat. 51. 40.

GLOGAW *the* LESS, a town of Silesia, in the duchy of Opelen, now in the possession of the king of Prussia. It is two miles south-east of great Glogaw, and 45 north-west of Breslaw. E. Lon. 16. 15. N. Lat. 51. 38.

GLORIA PATRI, among ecclesiastical writers. See DOXOLOGY.

GLORIOSA, SUPERB LILY, a genus of plants, belonging to the hexandria class, and in the natural method ranking under the 11th order, *Sarmentosæ*. See BOTANY *Index*.

GLORY, renown or celebrity. The love of renown, or desire of fame and reputation, appears to be one of the principal springs of action in human society. Glory, therefore, is not to be contemned, as some of the ancient philosophers affected to teach: but it imports us to regulate our pursuit after it by the dictates of reason; and if the public approbation will not follow us in that course, we must leave her behind.—We ought to have our judgments well instructed as to what actions are truly glorious; and to remember, that in every important enterprise, as Seneca observes, *Recte facti fecisse merces est; officii fructus, ipsum officium est*: "The reward of a thing well done, is to have done it; the fruit of a good office, is the office itself." Those who by other methods scatter their names into many mouths, show they rather hunt after a great reputation than a good one, and their reward is oftener infamy than fame.

Men generally, and almost instinctively, affix glory only to such actions as have been produced by an innate desire for public good; and we measure it by that degree of influence which any thing done has upon the common happiness.

If the actions of the hero conduct soonest to glory and with the greatest splendour, and if the victorious general is so great after a signal engagement; it is because the service he has done is for the moment, and for all; and because we think without reflecting, that he has saved our habitations, our wealth, and our children, and every thing that attaches us to life. If the man of science, who in his study has discovered and calculated the motions of the heavenly bodies, who in his alembics has unveiled some of the secrets of nature, or who has exhibited to mankind a new art, rises to fame with less noise; it is because the utility which he procures is more widely diffused, and is often of less service to the present than to succeeding generations.

The consequences, therefore, of these two advantages are as opposite as the causes are different; and while the benefits procured by the warrior appear to have no more influence, and while his glory becomes obscure, that of a celebrated writer or inventor still increases, and is more and more enlarged. His works every day bring back his name to that age which uses them, and thus still add to his celebrity and fame.

This posthumous fame indeed has been decried by some writers. In particular, the author of the *Religion of Nature delineated* has treated it as highly irrational and absurd. "In reality (says he) the man is not known ever the more to posterity, because his name is transmitted to them: He doth not live, because his name does. When it is said, Julius Cæsar subdued Gaul, conquered Pompey, &c. it is the same thing as to say, the conqueror of Pompey was Julius Cæsar; i. e. Cæsar and the conqueror of Pompey is the same thing; Cæsar is as much known by one designation as by the other. The amount then is only this, that the conqueror of Pompey conquered Pompey; or somebody conquered Pompey; or rather, since Pompey is as little known now as Cæsar, somebody conquered somebody. Such a poor business is this boasted immortality! and such is the thing called glory among us! To discerning men this fame is mere air, and what they despise if not shun."

But surely it were to consider too curiously (as Horatio says to Hamlet) to consider thus. For (as the elegant author of Fitzosborne's Letters observes) although fame with posterity should be, in the strict analysis of it, no other than what is here described, a mere uninteresting proposition, amounting to nothing more than that somebody acted meritoriously; yet it would not necessarily follow, that true philosophy would banish the desire of it from the human breast: for this passion may be (as most certainly it is) wisely implanted in our species, notwithstanding the corresponding object should in reality be very different from what it appears in imagination. Do not many of our most refined and even contemplative pleasures owe their existence to our mistakes? It is but extending some of our senses to to a higher degree of acuteness than we now possess them, to make the fairest views of nature, or the noblest productions of art, appear horrid and deformed. To see things as they truly and in themselves are, would not always, perhaps, be of advantage to us in the intellectual world, any more than in the natural. But, after all, who shall certainly assure us, that the pleasure of virtuous fame dies with its possessor, and reaches not to a farther scene of existence? There is nothing, it should seem, either absurd or unphilosophical in supposing it possible at least, that the praises of the good and the judicious, the sweetest music to an honest ear in this world, may be echoed back to the mansions of the next; that the poet's description of Fame may be literally true, and though she walks upon earth, she may yet lift her head into heaven.

To be convinced of the great advantage of cherishing this high regard to posterity, this noble desire of an after-life in the breath of others, one need only look back upon the history of the ancient Greeks and Romans. For what other principle was it which produced that exalted strain of virtue in those days, that may well serve, in too many respects, as a model to these? Was it not the *consentiens laus bonorum*, the *incorrupta vox benè judicantium* (as Tully calls it), "the concurrent approbation of the good, the uncorrupted applause of the wise," that animated their most generous pursuits?

In short, can it be reasonable to extinguish a passion which nature has universally lighted up in the human breast, and which we constantly find to burn with most strength and brightness in the noblest and best formed bosoms? Accordingly revelation is so far from endeavouring to eradicate the seed which nature has thus deeply planted, that she rather seems, on the contrary, to cherish and forward its growth. To be *exalted with honour*, and to be *had in everlasting remembrance*, are in the number of those encouragements which the Jewish dispensation offered to the virtuous; and the person from whom the sacred Author of the Christian system received his birth, is herself represented as rejoicing that *all generations should call her blessed*.

GLOSS, a comment on the text of any author, to explain his sense more fully and at large, whether in the same language or any other. See the article COMMENTARY.—The word, according to some, comes from the Greek γλωσσα, "tongue;" the office of a *gloss* being to explain the text, as that of the tongue is to discover the mind.

GLOSS is likewise used for a literal translation, or an interpretation of an author in another language word for word.

GLOSS is also used in matters of commerce, &c. for the lustre of a silk, stuff, or the like.

GLOSSARY, a sort of dictionary, explaining the obscure and antiquated terms in some old author; such are Du Cange's Latin and Greek Glossaries, Spelman's Glossary, and Kennet's Glossary at the end of his Parochial Antiquities.

GLOSSOPETRA, or GLOTTOPETRA, in *Natural History*, a kind of extraneous fossil, somewhat in form of a serpent's tongue; frequently found in the island of Malta and other places.

The vulgar notion is, that they are the tongues of serpents petrified; and hence their name, which is a compound of γλωσσα, "tongue" and πετρα, "stone." Hence also their traditionary virtue in curing the bites of serpents. The general opinion of naturalists is, that they are the teeth of fishes, left at land by the waters of the deluge, and since petrified.

The several sizes of the teeth of the same species, and those of the several different species of sharks, afford a vast variety of these fossil substances. Their usual colours are black, bluish, whitish, yellowish, or brown; and in shape they usually approach to a triangular figure. Some of them are simple; others are tricuspidate, having a small point on each side of the large one: many of them are quite straight; but they are frequently found crooked, and bent in all directions; many of them are serrated on their edges, and others have them plain; some are undulated on their edges, and slightly serrated on these undulations. They differ also in size as much as in figure; the larger being four or five inches long, and the smaller less than a quarter of an inch.

They are most usually found with us in the strata of blue clay, though sometimes also in other substances, and are frequent in the clay pits of Richmond and other places. They are very frequent also in Germany, but nowhere so plentiful as in the island of Malta.

The Germans attribute many virtues to these fossil teeth; they call them cordials, sudorifics, and alexipharmics: and the people of Malta, where they are extremely plentiful, hang them about their children's necks to promote dentition. They may possibly be of as much service this way as an anodyne necklace; and if suspended in such a manner that the child can get them to its mouth, may, by their hardness and smoothness, be of the same use as a piece of coral.

GLOTTIS, in *Anatomy*, the narrow slit at the upper part of the aspera arteria, which is covered by the epiglottis when we hold our breath and when we swallow. The glottis, by its dilatation and contraction, modulates the voice. See ANATOMY, N° 183.

GLOVE, a covering for the hand and wrist.

Gloves, with respect to commerce, are distinguished into leathern gloves, silk gloves, thread gloves, cotton gloves, worsted gloves, &c. Leathern gloves are made of chamois, kid, lamb, doe, elk, buff, &c. Gloves now pay a duty to the king, which increases according to their value.

To throw the glove, was a practice or ceremony very usual among our forefathers; being the challenge whereby another was defied to single combat. It is still retained at the coronation of our kings; when the king's champion casts his glove in Westminster hall. See CHAMPION.

Favyn supposes the custom to have arisen from the eastern nations, who in all their sales and deliveries of lands, goods, &c. used to give the purchaser their glove by way of livery or investiture. To this effect he quotes Ruth iv. 7. where the Chaldee paraphrase calls *glove* what the common version renders by *shoe*. He adds, that the Rabbins interpret by *glove* that passage in the cviiith Psalm, *In Idumeam extendam calceamentum meum*, "Over *Edom* will I cast out my shoe." Accordingly, among us, he who took up the *glove*, declared thereby his acceptance of the challenge; and as a part of the ceremony, continues Favyn, took the

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glove off his own right hand, and caſt it upon the ground, to be taken up by the challenger. This had the force of a mutual engagement on each ſide, to meet at the time and place which ſhould be appointed by the king, parliament, or judges. The ſame author aſſerts, that the cuſtom which ſtill obtains of bleſſing *gloves* in the coronation of the kings of France, is a remain of the eaſtern practice of giving poſſeſſion with the *glove*, lib. xvi. p. 1017, &c.

Anciently it was prohibited the judges to wear gloves on the bench. And at preſent in the ſtables of moſt princes, it is not ſafe going in without pulling off the gloves.

GLOVER, Richard, the author of Leonidas and ſeveral other eſteemed works, was the ſon of Richard Glover, a Hamburgh merchant in London, and was born in St Martin's lane in the year 1712. He very early ſhowed a ſtrong propenſity to and genius for poetry; and while at ſchool, he wrote, amongſt other pieces, a poem to the memory of Sir Iſaac Newton, prefixed to the view of that incomparable author's philoſophy, publiſhed in 4to, in 1728, by his intimate friend Dr Pemberton. But though poſſeſſed of talents which were calculated to excel in the literary world, he was content to devote his attention to commerce, and at a proper period commenced a Hamburgh merchant. He ſtill, however, cultivated literature, and aſſociated with thoſe who were eminent in ſcience. One of his earlieſt friends was Matthew Green, the ingenious but obſcure author of ſome admirable poems, which in 1737, after his death, were collected and publiſhed by Mr Glover. In 1737, Mr Glover married Miſs Nunn, with whom he received a handſome fortune; and in the ſame month publiſhed Leonidas, a poem in 4to, which in this and the next year paſſed through three editions. This poem was inſcribed to Lord Cobham; and on its firſt appearance was received by the world with great approbation, though it has ſince been unaccountably neglected. Lord Lyttelton, in a popular publication called Common Senſe, and in a poem addreſſed to the author, praiſed it in the warmeſt terms; and Dr Pemberton publiſhed, Obſervations on Poetry, eſpecially epic, occaſioned by the late poem upon Leonidas, 1738, 12mo, merely with a view to point out its beauties. In 1739, Mr Glover publiſhed "London, or the Progreſs of Commerce," 4to; and a ballad entitled, Hoſier's Ghoſt. Both theſe pieces ſeem to have been written with a view to incite the public to reſent the miſbehaviour of the Spaniards; and the latter had a very conſiderable effect. The political diſſenſions at this period raged with great violence, and more eſpecially in the metropolis; and at different meetings of the livery on thoſe occaſions, Mr Glover was always called to the chair, and acquitted himſelf in a very able manner, his conduct being patriotic and his ſpeeches maſterly. His talents for public ſpeaking, his knowledge of political affairs, and his information concerning trade and commerce, ſoon afterwards pointed him out to the merchants of London as a proper perſon to conduct their application to parliament on the ſubject of the neglect of their trade. He accepted the office; and in ſumming up the evidence gave very ſtriking proofs of his oratorical powers. This ſpeech was pronounced Jan. 27. 1742.

In the year 1744 died the ducheſs of Marlborough, and by her will left to Mr Glover and Mr Mallet 500l. each, to write the Hiſtory of the Duke of Marlborough's Life. This bequeſt, however, never took place. It is ſuppoſed that Mr Glover very early renounced his ſhare of it; and Mallet, though he continued to talk of performing the taſk almoſt as long as he lived, is now known never to have made the leaſt progreſs in it. About this period Mr Glover withdrew a good deal from public notice, and lived a life of retirement. He had been unſucceſsful in his buſineſs; and with a very laudable delicacy had preferred an obſcure retreat to popular obſervation, until his affairs ſhould put on a more proſperous appearance. He had been honoured with the attention of Frederick prince of Wales, who once preſented him with a complete ſet of the claſſics, elegantly bound; and, on his abſenting himſelf for ſome time on account of the embarraſſment in his circumſtances, ſent him, it is ſaid, 500l. The prince died in March 1751; and in May following Mr Glover was once more drawn from his retreat by the importunity of his friends, and ſtood candidate for the place of chamberlain of London. It unfortunately happened that he did not declare himſelf until moſt of the livery had engaged their votes; by which means he loſt his election.

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In 1753, Mr Glover produced at Drury Lane his tragedy of Boadicea; which was acted nine nights, in the month of December. It had the advantage of the performance of Mr Garrick, Mr Moſſop, Mrs Cibber, and Mrs Pritchard. From the prologue it ſeems to have been patronized by the author's friends in the city; and Dr Pemberton wrote a pamphlet to recommend it.—In 1761, Mr Glover publiſhed Medea, a tragedy written on the Greek model; but it was not acted until 1767, when it appeared for the firſt time on the ſtage at Drury Lane for Mrs Yates's benefit. At the acceſſion of his preſent majeſty, he appears to have ſurmounted the difficulties of his ſituation. In the parliament which was then called, he was choſen member for Weymouth, and continued to ſit as ſuch until the diſſolution of it. He, about this time, intereſted himſelf about India affairs, at one of Mr Sullivan's elections; and in a ſpeech introduced the fable of the man, horſe, and bear; and drew this concluſion, that, whenever merchants made uſe of armed forces to maintain their trade, it would end in their deſtruction.

In 1770, the poem of Leonidas requiring a new edition, it was republiſhed in two volumes 12mo, corrected throughout, and extended from nine books to twelve. It had alſo ſeveral new characters added, beſides placing the old ones in new ſituations. The improvements made in it were very conſiderable; but we believe the public curioſity, at this period, was not ſufficiently alive to recompenſe the pains beſtowed on this once popular performance. The calamities ariſing from the wounds given to public credit, in June 1772, by the failure of the bank of Douglas, Heron, and Co. in Scotland, occaſioned Mr Glover's taking a very active part in the ſettling thoſe complicated concerns, and in ſtopping the diſtreſs then ſo univerſally felt. In February 1774, he called the annuitants of that bankinghouſe together, at the King's Arms tavern, and laid propoſals before them for the ſecurity of their demands, with which they were fully ſatisfied. He alſo undertook to manage the intereſts of the merchants and

and traders of London concerned in the trade to Germany and Holland, and of the dealers in foreign linens, in their application to parliament in May 1774. Both the ſpeeches made on theſe occaſions were publiſhed in a pamphlet in that year. In the ſucceeding year he engaged on behalf of the Weſt India merchants in their application to parliament, and examined the witneſſes and ſummed up the evidence in the ſame maſterly manner he had done on former occaſions. For the aſſiſtance he afforded the merchants in this buſineſs, he was complimented by them with a ſervice of plate, of the value of 300l. The ſpeech which he delivered in the houſe was in the ſame year printed. This, we believe, was the laſt opportunity he had of diſplaying his oratorical talents in public. Having now arrived at a period of life which demanded a receſs from buſineſs, Mr Glover retired to eaſe and independence, and wore out the remainder of his days with dignity and with honour. It is probable that he ſtill continued his attention to his muſe, as we are informed that, beſides an epic poem of conſiderable length, he has left ſome tragedies and comedies behind him in manuſcript. After experiencing for ſome time the infirmities of age, he departed this life 25th November 1785; leaving behind him a moſt eſtimable character as a man, a citizen, and a writer.

GLOW-WORM. See LAMPYRIS, ENTOMOLOGY *Index*.

GLUCINA, in *Chemiſtry*, an earthy ſubſtance which was diſcovered by Vauquelin in 1798, in analyzing the emerald of which it forms a component part. For an account of its properties and combinations. See CHEMISTRY, N° 1165.

GLUCKSTADT, a ſtrong and conſiderable town of Germany, in the circle of Upper Saxony, and duchy of Holſtein, with a ſtrong caſtle, and ſubject to Denmark. It is ſeated on the river Elbe, near its mouth. E. Long. 9. 15. N. Lat. 52. 53.

GLUE, among artificers, a tenacious viſcid matter, which ſerves as a cement to bind or connect things together.

Glues are of different kinds, according to the various uſes they are deſigned for, as the common glue, glove glue, and parchment glue; whereof the two laſt are more properly called *ſize*.

Hamel du Monceau has written one of the beſt works on the ſubject of glue. According to this author, glue was at firſt principally prepared from the membranous, tendinous, and cartilaginous parts of animals, and after being dried, they were melted into tablets. It is certain, however, that every animal ſubſtance containing jelly, may be uſed in the manufacture of glue; and, according to Du Hamel himſelf, a ſtrong, but black-coloured glue may be obtained from bones and hartſhorn, after they are diſſolved in Papin's digeſter. Of the truth of this fact Papin himſelf likewiſe aſſures us, for he prepared a jelly from bones, and even from ivory, by which he glued together ſome pieces of broken glaſs; and ſubſequent experiments made by other chemiſts, have confirmed his aſſertion.

To the information contained on this ſubject in the works of Papin, Spielman has added many valuable remarks. He not only extracted glue from bones, but alſo from all the ſolid parts of animals, by boiling alone, as well as from the teeth of the ſea horſe, the wild boar, the wood-louſe, and the viper.

The glue manufactured in Europe is of different kinds; but that which is made in England is eſteemed the beſt. Its colour is of a browniſh red. The Flanders glue is conſidered as of an inferior quality to that made in England, while the glue manufactured in France is not ſo good as either. The reaſon aſſigned for this difference of quality is, that bones and ſinews are made uſe of by the Flemiſh and French in the manufacture of this article, while the Engliſh employ ſkins, which yield a much ſtronger glue. Dr Lewis informs us that the Engliſh ſteep and waſh the cuttings of the hides in water, then boil them in freſh water till the liquor becomes of a proper conſiſtence, after which they ſtrain it through baſkets, allow it to ſettle, then expoſe it to further evaporation, and pour it into flat moulds, where it unites. When thoroughly cooled, it is converted into ſolid cakes, which are cut into pieces, and dried on a kind of net.

Grenet for many years turned his attention to the manufacturing of glue. Having made a number of experiments on every ſubſtance formerly employed for this purpoſe, he found that bones afford the moſt abundant quantity of glue, and yield it with facility. Having deprived them of the fat they contain, he procured a jelly by ſimply boiling them, which, when dried, and thus changed into glue, he found ſuperior to that which was prepared in France, and nearly equal to the beſt glue of commerce.

From the experiments of Parmentier, it appears that ſix pounds of button-makers raſpings yielded a pound of excellent glue, not inferior to that which is manufactured in England. The glue which he obtained from the filings of ivory was equally as good, but more highly coloured. The filings of horn yielded none of this ſubſtance.

To obtain glue as colourleſs as poſſible, a very ſmall quantity of water ſhould be employed for extracting the jelly, by which means it may be concentrated without long evaporation, as expoſure to heat has always a greater or leſs influence on the colour in proportion to the time. The whiteneſs and tranſparency of the Flanders glue are ſaid to originate from an adherence to this plan.

In their conſiſtence, colour, taſte, ſmell, and ſolubility, glues are found to differ from each other. Some glues will diſſolve by agitation in cold water, while others are only ſoluble at the point of ebullition. It is generally admitted that the beſt glue is tranſparent, of a browniſh yellow colour, and having neither taſte nor ſmell. It is perfectly ſoluble in water, forming a viſcous fluid, which, when dry, preſerves its tenacity and tranſparency in every part, and has more ſolidity, colour, and viſcidity, in proportion to the age and ſtrength of the animal from which it is produced.

For the following account of the manufacture of glue we are indebted, to Mr John Clennel of Newcaſtle. "The improvement (he obſerves) of any manufacture depends upon its eaſy acceſs to men of ſcience, and a prudential theoriſt can never be better employed than in attempting to reduce to regularity or to ſyſtem the manufactures that may fall under his attention. In conformity to the firſt principle, I made ſome notes whilſt viſiting a glue manufactory a few years ago in Southwark, and thoſe, interwoven with the remarks on that ſubject of ſome chemiſts of the firſt reſpectability, I take the liberty of ſending

Glue.

sending you: at the same time I must beg of you, or your correspondents, that where it may be corrected in any manner, it may be done, and I shall feel myself obliged by the attention.

"Glue is an inspissated jelly, made of the parings of hides or horns of any kind, the pelts obtained from furriers, and the hoofs and ears of horses, oxen, calves, sheep, &c. quantities of all which are imported in addition to the home supply, by many of the great manufacturers of this article: these are first digested in lime water, to cleanse them as far as it can from the grease or dirt they may have contracted; they are then steeped in clean water, taking care to stir them well from time to time; afterwards they are laid in a heap, and the superabundant water pressed out; then they are boiled in a large brass caldron with clean water, skimming off the dirt as it rises, and further cleansed by putting in, after the whole is dissolved, a little melted alum or lime finely powdered, which, by their detersive properties, still further purge it: the skimming is continued for some time, when the mass is strained through baskets, and suffered to settle, that the remaining impurities, if any, may subside; it is then poured gently into the kettle again, and further evaporated by boiling a second time, and skimming, until it becomes of a clear but darkish brown colour: when it is thought to be strong enough (which is known either by the length of time a certain quantity of water and materials have boiled, or by its appearance during ebullition), it is poured into frames or moulds of about six feet long, one broad, and two deep, where it hardens gradually as the heat decreases: out of these troughs or receivers it is cut, when cold, by a spade, into square pieces or cakes, and each of these placed within a sort of wooden box, open in three divisions to the back; in this the glue, as yet soft, is taken to a table by women, where they divide it into three pieces (A) with an instrument not unlike a bow, having a brass wire for its string; with this they stand behind the box and cut by its openings, from front to back: the pieces thus cut are taken out into the open air, and dried on a kind of coarse net work, fastened in moveable sheds of about four feet square, which are placed in rows in the gluemaker's field (every one of which contains four or five rows of net work); when perfectly dry and hard, it is fit for sale.

"That is thought the best glue which swells considerably without melting, by three or four days immersion in cold water, and recovers its former dimensions and properties by drying. Glue that has got frost, or that looks thick and black, may be melted over again and refined, with a sufficient quantity added of fresh to overcome any injury it may have sustained; but it is generally put into the kettle after what is in it has been purged in the second boiling. To know good from bad glue, it is necessary for the purchaser to hold it between his eye and the light, and if it appears of a strong dark brown colour, and free from cloudy or black spots, the article is good."

A glue that is colourless and of superior quality, is obtained from the skins of eels, and known by the name of *size*. It is even procured from vellum, parchment, and some of the white species of leather; but for common purposes this is by far too expensive, and is only made use of in those cases of delicate workmanship where glue would be too gross. The skins of the rabbit, hare, and cat, are made use of in the manufacturing of size, by those who are employed in gilding gold, polishing, and painting, in various colours.

From the experiments of Mr Hatchett it appears, that membrane yields different quantities of gelatine, the solutions of which evaporated to dryness, afforded him an opportunity of observing the different degrees of viscidity and tenacity of mucilage, size, and glue. He also found that the more viscid glues are obtained with greater difficulty than such as are less so. When a cake of glue has been steeped three or four days in cold water, it is considered of the best quality, if it swell much without being dissolved, and if, when taken out, it recovers its original figure and hardness by drying.

On comparing the skins of different animals, Mr Hatchett found, that such as were most flexible more readily yielded their gelatine, and that produced from the skin of the rhinoceros was by far the most viscid of any. The true skin of any animal was most affected by long boiling; but the hide of the rhinoceros was the most insoluble.

He found that hair was not so much affected as skin; but the cartilages of the joints, when boiled long in water, were as perfectly soluble as the cutis, which is not the case with the other cartilages, as they afford little or no gelatine. The horns of the ox, ram, and goat, are very different from those of the stag; and the small quantity of gelatine they are found to contain, is produced more gradually, and with greater difficulty.

According to Hatchett, the effects of diluted nitric acid on the substances commonly employed in the manufacturing of glue, were exactly analogous to those of boiling water, and were always most powerful on those substances which contained the greatest quantity of gelatine. Almost all animal substances are convertible either into glue or soap, with this additional advantage, that those parts of them which would not be employed in making the one, are the most proper in the manufacture of the other.

Another fine species of glue, known by the name of *isinglass*, is the produce of certain fish, very common in the Russian seas, found on entering the rivers Wolga, Lyak, Don, and Danube. In Moscovy it is prepared of the *sturgeon* and the *sterled*, which yield the most beautiful isinglass. The fish from fresh water are esteemed the best, as they afford an isinglass more flexible and transparent than any other.

When the bladder is extracted, it is washed in water to free it from the blood, if any adheres to it, but not otherwise. It is then cut longitudinally, and the outer membrane taken off, the colour of which is brown, while the other membrane is so fine and white as to be with

(A) When the women, by mistake, cut only two, that which is double the size is called a *bishop*, and thrown into the kettle again.

with difficulty ſeparated from the fiſh. They are formed into rolls of the ſize of the finger, with the fine membrane in the middle, and hung in the air to dry by degrees. Good iſinglaſs is white, perfectly dry, ſemitranſparent, and without ſmell. It is ſoluble in water with a gentle heat, but is eaſily diſſolved in alcohol, in which it differs eſſentially from common glue. That which is made from different parts of ſea wolves, ſea cows, ſharks, and whales, is employed in the clarifying of different wines and other liquors. Iſinglaſs is of all ſhades of colour, from pure tranſparency to black; but ſuch as are large and yellow are reckoned the worſt. They are opaque, and their ſmell is diſagreeable.

From 500 grains of iſinglaſs Mr Hatchett obtained 56 grains of coal, from which $1\frac{1}{2}$ grain of earthy reſiduum were obtained by reducing it to aſhes. Of conſequence there were only 54.5 grains of pure coal, and the remaining 1.5 he found to be phoſphate of ſoda, with an extremely ſmall proportion of phoſphate of lime.

GLUME (*gluma*), among botaniſts, a ſpecies of calyx, conſiſting of two or three membranous valves, which are often pellucid at the edges. This kind of calyx belongs to the graſſes.

GLUT, among falconers, the ſlimy ſubſtance that lies in a hawk's paunch.

GLUTA, a genus of plants belonging to the gynandria claſs. See BOTANY *Index*.

GLUTÆUS, a name common to three muſcles whoſe office it is to extend the thigh. See ANATOMY, *Table of the Muſcles*.

GLUTTON. See MUSTELA, MAMMALIA *Index*.

GLUTTONY, a voracity of appetite, or a propenſity to gormandizing.

There is a morbid ſort of gluttony, called *fames canina*, "dog-like appetite," which ſometimes occurs, and renders the perſon ſeized with it an object of pity and of cure as in other diſeaſes: (ſee BULIMY).—But profeſſed habitual gluttons may be reckoned amongſt the monſters of nature, and deemed in a manner puniſhable for endeavouring to bring a dearth or famine into the places where they live. For which reaſon, people think King James I. was in the right, when a man being preſented to him that could eat a whole ſheep at one meal, he aſked "What he could do more than another man?" and being anſwered "He could not do ſo much, ſaid "Hang him then; for it is unfit a man ſhould live that eats ſo much as 20 men, and cannot do ſo much as one."

The emperor Clodius Albinus would devour more apples at once than a buſhel would hold. He would eat 500 figs to his breakfaſt, 100 peaches, 10 melons, 20 pound weight of grapes, 100 gnat-ſnappers, and 400 oyſters. "Fye upon him (ſaith Lipſius); God keep ſuch a curſe from the earth."

One of our Daniſh kings named *Hardiknute* was ſo great a glutton, that a hiſtorian calls him *Bacca de Porco*, "Swine's mouth." His tables were covered four times a-day with the moſt coſtly viands that either the air, ſea, or land, could furniſh; and as he lived he died; for, revelling and carouſing at a wedding banquet at Lambeth, he fell down dead. His death was ſo welcome to his ſubjects, that they celebrated the day with ſports and paſtimes, calling it *Hock tide*, which ſignifies ſcorn and contempt. With this king ended the reign of the Danes in England.

One Phagon, under the reign of the emperor Aurelianus, at one meal, ate a whole boar, 100 loaves of bread, a ſheep, a pig, and drank above three gallons of wine.

We are told by Fuller *, that one Nicholas Wood, of Harriſon in Kent, ate a whole ſheep of 16s. price at one meal, raw; at another time 30 dozen of pigeons. At Sir William Sidley's in the ſame county, he ate as much victuals as would have ſufficed 30 men. At Lord Wotton's manſion houſe in Kent, he devoured at one dinner 84 rabbits; which, by computation, at half a rabbit a man, would have ſerved 168 men. He ate to his breakfaſt 18 yards of black pudding. He devoured a whole hog at one ſitting down; and after it, being accommodated with fruit, he ate three pecks of damoſins.

* *Worthies*, p. 86.

A counſellor at law, whoſe name was Mallet, well known in the reign of Charles I. ate at one time an ordinary provided in Weſtminſter for 30 men at 12d. a-piece. His practice not being ſufficient to ſupply him with better ſort of meat, he fed generally on offals, ox livers, hearts, &c. He lived to almoſt 60 years of age, and for the ſeven laſt years of his life ate as moderately as other men. A narrative of his life was publiſhed.

GLYCINE, KNOBBED-ROOTED LIQUORICE-VETCH; a genus of plants belonging to the diadelphia claſs; and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

GLYCIRRHIZA, LIQUORICE; a genus of plants belonging to the diadelphia claſs; and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY and MATERIA MEDICA *Index*.

GLYNN, a county in the lower diſtrict of Georgia, in America, bounded on the eaſt by the ocean, on the north by the river Alatamaha, by which it is ſeparated from Liberty county, and on the ſouth by Camden. It contains 413 people, of which 215 are ſlaves. The chief town is Brunſwick.

GLYPH, in *Sculpture* and *Architecture*, denotes any canal or cavity uſed as an ornament.

GMELIN, JOHN GEORGE, M. D. public lecturer on botany and phyſic at Tubingen, member of the Royal Society of Gottingen, and of the Academy of Sciences at Stockholm, was born on the 12th of Auguſt 1709, at Tubingen, where his father was an apothecary. Such was his diligence while at ſchool, that he was qualified to attend the academical lectures at the age of 14, and was created doctor of medicine when only 19. He paid a viſit about this time to the metropolis of the Ruſſian empire, that he might have the pleaſure of ſeeing ſome of his former teachers. There he became acquainted with Blumentroſt, director of the academy, who introduced him to the meetings of the members, and procured for him an annual penſion. At Peterſburgh he was ſo much eſteemed, that when he intimated a wiſh in 1729 to return to Tubingen, he was honoured with a place among the regular members of the academy, and choſen profeſſor of chemiſtry and natural hiſtory in the year 1731. In order to carry into execution a plan which had been formed by Peter the Great, for exploring a paſſage to China and Japan along the coaſt of the Ruſſian empire, Gmelin was selected along with two others, as properly qualified for that undertaking, and likewise to ascertain the boundaries of Siberia. The department of natural history was assigned to our author. He had with him and his companions, six students, two draftsmen, two hunters, two miners, four land-surveyors, and 12 soldiers, with a serjeant and drummer. They began their journey on the 19th of August 1733; and in 1736, Steller and a painter joined their society, in order to assist Gmelin in his arduous labours.

By exploring Kamtschatka, they hoped to accomplish their mission in a satisfactory manner, for which purpose Steller proceeded to this place, and the rest of the society continued their travels through Siberia. In February 1743 Gmelin returned to Petersburgh in safety after a dangerous journey which lasted nine years and a half, but proved of the utmost importance to various branches of science. He resumed the offices which he had filled before; and having paid a visit in 1747 to his native country, he was chosen professor, while absent, in the room of Bachmeister deceased. He was seized with a violent fever in May 1755, which put a period to his valuable life, in the 45th year of his age. He was undoubtedly one of the most eminent botanists of the last century, and has rendered his name immortal by his *Flora Sibirica, seu historia plantarum Siberiæ*, in four parts, large quarto. He determined the boundaries between Europe and Asia, which every celebrated geographer has adopted since his day. Through all his works the traces of great modesty, a sacred regard to truth, and the most extensive knowledge of nature, are remarkably conspicuous.

GMELIN, *Dr Samuel*, was born in 1743 at Tubingen, where he also studied, and became doctor in medicine in 1763. He was afterwards admitted a member of the Imperial Academy of Sciences at St Petersburg. He commenced his travels in June 1768; and having traversed the provinces of Moscow, Voronetz, New Russia, Azof, Casan, and Astracan, he visited, in 1770 and 1771, the different harbours of the Caspian, and examined with peculiar attention those parts of the Persian provinces which border upon that sea, of which he has given a circumstantial account in the three volumes of his travels already published. Actuated by a zeal for extending his observations, he attempted to pass through the western provinces of Persia, which are in a perpetual state of warfare, and infested by numerous banditti. Upon this expedition, he quitted, in April 1772, Einzillee, a small trading place in Ghilan, upon the southern shore of the Caspian; and, on account of many difficulties and dangers, did not, until December 2. 1773, reach Sallian, a town situated upon the mouth of the river Koor. Thence he proceeded to Baku and Kuba, in the province of Shirvan, where he met with a friendly reception from Ali Feth Khan, the sovereign of that district. After he had been joined by 20 Uralian Cossacks, and when he was only four days journey from the Russian fortress Kislar, he and his companions were, on the 5th of February 1774, arrested by order of Usméi Khan, a petty Tartar prince, through whose territories he was obliged to pass. Usméi urged as a pretence for this arrest, that 30 years ago several families had escaped from his dominions, and had found an asylum in the Russian territories; adding, that Gmelin should not be released until these families were restored. The professor was removed from prison to prison; and at length, wearied out with continued persecutions, he expired, July 27th, at Achmet-Kent, a village of Mount Caucasus. His death was occasioned partly by vexation for the loss of several papers and collections, and partly by disorders contracted from the fatigues of his long journey. Some of his papers had been sent to Kislar during his imprisonment, and the others were not without great difficulty rescued from the hands of the barbarian who had detained him in captivity. The arrangement of these papers, which will form a fourth volume of his travels, was at first consigned to the care of Guildenstaedt, but upon his death has been transferred to the learned Pallas.

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

GNAPHALIUM, CUDWEED, GOLDY-LOCKS, ETERNAL FLOWER, &c.; a genus of plants belonging to the syngenesia class; and in the natural method ranking under the 49th order, *Compositæ*. See BOTANY *Index*.

GNAT. See CULEX, ENTOMOLOGY *Index*.

GNESNA, a large and strong town of Great Poland, of which it is capital, and in the palatinate of Calish, with an archbishop's see, whose prelate is primate of Poland, and viceroy during the vacancy of the throne. It was the first town built in the kingdom, and formerly more considerable than at present. E. Long. 18. 20. N. Lat. 52. 28.

GNETUM, a genus of plants belonging to the monœcia class. See BOTANY *Index*.

GNIDIA, a genus of plants belonging to the octandria class. See BOTANY *Index*.

GNOMES, GNOMI, certain imaginary beings, who, according to the cabbalists, inhabit the inner parts of the earth. They are supposed small in stature, and the guardians of quarries, mines, &c. See FAIRY.

GNOMON, in *Dialling*, the style, pin, or cock of a dial, which by its shadow shows the hour of the day. The gnomon of every dial represents the axis of the earth: (See DIAL and DIALLING.)—The word is Greek, γνωμων, which literally implies something that makes a thing known; by reason that the style or pin indicates or makes the hour known.

GNOMON, in *Astronomy*, a style erected perpendicular to the horizon, in order to find the altitude of the sun. See ASTRONOMY.

By means of a gnomon, the sun's meridian altitude, and consequently the latitude of the place, may be found more exactly than with the smaller quadrants. See QUADRANT.

By the same instrument the height of any object may be found: for as the distance of the observer's eye from the gnomon, is to the height of the style; so is the distance of the observer's eye from the object, to its height.

For the uses and application of gnomons, see GEOGRAPHY.

GNOMON of a Globe; the index of the hour circle.

GNOMONICS, the art of dialling. See DIALLING.

GNOSTICS, ancient heretics, famous from the first rise of Christianity, principally in the east.

It

Gnostics.

It appears from several passages of the sacred writings, particularly 1 John ii. 18. 1 Tim. vi. 20. and Col. ii. 8. that many persons were infected with the Gnostic heresy in the first century; though the sect did not render itself conspicuous, either for number or reputation, before the time of Adrian, when some writers erroneously date its rise.

The name is formed of the Latin *gnosticus*, and that of the Greek γνωςικος, "knowing," of γινωσκω, "I know;" and was adopted by those of this sect, as if they were the only persons who had the true knowledge of Christianity. Accordingly, they looked on all other Christians as simple, ignorant, and barbarous persons, who explained and interpreted the sacred writings in a too low, literal, and unedifying signification.

At first the Gnostics were only the philosophers and wits of those times, who formed for themselves a peculiar system of theology, agreeable to the philosophy of Pythagoras and Plato; to which they accommodated all their interpretations of Scripture. But

GNOSTICS afterwards became a general name, comprehending divers sects and parties of heretics, who rose in the first centuries, and who, though they differed among themselves as to circumstances, yet all agreed in some common principles. They were such as corrupted the doctrine of the gospel by a profane mixture of the tenets of the oriental philosophy, concerning the origin of evil and the creation of the world, with its divine truths. Such were the Valentinians, Simonians, Carpocratians, Nicolaitans, &c.

GNOSTICS was sometimes also more particularly attributed to the successors of the first Nicolaitans and Carpocratians, in the second century, upon their laying aside the names of the first authors. Such as would be thoroughly acquainted with all their doctrines, reveries, and visions, may consult St Irenæus, Tertullian, Clemens Alexandrinus, Origen, and St Epiphanius; particularly the first of these writers, who relates their sentiments at large, and confutes them at the same time: indeed, he dwells more expresly on the Valentinians than any other sort of Gnostics; but he shows the general principles whereon all their mistaken opinions were founded, and the method they followed in explaining scripture. He accuses them of introducing into religion certain vain and ridiculous genealogies, i. e. a kind of divine processions or emanations, which had no other foundation but in their own wild imaginations.

In effect, the Gnostics confessed, that these æons or emanations were nowhere expresly delivered in the sacred writings; but insisted at the same time, that Jesus Christ had intimated them in parables to such as could understand him. They built their theology not only on the gospels and the epistles of St Paul, but also on the law of Moses and the prophets. These last laws were peculiarly serviceable to them, on account of the allegories and allusions with which they abound, which are capable of different interpretations: Though their doctrine, concerning the creation of the world by one or more inferior beings of an evil or imperfect nature, led them to deny the divine authority of the books of the Old Testament, which contradicted this idle fiction, and filled them with an abhorrence of Moses and the religion he taught; alleging, that he was actuated by the malignant author of this world, who consulted his own glory and authority, and not the real advantage of men. Their persuasion that evil resided in matter, as its centre and source, made them treat the body with contempt, discourage marriage, and reject the doctrine of the resurrection of the body and its re-union with the immortal spirit. Their notion, that malevolent genii presided in nature, and occasioned diseases and calamities, wars, and desolations, induced them to apply themselves to the study of magic, in order to weaken the powers or suspend the influence of their malignant agents.

The Gnostics considered Jesus Christ as the Son of God, and consequently inferior to the Father, who came into the world for the rescue and happiness of miserable mortals, oppressed by matter and evil beings; but they rejected our Lord's humanity, on the principle that every thing corporeal is essentially and intrinsically evil; and therefore the greatest part of them denied the reality of his sufferings. They set a great value on the beginning of the gospel of St John, where they fancied they saw a great deal of their æons, or emanations, under the *Word*, the *Life*, the *Light*, &c. They divided all nature into three kinds of beings, viz. *hylic*, or material; *psychic*, or animal; and *pneumatic*, or spiritual. On the like principle they also distinguished three sorts of men; *material*, *animal*, and *spiritual*. The first, who were material and incapable of knowledge, inevitably perished, both soul and body; the third, such as the Gnostics themselves pretended to be, were all certainly saved; the psychic, or animal, who were the middle between the other two, were capable either of being saved or damned, according to their good or evil actions.

With regard to their moral doctrines and conduct, they were much divided. The greatest part of the sect adopted very austere rules of life, recommended rigorous abstinence, and prescribed severe bodily mortifications, with a view of purifying and exalting the mind. However, some maintained, that there was no moral difference in human actions; and thus, confounding right with wrong, they gave a loose rein to all the passions, and asserted the innocence of following blindly all their motions, and of living by their tumultuous dictates. They supported their opinions and practice by various authorities: some referred to fictitious and apocryphal writings of Adam, Abraham, Zoroaster, Christ, and his apostles; others boasted, that they had deduced their sentiments from secret doctrines of Christ, concealed from the vulgar; others affirmed, that they arrived at superior degrees of wisdom by an innate vigour of mind; and others asserted, that they were instructed in these mysterious parts of theological science by Theudas, a disciple of St Paul, and by Matthias, one of the friends of our Lord. The tenets of the ancient Gnostics were revived in Spain, in the fourth century, by a sect called the *Priscillianists*.

The appellation *Gnostic* sometimes also occurs in a good sense, in the ancient ecclesiastical writers, and particularly Clemens Alexandrinus, who, in the person of his Gnostic, describes the characters and qualities of a perfect Christian. This point he labours in the seventh book of his Stromata, where he shows that none but the Gnostic, or learned person, has any true religion. He affirms, that were it possible for the knowledge of God to be ſeparated from eternal ſalvation, the Gnoſtic would make no ſcruple to chooſe the knowledge; and that if God would promiſe him impunity in doing of any thing he has once ſpoken againſt, or offer him heaven on thoſe terms, he would never alter a whit of his meaſures. In this ſenſe the father uſes Gnoſties, in oppoſition to the heretics of the ſame name; affirming, that the true Gnoſtic is grown old in the ſtudy of the holy ſcriptures; and that he preſerves the orthodox doctrine of the apoſtles and of the church; whereas the falſe Gnoſtic abandons all the apoſtolical traditions, as imagining himſelf wiſer than the apoſtles. At length the name *Gnoſtic*, which originally was the moſt glorious, became infamous, by the idle opinions and diſſolute lives of the perſons who bore it.

GNU, or GNOU. See CAPRA, MAMMALIA *Index*.

GOA, a large and ſtrong town of Aſia, in the peninſula on this ſide the Ganges, and on the Malabar coaſt. It was taken by the Portugueſe in 1508, and is the chief town of all their ſettlements on this ſide the Cape of Good Hope. It ſtands in an iſland of the ſame name, about 12 miles in length, and ſix in breadth; and the city is built on the north ſide of it, having the conveniency of a fine ſalt-water river, capable of receiving ſhips of the greateſt burden, where they lie within a mile of the town. The banks of the river are beautified with a great number of handſome ſtructures; ſuch as churches, caſtles, and gentlemen's houſes. The air within the town is unwhoſeſome, for which reaſon it is not ſo well inhabited now as it was formerly. The viceroy's palace is a noble building; and ſtands at a ſmall diſtance from the river, over one of the gates of the city, which leads to a ſpacious ſtreet, terminated by a beautiful church. This city contains a great number of handſome churches, convents, and cloiſters, with a ſtately large hoſpital; all well endowed, and kept in good repair. The market place takes up an acre of ground; and in the ſhops about it may be had the produce of Europe, China, Bengal, and other countries of leſs note. Every church has a ſet of bells, ſome of which are continually ringing. There are a great many Indian converts; but they generally retain ſome of their old cuſtoms, particularly they cannot be brought to eat beef. The clergy are very numerous and illiterate; but the churches are finely embelliſhed, and have great numbers of images. In one of theſe churches, dedicated to Bon Jeſus, is the chapel of St Franciſco de Xaviere, whoſe tomb it contains: this chapel is a moſt ſuperb and magnificent place; the tomb of the ſaint is entirely of fine black marble brought from Liſbon; on the four ſides of it the principal actions of the life of the ſaint are moſt elegantly carved in baſſo relievo; theſe repreſent his converting the different nations to the Catholic faith: the figures are done to the life, and moſt admirably executed: it extends to the top in a pyramidical form, which terminates with a coronet of mother-of-pearl. On the ſides of this chapel are excellent paintings, done by Italian maſters; the ſubjects chiefly from Scripture. This tomb and the chapel appertaining to it, muſt have coſt an immenſe ſum of money; the Portugueſe juſtly eſteem it the greateſt rarity in the place. The houſes are large, and make a fine ſhow: but within they are but poorly furniſhed. The inhabitants are contented with greens, fruits, and roots; which, with a little bread, rice, and fiſh, is their principal diet, though they have hogs and fowls in plenty. The river's mouth is defended by ſeveral forts and batteries, well planted with large cannon on both ſides; and there are ſeveral other forts in different places.

Goa is the reſidence of a captain general, who lives in great ſplendour. He is alſo commander in chief of all the Portugueſe forces in the Eaſt Indies. They have here two regiments of European infantry, three legions of ſepoys, three troops of native light horſe, and a militia; in all about five thouſand men. Goa is at preſent on the decline, and in little or no eſtimation with the country powers; indeed their bigotry and ſuperſtitious attachment to their faith is ſo general, that the inhabitants, formerly populous, are now reduced to a few thinly inhabited villages; the chief part of whom have been baptized; for they will not ſuffer any Muſſulman or Gentoo to live within the precincts of the city: and theſe few are unable to carry on the huſbandry or manufactures of the country. The court of Portugal is obliged to ſend out annually a very large ſum of money, to defray the current expences of the government; which money is generally ſwallowed up by the convents and ſoldiery.

There was formerly an inquiſition at this place, but it is now aboliſhed; the building ſtill remains, and by its black outſide appears a fit emblem of the cruel and bloody tranſactions that paſſed within its walls! Proviſions are to be had at this place in great plenty and perfection. E. Long. 74. 0. N. Lat. 15. 31.

GOAL. See GAOL.

GOAT. See CAPRA, MAMMALIA *Index*.

GOAT's *Beard*. See TRAGOPOGON, BOTANY *Index*.

GOAT-*Sucker*. See CAPRIMULGUS, ORNITHOLOGY *Index*.

GOBELIN, GILES, a celebrated French dyer, in the reign of Francis I. diſcovered a method of dyeing a beautiful ſcarlet, and his name has been given ever ſince to the fineſt French ſcarlets. His houſe, in the ſuburb of St Marcel at Paris, and the river he made uſe of, are ſtill called *the Gobelins*. An academy for drawing, and a manufactory of fine tapeſtries, were erected in this quarter in 1666; for which reaſon the tapeſtries are called *the Gobelins*.

GOBIUS, a genus of fiſhes belonging to the order of thoracici. See ICHTHYOLOGY *Index*.

GOBLET, or GOBELET, a kind of drinking cup, or bowl, ordinarily of a round figure, and without either foot or handle. The word is French, *gobelet*; which Salmaſius, and others, derive from the barbarous Latin *cupa*. Budeus deduces it from the Greek κυπελλον, *a ſort of cup*.

GOD, one of the many names of the Supreme Being. See CHRISTIANITY, METAPHYSICS, MORAL PHILOSOPHY, and THEOLOGY.

GOD is alſo uſed in ſpeaking of the falſe deities of the heathens, many of which were only creatures to which divine honours and worſhip were ſuperſtitiouſly paid.

The Greeks and Latins, it is obſervable, did not mean by the name *God*, an all-perfect being, whereof eternity, infinity, omnipreſence, &c. were eſſential attributes; with them, the word only implied an excellent and ſuperior nature; and accordingly they gave the

the appellation *gods* to all beings of a rank or clafs higher and more perfect than that of men; and efpecially to thofe who were inferior agents in the divine adminiftration, all fubject to the one Supreme. Thus men themfelves, according to their fyftem, might become gods after death; inafmuch as their fouls might attain to a degree of excellence fuperior to what they were capable of in life.

The firft divines, Father Boffu obferves, were the poets: the two functions, though now feparated, were originally combined; or, rather, were one and the fame thing.

Now the great variety of attributes in God, that is, the number of relations, capacities, and circumftances, wherein they had occafion to confider him, put thefe poets, &c. under a neceffity of making a partition, and of feparating the divine attributes into feveral perfons; becaufe the weaknefs of the human mind could not conceive fo much power and action in the fimplicity of one fingle divine nature. Thus the omnipotence of God came to be reprefented under the perfon and appellation of Jupiter; the wifdom of God, under that of Minerva; the juftice of God, under that of Juno.

The firft idols or falfe gods that are faid to have been adored, were the ftars, fun, moon, &c. on account of the light, heat, and other benefits, which we derive from them. Afterwards the earth came to be deified, for furnifhing fruits neceffary for the fubfiftence of men and animals; then fire and water became objects of divine worfhip, for their ufefulnefs to human life. In procefs of time, and by degrees, gods became multiplied to infinity: and there was fcarce any thing but the weaknefs or caprice of fome devotee or other elevated into the rank of deity; things ufelefs or even deftructive not excepted. See MYTHOLOGY.

GODALMING, a town of England, in the county of Surrey, fituated on the river Wye, 35 miles from London. Here is a manufactory of mixed and blue kerfeys, and of ftockings; the place is alfo famous for liquorice, and ftore of peat that burns better than pit-coal: in 1739, the fmall-pox carried off above 500 perfons here in three months, which was more than a third of the inhabitants.

GODDARD, JONATHAN, an eminent phyfician and chemift, and one of the firft promoters of the Royal Society, was born about the year 1617. He was elected a fellow of the college of phyficians in 1646, and appointed reader of the anatomical lecture in that college in 1647. As he took part againft Charles I. accepted the wardenfhip of Merton-college, Oxford, from Oliver Cromwell when chancellor, and fat fole reprefentative of that univerfity in Cromwell's parliament, he was removed from his wardenfhip in a manner difgraceful to him by Charles II. He was however then profeffor of phyfic at Grefham college, to which he retired, and continued to attend thofe meetings that gave birth to the Royal Society; upon the firft eftablifhment of which he was nominated one of the council. Being fully perfuaded that the preparation of medicines was no lefs the phyfician's duty than the prefcribing them, he conftantly prepared his own; and in 1668 publifhed a treatife recommending his example to general practice. He died of an apoplectic fit in 1674; and his memory was preferved by the drops that bore his name, otherwife called *Guttæ Anglicanæ*, the fecret of which he fold to Charles II. for 5000l. and which Dr Lifter affures us was only the volatile fpirit of raw filk rectified with oil of cinnamon or fome other effential oil. But he claims more particular regard, if what Bifhop Seth Ward fays be true, that he was the firft Englifhman who made that noble aftronomical inftrument, the telefcope.

GODDESS, a heathen deity of the female fex.

The ancients had almoft as many goddeffes as gods: fuch were, Juno the goddefs of air, Diana the goddefs of woods, &c. and under this character were reprefented the virtues, graces, and principal advantages of life; truth, juftice, piety, liberty, fortune, victory, &c.

It was the peculiar privilege of the goddeffes to be reprefented naked on medals; for it was fuppofed that the imagination muft be awed and reftrained by the confideration of the divine character.

GODFATHERS and GODMOTHERS, perfons who, at the baptifm of infants, anfwer for their future conduct, and folemnly promife that they will renounce the devil and all his works, and follow a life of piety and virtue; and by this means lay themfelves under an indifpenfable obligation to inftruct them, and watch over their conduct.

This cuftom is of great antiquity in the Chriftian church; and was probably inftituted to prevent children being brought up in idolatry, in cafe their parents died before they arrived at years of difcretion.

The number of godfathers and godmothers is reduced to two, in the church of Rome; and three, in the church of England: but formerly they had as many as they pleafed.

GODFREY of Bouillon, prince of Lorrain, a moft celebrated crufader, and victorious general. He was chofen general of the expedition which the Chriftians undertook for the recovery of the Holy Land, and fold his dukedom to prepare for the war. He took Jerufalem from the Turks in 1099; but his piety, as hiftorians relate, would not permit him to wear a diadem of gold in the city where his Saviour had been crowned with thorns. The fultan of Egypt afterwards fent a terrible army againft him; which he defeated, with the flaughter of about 100,000 of the enemy. He died in 1160.

GODMANCHESTER, a town of Huntingdonfhire 16 miles from Cambridge, and 57 from London. It has a bridge on the Oufe, oppofite to Huntingdon; was formerly a Roman city, by the name of Durofiponte, where many Roman coins have been often dug up; and according to old writers, in the time of the Saxons it was the fee of a bifhop, and had a caftle built by one Gorman a Danifh king, from which the town was called *Gormanchefter*. It is reckoned one of the largeft villages in England, and is feated in a fertile foil, abounding with corn. It is faid that no town in England kept more ploughs at work than this has done. The inhabitants boaft they formerly received our kings as they made a progrefs this way, with nine fcoploughs at a time, finely adorned with their trappings &c. James I. made it a corporation by the name of two bailiffs, 12 affiftants, and the commonalty of the borough of Godmanchefter. Here is a fchool, called the Free Grammar-School of Queen Elizabeth. On the weft fide of the town is a noble though ancient feat of of the earl of Sandwich. Near this place, in the London road between Huntingdon and Caxton, is a tree well known to travellers by the name of Beggar's Buſh.

GODSTOW, a place north-weſt of Oxford, in a ſort of iſland formed by the divided ſtreams of the Iſis after being joined by the Evenlode. It is noted for catching of fiſh and dreſſing them; but more ſo for the ruins of that nunnery which fair Roſamond quitted for the embraces of Henry II. The people ſhow a great hole in the earth here, where they ſay is a ſubterraneous paſſage, which goes under the river to Woodſtock, by which ſhe uſed to paſs and repaſs. Little more remains at preſent than ragged walls, ſcattered over a conſiderable extent of ground. An arched gateway, and another venerable ruin, part of the tower of the conventual church, are ſtill ſtanding. Near the altar in this church fair Roſamond was buried, but the body was afterwards removed by order of a biſhop of Lincoln, the viſitor. The only entire part is ſmall, formerly a private chapel. Not many years ſince a ſtone coffin, ſaid to have been Roſamond's, who, perhaps, was removed from the church to this place, was to be ſeen here. The building has been put to various uſes, and at preſent ſerves occaſionally for a ſtable.

GODWIN, Francis, ſucceſſively biſhop of Landaff and Hereford, was born in 1567. He was eminent for his learning and abilities; being a good mathematician, an excellent philoſopher, a pure Latiniſt, and an accurate hiſtorian. He underſtood the true theory of the moon's motion a century before it was generally known. He firſt ſtarted thoſe hints afterwards purſued by Biſhop Wilkins, in his "Secret and ſwift meſſenger;" and publiſhed "A catalogue of the lives of Engliſh biſhops." He has nevertheleſs been accuſed as a great ſimoniac, for omitting no opportunity of diſpoſing of preferments in order to provide for his children. He died in 1648.

Godwin or *Goodwin Sands*. See Goodwin *Sands*.

GODWIT. See Scolopax, Ornithology *Index*.

GOES, or Ter Goes, a ſtrong and conſiderable town of the United Provinces, in Zealand, and capital of the iſland of South Beverland. It communicates with the ſea by a canal; and is 10 miles eaſt of Middleburgh, and 30 north of Ghent. E. Long. 3. 50. N. Lat. 51. 33.

GOG and Magog, two names generally joined together in ſcripture, Ezek. xxxviii. 2, 3, &c. xxxix. 1, 2, &c. Rev. xx. 8.) Moſes ſpeaks of Magog the ſon of Japhet, but ſays nothing of Gog, (Gen. x. 2. 1 Chr. i. 5.). Gog was prince of Magog, according to Ezekiel. Magog ſignifies the country or people, and Gog the king of that country. The generality of the ancients made Magog the father of the Scythians and Tartars; and ſeveral interpreters diſcovered many footſteps of their name in the provinces of Great Tartary. Others have been of opinion that the Perſians were the deſcendants of Magog; and ſome have imagined that the Goths were deſcended from Gog and Magog; and that the wars deſcribed by Ezekiel, and undertaken by Gog againſt the ſaints, are no other than thoſe which the Goths carried on in the fifth age againſt the Roman empire.

Bochart has placed Gog in the neighbourhood of Caucaſus. He derives the name of this celebrated mountain from the Hebrew *Gog chaſan* "the fortreſs of Gog." He maintains that Prometheus, ſaid to be chained to Caucaſus by Jupiter, is Gog, and no other. There is a province in Iberia called the *Gogarene*.

Laſtly, the generality believe, that Gog and Magog, mentioned in Ezekiel and the Revelation, are to be taken in an allegorical ſenſe, for ſuch princes as were enemies to the church and ſaints. Thus many by Gog in Ezekiel underſtand Antiochus Epiphanes, the perſecutor of the Jews who were firm to their religion; and by the perſon of the ſame name in the Revelations, they ſuppoſe Antichriſt to be meant, the great enemy of the church and faithful. Some have endeavoured to prove that Gog, ſpoken of in Ezekiel, and Cambyſes king of Perſia, were one and the ſame perſon; and that Gog and Magog in the Revelation denote all the enemies of the church, who ſhould be perſecutors of it to the conſummation of ages.

GOGGLES, in *Surgery*, are inſtruments uſed for curing ſquinting, or that diſtortion of the eyes which occaſions this diſorder. They are ſhort conical tubes, compoſed of ivory ſtained black, with a thin plate of the ſame ivory fixed in the tubes near their anterior extremities. Through the centre of each of theſe plates is a ſmall circular hole, about the ſize of the pupil of the eye, for the tranſmiſſion of the rays of light. Theſe goggles muſt be continually worn in the daytime, till the muſcles of the eye are brought to act regularly and uniformly, ſo as to direct the pupil ſtraight forwards; and by theſe means the cure will be ſooner or later effected.

GOGMAGOG hills, are hills ſo called, three miles from Cambridge, remarkable for the intrenchments and other works caſt up here: whence ſome ſuppoſe it was a Roman camp; and others, that it was the work of the Danes.

GOGUET, Antony-Yves, a French writer, and author of a celebrated work, intitled, *L'Origine des Loix, des Arts, des Sciences, & de leur Progrès chez les anciens Peuples*, 1758, 3 vols 4to. His father was an advocate, and he was born at Paris in 1716. He was very unpromiſing as to abilities, and reckoned even dull, in his early years; but his underſtanding developing itſelf, he applied to letters, and at length produced the above work. The reputation he gained by it was great; but he enjoyed it a very ſhort time; dying the ſame year of the ſmall-pox, which diſorder, it ſeems, he always dreaded. It is remarkable, that Conrad Fugere, to whom he left his library and his MSS. was ſo deeply affected with the death of his friend, as to die himſelf three days after him. The above work has been tranſlated into Engliſh, and publiſhed in 3 vols 8vo.

GOITO, a town of Italy, in the duchy of Mantua, taken by the Germans in 1701, and by the prince of Heſſe in 1706. It is ſeated on the river Mincio, between the lake of Mantua and that of Garda, 10 miles north-weſt of Mantua. E. Long. 11. 0. N. Lat. 45. 16.

GOLCONDA, a kingdom of Aſia, in the peninſula on this ſide the Ganges. It is bounded on the north by that of Orixa, on the weſt by that of Balagate, on the ſouth by Biſnagar, and on the eaſt by the gulf of Bengal. It abounds in corn, rice, and cattle; but that which renders it moſt remarkable

able are the diamond-mines, they being the moft confiderable in the world: they are ufually purchafed of the black merchants, who buy parcels of ground to fearch for thefe precious ftones in. They fometimes fail in meeting with any, and in others they find immenfe riches. They have alfo mines of falt, fine iron for fword-blades, and curious callicoes and chintzes. It is fubject to the Great Mogul; and has a town of the fame name, feated at the foot of a mountain, being one of the largeft in the Eaft Indies. It is about fix miles in circumference; and was formerly the refidence of the kings, till it was conquered by the Great Mogul. It is now much frequented by the European merchants. E. Long. 70. 10. N. Lat. 16. 30.

GOLD, the moft valuable of all the metals, is of a bright yellow colour when pure, but becomes more or lefs white in proportion as it is alloyed with other metals. It is the heavieft of all known bodies, platina only excepted. See CHEMISTRY and MINERALOGY *Index*.

Method of Recovering GOLD *from Gilt Works*. The folubility of gold, and the indiffolubility of filver, in aqua regia, affords a principle on which gold may be feparated from the furface of filver; and, on this foundation, different proceffes have been contrived, of which the two following appear to be the beft.—Some powdered fal ammoniac, moiftened with aquafortis into the confiftence of a pafte, is fpread upon the gilt filver, and the piece heated till the matter fmokes and becomes nearly dry: being then thrown into water, it is rubbed with a fcratch brufh compofed of fine brafs wire bound together; by which the gold eafily comes off. The other way is, by putting the gilt filver into common aqua regia, kept fo hot as nearly to boil, and turning the metal frequently till it becomes all over black; it is then to be wafhed with a little water, and rubbed with the fcratch brufh, to get off what gold the aqua regia may have left. This laft method appears preferable to the other; as the fame aqua regia may be made to ferve repeatedly till it becomes faturated with the gold, after which the gold may be recovered pure by precipitation with fulphate of iron.

For feparating gold from gilt copper, fome direct a folution of borax to be applied on the gilt parts, but nowhere elfe, with a pencil, and a little powdered fulphur to be fprinkled on the places thus moiftened; the principal ufe of the folution of borax feems to be to make the fulphur adhere; the piece being then made red hot, and quenched in water, the gold is faid to be fo far loofened, as to be wiped off with a brufh. Others mix the fulphur with nitre and tartar, and form the mixture with vinegar into a pafte, which is fpread upon the gilt parts.

Schlutter recommends mechanical means, as being generally the leaft expenfive, for feparating gold from the furface both of filver and copper. If the gilt veffel is round, the gold is conveniently got off by turning it in a lathe, and applying a proper tool, a fkin being placed underneath for receiving the fhavings: he fays it is eafy to collect into two ounces of fhavings all the gold of a gilt veffel weighing thrice as many pounds. Where the figure of the piece does not admit of this method, it is to be properly fixed, and fcrapers applied of different kinds according to its fize and figure; fome large, and furnifhed with two handles, one at each end; others fmall and narrow, for penetrating into depreffed parts. If the gold cannot be got off by either of thefe ways, the file muft be had recourfe to, which takes off more of the metal underneath than the turning tool or the fcraper, particularly than the former. The gold fcrapings or filings may be purified from the filver or copper they contain, by the methods defcribed under the article METALLURGY.

The editors of the *Encyclopedie* give a method of recovering the gold from wood that has been gilt on a water-fize: this account is extracted from a memoir on the fame fubject, prefented to the Academy of Sciences by M. de Montamy. The gilt wood is fteeped for a quarter of an hour in a quantity of water fufficient to cover it, made very hot: the fize being thus foftened, the wood is taken out, and fcrubbed piece by piece, in a little warm water, with fhort ftiff briftle brufhes of different fizes, fome fmall for penetrating into the carvings, and others large for the greater difpatch in flat pieces. The whole mixture of water, fize, gold, &c. is to be boiled to drynefs, the dry matter made red hot in a crucible to burn off the fize, and the remainder ground with mercury, either in a mortar, or, where the quantity is large, in a mill.

Gold-Coaft. See GUINEA.

Gold-Wire, a cylindrical ingot of filver, fuperficially gilt or covered with gold at the fire, and afterwards drawn fucceffively through a great number of little round holes, of a wire-drawing iron, each lefs than the other, till it be fometimes no bigger than a hair of the head. See *Wire-Drawing*.

It may be obferved that, before the wire be reduced to this exceffive finenefs, it is drawn through above 140 different holes; and that each time they draw it, it is rubbed afrefh over with new wax, both to facilitate its paffage, and to prevent the filver's appearing through it.

Gold-Wire flatted, is the former wire flatted between two rollers of polifhed fteel, to fit it to be fpun on a ftick, or to be ufed flat, as it is, without fpinning, in certain ftuffs, laces, embroideries, &c. See STUFF, &c.

Gold-Thread, or *Spun-gold*, is flatted gold, wrapped or laid over a thread of filk, by twifting it with wheel and iron bobbins.

To difpofe the wire to be fpun on filk, they pafs it between two rollers of a little mill: thefe rollers are of nicely polifhed fteel, and about three inches in diameter. They are fet very clofe to each other, and turned by means of a handle faftened to one of them, which gives motion to the other. The gold wire in paffing between the two is rendered quite flat, but without lofing any thing of its gilding; and is rendered fo exceedingly thin and flexible, that it is eafily fpun on filk-thread, by means of a hand-wheel, and fo wound on a fpool or bobbin. See *Wire-Drawing*.

Gold-Leaf, or *Beaten Gold*, is gold beaten with a hammer into exceeding thin leaves, fo that it is computed, that an ounce may be beaten into 1600 leaves, each three inches fquare, in which ftate it takes up more than 159,052 times its former furface.

The preparation of gold leaf, according to Dr Lewis, is as follows:

"The gold is melted in a black-lead crucible, with fome

Gold.

fome borax, in a wind furnace, called by the workmen a *wind hole*: as foon as it appears in perfect fufion, it is poured out into an iron ingot mould, fix or eight inches long, and three quarters of an inch wide, previoufly greafed, and heated, fo as to make the tallow run and fmoke, but not to take flame. The bar of gold is made red hot, to burn off the unctuous matter, and forged on an anvil into a long plate, which is further extended, by being paffed repeatedly between polifhed fteel rollers, till it becomes a ribbon as thin as paper. Formerly the whole of this extenfion was procured by means of the hammer, and fome of the French workmen are ftill faid to follow the fame practice: but the ufe of the flatting mill both abridges the operation, and renders the plate of more uniform thicknefs. The ribbon is divided by compaffes, and cut with fheers into equal pieces, which confequently are of equal weights: thefe are forged on an anvil till they are an inch fquare; and afterwards well nealed, to correct the rigidity which the metal has contracted in the hammering and flatting. Two ounces of gold, or 960 grains, the quantity which the workmen ufually melt at a time, make 150 of thefe fquares, whence each of them weighs fix grains and two fifths; and as 902 grains of gold make a cubic inch, the thicknefs of the fquare plates is about the 766th part of an inch.

" In order to the further extenfion of thefe pieces into fine leaves, it is neceffary to interpofe fome fmooth body between them and the hammer, for foftening its blow, and defending them from the rudenefs of its immediate action: as alfo to place between every two of the pieces fome proper intermedium, which, while it prevents their uniting together, or injuring one another, may fuffer them freely to extend. Both thefe ends are anfwered by certain animal membranes.

" The goldbeaters ufe three kinds of membranes; for the outfide cover, common parchment made of fheep fkin; for interlaying with the gold, firft the fmootheft and clofeft vellum, made of calf fkin; and afterwards the much finer fkins of ox gut, ftript off from the large ftraight gut flipt open, curioufly prepared on purpofe for this ufe, and hence called *goldbeater's fkin*. The preparation of thefe laft is a diftinct bufinefs, practifed by only two or three perfons in the kingdom, fome of the particulars of which I have not fatisfactorily learned. The general procefs is faid to confift, in applying one upon another, by the fmooth fides, in a moift ftate, in which they readily cohere and unite infeparably; ftretching them on a frame, and carefully fcraping off the fat and rough matter, fo as to leave only the fine exterior membrane of the gut; beating them between double leaves of paper, to force out what unctuofity may remain in them; moiftening them once or twice with an infufion of warm fpices; and laftly, drying and preffing them. It is faid, that fome calcined gypfum, or plafter of Paris, is rubbed with a hare's foot both on the vellum and the ox gut fkins, which fills up fuch minute holes as may happen in them, and prevents the gold leaf from fticking, as it would do to the fimple animal membrane. It is obfervable, that, notwithftanding the vaft extent to which the gold is beaten between thefe fkins, and the great tenuity of the fkins themfelves, yet they fuftain continual repetitions of the procefs for feveral months, without extending or growing thinner. Our workmen find, that, after 70 or 80 repetitions, the fkins, though they contract no flaw, will no longer permit the gold to extend between them; but that they may be again rendered fit for ufe by impregnating them with the virtue which they have loft, and that even holes in them may be repaired by the dexterous application of frefh pieces of fkin: a microfcopical examination of fome fkins that had been long ufed plainly fhowed thefe repairs. The method of reftoring their virtue is faid in the *Encyclopédie* to be, by interlaying them with leaves of paper moiftened with white wine vinegar, beating them for a whole day, and afterwards rubbing them over as at firft with plafter of Paris. The gold is faid to extend between them more eafily, after they have been ufed a little, than when they are new.

Gold.

" The beating of the gold is performed on a fmooth block of black marble, weighing from 200 to 600 pounds, the heavier the better; about nine inches fquare on the upper furface, and fometimes lefs, fitted into the middle of a wooden frame, about two feet fquare, fo as that the furface of the marble and the frame form one continuous plane. Three of the fides are furnifhed with a high ledge; and the front, which is open, has a leather flap faftened to it, which the gold-beater takes before him as an apron, for preferving the fragments of gold that fall off. Three hammers are employed, all of them with two round and fomewhat convex faces, though commonly the workman ufes only one of the faces: the firft, called the *cutch hammer*, is about four inches in diameter, and weighs 15 or 16 pounds, and fometimes 20, though few workmen can manage thofe of this laft fize: the fecond, called the *fhoddering hammer*, weighs about 12 pounds, and is about the fame diameter: the third, called the *gold hammer*, or *finifhing hammer*, weighs 10 or 11 pounds, and is nearly of the fame width. The French ufe four hammers, differing both in fize and fhape from thofe of our workmen: they have only one face, being in figure truncated cones. The firft has very little convexity, is near five inches in diameter, and weighs 14 or 15 pounds: the fecond is more convex than the firft, about an inch narrower, and fcarcely half its weight: the third, ftill more convex, is only about two inches wide, and four or five pounds in weight: the fourth or finifhing hammer is near as heavy as the firft, but narrower by an inch, and the moft convex of all. As thefe hammers differ fo remarkably from ours, I thought proper to infert them, leaving the workmen to judge what advantage one fet may have above the other.

" A hundred and fifty of the pieces of gold are interlaid with leaves of vellum, three or four inches fquare, one vellum leaf being placed between every two of the pieces, and about 20 more of the vellum leaves on the outfides; over thefe is drawn a parchment cafe, open at both ends, and over this another in a contrary direction, fo that the affemblage of gold and vellum leaves is kept tight and clofe on all fides. The whole is beaten with the heavieft hammer, and every now and then turned upfide down, till the gold is ftretched to the extent of the vellum; the cafe being from time to time opened for difcovering how the extenfion goes on, and the packet, at times, bent and rolled

rolled as it were between the hands, for procuring sufficient freedom to the gold, or, as the workmen say, to make the gold work. The pieces, taken out from between the vellum leaves, are cut in four with a steel knife; and the 600 divisions, hence resulting, are interlaid, in the same manner, with pieces of the ox-gut skins five inches square. The beating being repeated with a lighter hammer till the golden plates have again acquired the extent of the skins, they are a second time divided in four: the instrument used for this division is a piece of cane cut to an edge, the leaves being now so light, that the moisture of the air or breath condensing on a metalline knife would occasion them to stick to it. These last divisions being so numerous, that the skins necessary for interposing between them would make the packet too thick to be beaten at once, they are parted into three parcels, which are beaten separately, with the smallest hammer, till they are stretched for the third time to the size of the skins: they are now found to be reduced to the greatest thinness they will admit of; and indeed many of them, before this period, break or fail. The French workmen, according to the minute detail of this process given in the *Encyclopédie*, repeat the division and the beating once more; but as the squares of gold, taken for the first operation, have four times the area of those used among us, the number of leaves from an equal area is the same in both methods, viz. 16 from a square inch. In the beating, however simple the process appears to be, a good deal of address is requisite, for applying the hammers so as to extend the metal uniformly from the middle to the sides: one improper blow is apt not only to break the gold leaves, but to cut the skins.

"After the last beating, the leaves are taken up by the end of a cane instrument, and, being blown flat on a leather cushion, are cut to a size, one by one, with a square frame of cane made of a proper sharpness, or with a frame of wood edged with cane: they are then fitted into books of 25 leaves each, the paper of which is well smoothed, and rubbed with red bole to prevent their sticking to it. The French, for sizing the leaves, use only the cane knife; cutting them first straight on one side, fitting them into the book by the straight side, and then paring off the superfluous parts of the gold about the edges of the book. The size of the French gold leaves is from somewhat less than three inches to three and three quarters square; that of ours, from three inches to three and three-eighths.

"The process of gold-beating is considerably influenced by the weather. In wet weather, the skins grow somewhat damp, and in this state make the extension of the gold more tedious: the French are said to dry and press them at every time of using; with care not to overdry them, which would render them unfit for farther service. Our workmen complain more of frost, which appears to affect the metalline leaves themselves: in frost, a gold leaf cannot easily be blown flat, but breaks, wrinkles, or runs together.

"Gold leaf ought to be prepared from the finest gold; as the admixture of other metals, though in too small a proportion to affect sensibly the colour of the leaf, would dispose it to lose of its beauty in the air. And indeed there is little temptation to the workman to use any other; the greater hardness of alloyed gold occasioning as much to be lost in point of time and labour, and in the greater number of leaves that break, as can be gained by any quantity of alloy that would not be at once discoverable by the eye. All metals render gold harder and more difficult of extension. Even silver, which in this respect seems to alter its quality less than any other metal, produces with gold a mixture sensibly harder than either of them separately, and this hardness is in no art more felt than in the goldbeater's. The French are said to prepare what is called the *green gold leaf*, from a composition of one part of copper and two of silver with eighty of gold. But this is probably a mistake: for such an admixture gives no greenness to gold: and I have been informed by our workmen, that this kind of leaf is made from the same fine gold as the highest gold-coloured sort, the greenish hue being only a superficial teint induced upon the gold in some part of the process: this greenish leaf is little otherwise used than for the gilding of certain books.

"But though the goldbeater cannot advantageously diminish the quantity of gold in the leaf by the admixture of any other substance with the gold, yet means have been contrived, for some particular purposes, of saving the precious metal, by producing a kind of leaf called *party-gold*, whose basis is silver, and which has only a superficial coat of gold upon one side: a thick leaf of silver and a thinner one of gold, laid flat on one another, heated and pressed together, unite and cohere; and being then beaten into fine leaves, as in the foregoing process, the gold, though its quantity is only about one fourth of that of the silver, continues everywhere to cover it, the extension of the former keeping pace with that of the latter.

But it is observed by Mr Nicholson, that pure gold is too ductile to be worked between the goldbeaters skin. The newest skins will work the finest gold, and make the thinnest leaf, because they are the smoothest. Old skins, being rough or foul, require coarser gold. The finer the gold, the more ductile; insomuch that pure gold, when driven out by the hammer, is too soft to force itself over the irregularities, but would pass round them, and by that means become divided into narrow slips. The finest gold for this purpose has three grains of alloy in the ounce, and the coarsest twelve grains. In general, the alloy is six grains, or one-eightieth part. That which is called pale gold contains three pennyweights of silver in the ounce. The alloy of leaf gold is silver, or copper, or both, and the colour is produced of various tints accordingly. Two ounces and two pennyweights of gold is delivered by the master to the workman, who, if extraordinarily skilful, returns two thousand leaves, or eighty books of gold, together with one ounce and six pennyweights of waste cuttings. Hence one book weighs 4.8 grains; and as the leaves measure 3.3 inches in the side, the thickness of the leaf is one two hundred and eighty-two thousandth part of an inch.

The yellow metal called Dutch gold is fine brass. It is said to be made from copper plates, by cementation with calamine, without subsequent fusion. Its thickness, compared with that of leaf gold, proved as 19 to 4, and under equal surfaces it is considerably more than twice as heavy as the gold. *Jour.* vol. i.

It

Gold, Golden.

It muſt be obſerved, however, that gold is beaten more or leſs, according to the kind or quality of the work it is intended for; that for the gold-wire-drawers to gild their ingots withal, is left much thicker than that for gilding the frames of pictures, &c. See GILDING.

GOLD Brocade. See BROCADE.

Fulminating GOLD. See CHEMISTRY *Index.*

Moſaic GOLD, is gold applied in pannels on a proper ground, diſtributed into ſquares, lozenges, and other compartments; part of which is ſhadowed to raiſe or heighten the reſt. See MOSAIC.

GOLD Plates for Enamelling are generally made of ducat gold, whoſe fineneſs is from $23\frac{1}{2}$ to $23\frac{3}{4}$ carats; and the fineſt gold is the beſt for this purpoſe, unleſs where ſome parts of the gold are left bare and unpoliſhed, as in watch-caſes, ſnuff-boxes, &c. for which purpoſe a mixture of alloy is neceſſary, and ſilver is preferred to copper, becauſe the latter diſpoſes the plates to tarniſh and turn green. See ENAMELLING.

Shell-GOLD is that uſed by the gilders and illuminers, and with which gold letters are written. It is made by grinding gold leaves, or gold-beaters fragments, with a little honey, and afterwards ſeparating the honey from the powdered gold by means of water. When the honey is waſhed away, the gold may be put on paper or kept in ſhells; whence its name. When it is uſed, it is diluted with gum-water or ſoap-ſuds.—The German gold-powder, prepared from the Dutch gold-leaf in the ſame manner, is generally uſed; and when it is well ſcoured with varniſh, anſwers the end in japanners gilding as well as the genuine.

GOLD Size for burniſhed gilding is prepared of one pound and a half of tobacco-pipe clay, half an ounce of red chalk, a quarter of an ounce of black lead, forty drops of ſweet oil, and three drams of pure tallow; grind the clay, chalk, and black lead, ſeparately, very fine in water; then mix them together, add the oil and tallow, and grind the mixture to a due conſiſtence.

Gold ſize of japanners may be made by pulverizing gum animi and aſphaltum, of each one ounce; red lead, litharge of gold, and umber, of each one ounce and a half, mixing them with a pound of linſeed oil, and boiling them, obſerving to ſtir them till the whole be incorporated, and appears on growing cold of the conſiſtence of tar: ſtrain the mixture through a flannel, and keep it ſtopped up in a bottle for uſe. When it is uſed, it muſt be ground with as much vermilion as will give it an opake body, and diluted with oil of turpentine, ſo that it may be worked freely with the pencil. A ſimple preparation conſiſts of one pound of linſeed oil and four ounces of gum animi; powder the gum, and mix it gradually with the boiling oil; let it continue to boil till it becomes of the conſiſtence of tar; ſtrain it through a coarſe cloth; keep and uſe it as the other.

GOLD-Finch. See FRINGILLA, ORNITHOLOGY *Index.*

GOLD-Fiſh. See CYPRINUS, ICHTHYOLOGY *Index.*

GOLDEN, ſomething that has a relation to gold, or conſiſts of gold.

GOLDEN-Calf, was a figure of a calf, which the Iſraelites caſt in that metal, and ſet up in the wilderneſs to worſhip during Moſes's abſence in the mount; and which that legiſlator at his return burnt, grinded to powder, and mixed with the water the people were to drink of; as related in Exod. xxxii. The commentators have been divided on this article: the pulverizing of gold, and rendering it potable, is a very difficult operation in chemiſtry. Many, therefore, ſuppoſe it done by a miracle; and the reſt, who allow of nothing ſupernatural in it, advance nothing but conjectures as to the manner of the proceſs. Moſes could not have done it by ſimple calcination, nor amalgamation, nor antimony, nor calcination; nor is there one of thoſe operations that quadrates with the text.

Golden.

M. Stahl has endeavoured to remove this difficulty. The method Moſes made uſe of, according to this author, was by diſſolving the metal with hepar ſulphuris; only, inſtead of the vegetable alkali, he made uſe of the Egyptian natron, which is common enough throughout the eaſt.

GOLDEN-Fleece, in the ancient mythology, was the ſkin or fleece of the ram upon which Phryxus and Hella are ſuppoſed to have ſwam over the ſea to Colchis; and which being ſacrificed to Jupiter, was hung upon a tree in the grove of Mars, guarded by two brazen-hoofed bulls, and a monſtrous dragon that never ſlept; but was taken and carried off by Jaſon and the Argonauts.

Many authors have endeavoured to ſhow that this fable is an allegorical repreſentation of ſome real hiſtory, particularly of the philoſophers ſtone. Others have explained it by the profit of the wool trade to Colchis, or the gold which they commonly gathered there with fleeces in the rivers. See ARGONAUTS.

Order of the GOLDEN Fleece, is a military order inſtituted by Philip the Good, duke of Burgundy, in 1429. It took its denomination from a repreſentation of the golden fleece, borne by the knights on their collars, which conſiſted of flints and ſteels. The king of Spain is now grand-maſter of the order, in quality of duke of Burgundy: the number of knights is fixed to thirty-one.

It is uſually ſaid to have been inſtituted on occaſion of an immenſe profit which that prince made by wool; though others will have a chemical myſtery couched under it, as under that famous one of the ancients, which the adepts contend to be no other than the ſecret of the elixir, wrote on the fleece of a ſheep.

Oliver de la Marche writes, that he had ſuggeſted to Philip I. archduke of Auſtria, that the order was inſtituted by his grandfather Philip the Good duke of Burgundy, with a view to that of Jaſon; and that John Germain biſhop of Chalons, chancellor of the order, upon this occaſion made him change his opinion, and aſſured the young prince that the order had been inſtituted with a view to the fleece of Gideon. William biſhop of Tournay, chancellor likewiſe of the order, pretends that the duke of Burgundy had in view both the golden fleece of Jaſon and Jacob's fleece; i. e. the ſpecked ſheep belonging to this patriarch, according to agreement made with his father-in-law Laban. Which ſentiment gave birth to a great work of this prelate, in two parts: in the firſt, under the ſymbol of the fleece of Jaſon, is repreſented the virtue of magnanimity, which a knight ought to poſſeſs; and under the ſymbol of the fleece of Jacob he repreſents the virtue of juſtice.

Paradin

Paradin is of the fame mind; and tells us, that the duke defigned to infinuate that the fabulous conqueft which Jafon is faid to have made of the golden fleece in Colchis, was nothing elfe but the conqueft of virtue, which gains a victory over thofe horrible monfters vice and our evil inclinations.

Golden *Number*, in *Chronology*, a number fhowing what year of the moon's cycle any given year is. See Chronology, N° 27—30.

Golden *Rod*, in *Botany*. See Solidago, Botany *Index*.

Golden *Rofe*. The pope annually confecrates a golden rofe on the fourth Sunday in Lent, which is fent to princeffes, or to fome church, as a mark of his peculiar affection.

Golden *Rule*, in *Arithmetic*, a rule or praxis, of great ufe and extent in the art of numbers; whereby we find a fourth proportional to three quantities given.

The golden rule is alfo called the *Rule of Three* and *Rule of Proportion*. See its nature and ufe under the article Arithmetic, N° 13.

GOLDENGEN, a town of Poland in the duchy of Courland, with a handfome caftle, feated on the river Weia, in E. Long. 22. 31. N. Lat. 56. 48.

GOLDONI, Charles, a comic writer of confiderable eminence, was born at Venice in the year 1707, in which city his father acted in the capacity of phyfician. His attachment to the drama became confpicuous even in childhood, which his father was fond of countenancing, erecting a theatre in his own houfe, where young Goldoni and fome of his companions were the actors. It is faid that he even drew the outlines of a comedy of his own invention when he was no more than 8 years of age,—a moft extraordinary indication of his future eminence. He ftudied rhetoric at Perugia, in the college of the Jefuits, and profecuted his philofophical ftudies at Rimini. The ftage, however had too many charms to allow him to pay much attention to Ariftotle or Quintilian, and he eloped from Rimini with a company of comedians when they removed to Chiozza. In vain did his father attempt to make him fall in love with phyfic, or the ftudy of the law; yet his ardent imagination was fo forcibly ftruck with a particular church-ceremony, that he formed the refolution of commencing capuchin, but the diffipation of Venice foon deftroyed this refolution. After the demife of his father, he was prevailed upon by his furviving parent to take up the profeffion of the law for immediate fupport, but fome unknown reafons induced him to quit the bar, after which he went to Milan, where he was appointed fecretary to the Venetian refident.

At Milan he brought out his firft performance, under the title of *Il Gondoliere Veneziano*. He removed afterwards to Verona, where he joined himfelf to a company of players; and here too he entered into a ftate of wedlock. He compofed a number of pieces for the players to whom he attached himfelf. While at Venice, he formed the laudable refolution of reforming the Italian ftage, which at that time was difgraced by contemptible farce and low buffoonery. He made himfelf acquainted with the true nature of comedy, and kept within the limits of nature and decorum. Such was the fertility of his genius, and fuch his indefatigable induftry, that he produced no fewer than fixteen comedies and 42 other theatrical pieces in the courfe of twelve months! And what is moft aftonifhing, fome of thefe hafty performances are deemed his mafterpieces.

His works in 10 vols. 8vo. were firft printed in 1753, and in 1761 his new pieces amounted to 59. About this time he was invited to Paris by the manager of the Italian theatre in that city, to compofe pieces for the ftage, of which invitation he accepted. His firft attempt was unfuccefsful, becaufe he had to contend with the pantomime drollery, which was moft agreeable to the depraved tafte of the times. When about to leave Paris on the expiration of his engagement, he was introduced to the court, and appointed teacher of the Italian language to the princeffes. He had lodgings in Verfailles, but his penfion was not fufficient to keep him from writing for the ftage. When 62 years old, he ventured to compofe in a foreign language, his *La Bourru Bienfaifant*, which was received in the court theatre with extraordinary applaufe. He was deprived of his penfion in confequence of the revolution, and reduced to indigence. It ought to be confeffed, however, that this verfatile nation was juft about to make him amends when he expired in 1792, and in the 85th year of his age. If the rapidity with which Goldoni compofed was fuch as to prevent him from ranking with authors of the firft clafs, it cannot be denied that his talent for comedy was very great. Some have given him the appellation of the *Moliere of Italy*, but this perhaps is too flattering a title. His whole works were printed at Leghorn about the years 1788 and 1791, in 31 volumes 8vo.

GOLDSMITH, or, as fome choofe to exprefs it, *filverfmith*, an artift who makes veffels, utenfils, and ornaments, in gold and filver.

The goldfmith's work is either performed in the mould, or beat out with the hammer or other engine. All works that have raifed figures are caft in a mould, and afterwards polifhed and finifhed; plates or difhes, of filver or gold, are beat out from thin flat plates; and tankards, and other veffels of that kind, are formed of plates foldered together, and their mouldings are beat, not caft. The bufinefs of the goldfmiths formerly required much more labour than it does at prefent; for they were obliged to hammer the metal from the ingot to the thinnefs they wanted; but there are now invented flatting-mills, which reduce metals to the thinnefs that is required, at a very fmall expence. The goldfmith is to make his own moulds; and for that reafon, ought to be a good defigner, and have a tafte in fculpture: he ought alfo to know enough of metallurgy to be able to affay mixed metals, and to mix the alloy.

The goldfmiths in London employ feveral hands under them for the various articles of their trade; fuch are the jeweller, the fnuff-box and toy-maker, the filver-turner, the gilder, the burnifher, the chafer, the refiner, and the gold-beater.

Goldfmiths are fuperior tradefmen; their wares muft be affayed by the wardens of the company of this name in London, and marked; and gold is to be of a certain touch. No goldfmith may take above one fhilling the ounce of gold, befides what he has for the fafhioning, more than the buyer may be allowed for it at the king's exchange; and here any falfe metal fhall be feized and forfeited to the king. The cities of

Goldsmith. of York, Exeter, Bristol, &c. are places appointed for the assaying wrought plate of goldsmiths; also a duty is granted on silver-plate of sixpence an ounce, &c. Plate made by goldsmiths shall be of a particular fineness, on pain of forfeiting 10l. and if any parcel of plate sent to the assayers is discovered to be of a coarser alloy than the respective standards, it may be broken and defaced; and the fees for assaying are particularly limited.

GOLDSMITH, *Oliver*, a celebrated English writer, was born at Roscommon in Ireland in the year 1731. His father, who possessed a small estate in that county, had nine sons, of whom Oliver was the third. He was originally intended for the church; and with that view, after being well instructed in the classics, was, with his brother the Rev. Henry Goldsmith, placed in Trinity-college, Dublin, about the latter end of the year 1749. In this seminary of learning he continued a few years, when he took a bachelor's degree: but his brother not being able to obtain any preferment after he left the college, Oliver, by the advice of Dean Goldsmith of Cork, turned his thoughts to the study of physic; and, after attending some courses of anatomy in Dublin, proceeded to Edinburgh in the year 1751, where he studied the several branches of medicine under the different professors in that university. His beneficent disposition soon involved him in unexpected difficulties; and he was obliged precipitately to leave Scotland, in consequence of engaging himself to pay a considerable sum of money for a fellow-student.

A few days after, about the beginning of the year 1754, he arrived at Sunderland, near Newcastle, where he was arrested at the suit of a taylor in Edinburgh, to whom he had given security for his friend.

By the good offices of Laughlan Maclane, Esq. and Dr Sleigh, who were then in the college, he was soon delivered out of the hands of the bailiff; and took his passage on board a Dutch ship to Rotterdam, where, after a short stay, he proceeded to Brussels; he then visited great part of Flanders; and after passing some time at Strasburg and Louvain, where he obtained a degree of bachelor of physic, he accompanied an English gentleman to Berne and Geneva.

It is undoubtedly fact, that this ingenious unfortunate man travelled on foot most part of his tour. He had left England with very little money; and being of a philosophical turn, and at that time possessing a body capable of sustaining every fatigue, and a heart not easily terrified at danger, he became an enthusiast to the design he had formed of seeing the manners of different countries. He had some knowledge of the French language and of music, and he played tolerably well on the German flute; which, from an amusement, became at some times the means of subsistence. His learning produced him a hospitable reception at most of the religious houses; and his music made him welcome to the peasants of Flanders and other parts of Germany. "Whenever I approached," he used to say, "a peasant's house towards night-fall, I played one of my most merry tunes; and that procured me not only a lodging, but subsistence for the next day: but in truth (his constant expression), I must own, whenever I attempted to entertain persons of a higher rank, they always thought my performance odious, and never made me any return for my endeavours to please them."

Goldsmith. On Mr Goldsmith's arrival at Geneva, he was recommended as a proper person for a travelling tutor to a young man, who had been unexpectedly left a considerable sum of money by his uncle Mr S——, formerly an eminent pawnbroker near Holborn. This youth, who had been articled to an attorney, on receipt of his fortune determined to see the world; and, on his engaging with his preceptor, made a proviso that he should be permitted to govern himself; and Goldsmith soon found his pupil understood the art of directing in money-concerns extremely well, as avarice was his prevailing passion. His questions were usually how money might be saved, and which was the least expensive course of travelling; whether any thing could be bought that would turn to account when disposed of again in London? Such curiosities on the way as could be seen for nothing he was ready enough to look at; but if the sight of them was to be paid for, he usually asserted that he had been told they were not worth seeing. He never paid a bill that he would not observe how amazingly expensive travelling was; and all this, though he was not yet twenty-one. During Goldsmith's continuance in Switzerland, he assiduously cultivated his poetical talent, of which he had given some striking proofs while at the college of Edinburgh. It was here he sent the first sketch of his delightful poem called the *Traveller*, to his brother the clergyman in Ireland, who, giving up fame and fortune, had retired with an amiable wife to happiness and obscurity, on an income of only 40l. a-year.

From Geneva Mr Goldsmith and his pupil visited the south of France; where the young man, upon some disagreement with his preceptor, paid him the small part of his salary which was due, and embarked at Marseilles for England. Our wanderer was left once more upon the world at large, and passed through a variety of difficulties in traversing the greatest part of France. At length his curiosity being satiated, he bent his course towards England, and arrived at Dover the beginning of the winter 1758. When he came to London, his stock of cash did not amount to two livres. An entire stranger in this metropolis, his mind was filled with the most gloomy reflections on his embarrassed situation. With some difficulty he discovered that part of the town in which his old acquaintance Dr Sleigh resided. This gentleman received him with the warmest affection, and liberally invited him to share his purse till some establishment could be procured for him. Goldsmith, unwilling to be a burden to his friend, a short time after eagerly embraced an offer which was made him to assist the late Rev. Dr Milner in instructing the young gentlemen at the academy at Peckham; and acquitted himself greatly to the Doctor's satisfaction for a short time: but having obtained some reputation by the criticisms he had written in the Monthly Review, Mr Griffith, the proprietor, engaged him in the compilation of it; and, resolving to pursue the profession of writing, he returned to London, as the mart where abilities of every kind were sure of meeting distinction and reward. As his finances were by no means in a good state, he determined to adopt a plan of the strictest economy: and took

Goldsmith.

took lodgings in an obscure court in the Old Bailey, where he wrote several ingenious little pieces. The late Mr Newberry, who at that time gave great encouragement to men of literary abilities, became a kind of patron to our young author; and introduced him as one of the writers in the Public Ledger, in which his Citizen of the World originally appeared, under the title of *Chinese Letters*.

Fortune now seemed to take some notice of a man she had long neglected. The simplicity of his character, the integrity of his heart, and the merit of his productions, made his company very acceptable to a number of respectable families; and he emerged from his shabby apartments in the Old Bailey to the politer air of the Temple, where he took handsome chambers, and lived in a genteel style. The publication of his Traveller, and his Vicar of Wakefield, was followed by the performance of his comedy of the Good-natured Man at Covent Garden theatre, and placed him in the first rank of the poets of the present age.

Among many other persons of distinction who were desirous to know him was the duke of Northumberland; and the circumstance that attended his introduction to that nobleman is worthy of being related, in order to show a striking trait of his character. "I was invited," said the Doctor (as he was then universally called) by my friend Mr Piercy, to wait upon the duke, in consequence of the satisfaction he had received from the perusal of one of my productions. I dressed myself in the best manner I could; and, after studying some compliments I thought necessary on such an occasion, proceeded to Northumberland-house, and acquainted the servants that I had particular business with his Grace. They showed me into an antichamber; where, after waiting some time, a gentleman very genteelly dressed made his appearance. Taking him for the duke, I delivered all the fine things I had composed in order to compliment him on the honour he had done me; when, to my great astonishment, he told me I had mistaken him for his master, who would see me immediately. At that instant the duke came into my apartment; and I was so confused on the occasion, that I wanted words barely sufficient to express the sense I entertained of the duke's politeness, and went away extremely chagrined at the blunder I had committed."

Another feature of his character we cannot help laying before the reader. Previous to the publication of his Deserted Village, the bookseller had given him a note for one hundred guineas for the copy, which the Doctor mentioned a few hours after to one of his friends: who observed, it was a very great sum for so short a performance. "In truth," replied Goldsmith, "I think so too; I have not been easy since I received it; therefore I will go back and return him his note;" which he absolutely did; and left it entirely to the bookseller to pay him according to the profits produced by the sale of the piece, which turned out very considerable.

During the last rehearsal of his comedy intitled She stoops to Conquer, which Mr Coleman had no opinion would succeed, on the Doctor's objecting to the repetition of one of Tony Lumkin's speeches, being apprehensive it might injure the play, the manager with great keenness replied, "Psha, my dear Doctor, do not be fearful of squibs, when we have been sitting almost these two hours upon a barrel of gunpowder." The piece, however, contrary to Mr Coleman's expectation, was received with uncommon applause by the audience; and Goldsmith's pride was so hurt by the severity of the above observation, that it entirely put an end to his friendship for the gentleman that made it.

Goldsmith.

Notwithstanding the great success of his pieces, by some of which it is asserted, upon good authority, he cleared 1800l. in one year, his circumstances were by no means in a prosperous situation; which was partly owing to the liberality of his disposition, and partly to an unfortunate habit he had contracted of gaming; the arts of which he knew very little of, and consequently became the prey of those who were unprincipled enough to take advantage of his simplicity.

Just before his death he had formed a design for executing an Universal Dictionary of Arts and Sciences, the prospectus of which he actually published. In this work several of his literary friends (particularly Sir Joshua Reynolds, Dr Johnson, Mr Beauclerc, and Mr Garrick), had undertaken to furnish him with articles upon different subjects. He had entertained the most sanguine expectations from the success of it. The undertaking, however, did not meet with that encouragement from the booksellers which he had imagined it would undoubtedly receive; and he used to lament this circumstance almost to the last hour of his existence.

He had been for some years afflicted, at different times, with a violent strangury, which contributed not a little to embitter the latter part of his life; and which, united with the vexations which he suffered upon other occasions, brought on a kind of habitual despondency. In this unhappy condition he was attacked by a nervous fever, which, being improperly treated, terminated in his dissolution on the 4th of April 1774.

As to his character, it is strongly illustrated by Mr Pope's line,

In wit a man, simplicity a child.

The learned leisure he loved to enjoy was too often interrupted by distresses which arose from the liberality of his temper, and which sometimes threw him into loud fits of passion: but this impetuosity was corrected upon a moment's reflection; and his servants have been known, upon these occasions, purposely to throw themselves in his way, that they might profit by it immediately after; for he who had the good fortune to be reproved, was certain of being rewarded for it. The universal esteem in which his poems were held, and the repeated pleasure they give in the perusal, is a striking test of their merit. He was a studious and correct observer of nature; happy in the selection of his images, in the choice of his subjects, and in the harmony of his versification; and, though his embarrassed situation prevented him from putting the last hand to many of his productions, his Hermit, his Traveller, and his Deserted Village, bid fair to claim a place among the most finished pieces in the English language.

Besides the works already mentioned, he wrote, 1. History of the earth and animated nature, 6 vols 8vo. 2. History of England, 4 vols 8vo. 3. History of Rome, 2 vols. 4. Abridgments of the two last, for the

the uſe of ſchools. 5. A view of experimental philoſophy, 3 vols 8vo; a poſthumous work, not eſteemed. 6. Miſcellanies, &c.

GOLF, the name of a certain game among the Scots, and ſaid to be peculiar to their country.—Among them it has been very ancient; for there are ſtatutes prohibiting it as early as the year 1457, leſt it ſhould interfere with the ſport of archery. It is commonly played on rugged broken ground, covered with ſhort graſs, in the neighbourhood of the ſea ſhore. A field of this ſort is in Scotland called *links*. The game is generally played in parties of one or two on each ſide. Each party has an exceeding hard ball, ſomewhat larger than a hen's egg. This they ſtrike with a ſlender and elaſtic club, of about four feet long, crooked in the head, and having lead run into it, to make it heavy. The ball being ſtruck with this club, will fly to the diſtance of 200 yards, and the game is gained by the party who puts his ball into the hole with the feweſt ſtrokes. But the game does not depend ſolely upon the ſtriking of the longeſt ball, but alſo upon meaſuring the ſtrength of the ſtroke, and applying it in ſuch direction as to lay the ball in ſmooth ground, whence it may be eaſily moved at the next ſtroke. To encourage this amuſement, the city of Edinburgh, A. D. 1744, gave to the company of golfers a ſilver club, to be played for annually by the company, the victor to append a gold or ſilver piece to the prize. It has been played for every year ſince, except the years 1746 and 1747. For their better accommodation, 22 members of the company ſubſcribed 30l. each in the year 1768, for building a houſe, where their meetings might be held. The ſpot choſen for this purpoſe was the ſouth-weſt corner of Leith Links, where an area was taken in feu from the magiſtrates of Edinburgh, and a commodious houſe and tavern built upon it.

GOLIUS, James, a celebrated profeſſor of Arabic and the mathematics at Leyden, was deſcended from a very honourable family, and born at the Hague in the year 1596. He was put to the univerſity of Leyden, where he ſtudied under Erpinius; and having made himſelf maſter of all the learned languages, applied himſelf to the mathematics, phyſic, and divinity. He afterwards travelled into Africa and Aſia; and became greatly eſteemed by the king of Morocco, and the ſultan of the Turks. He at length returned to Leyden, loaded with manuſcripts; and in 1624, ſucceeded Erpinius in the Arabic chair. As he had been an eye-witneſs of the wretched ſtate of Chriſtianity in the Mahometan countries, he was filled with the compaſſion of a fellow-chriſtian; and none ever ſolicited for a place of honour and profit with greater eagerneſs, than he for procuring a new edition of the New Teſtament, in the original language, with a tranſlation into the vulgar Greek, by an Archimandrite; and as there are ſome of theſe Chriſtians who uſe the Arabic tongue in divine ſervice, he alſo took care to have diſperſed among them an Arabic tranſlation of the Confeſſion of the Proteſtants, together with the Catechiſm and Liturgy. In 1626, he was alſo choſen profeſſor of mathematics; and diſcharged the functions of both profeſſorſhips with the greateſt applauſe during 40 years. He was likewiſe appointed interpreter in ordinary to the ſtates for the Arabic, Turkiſh, Perſian, and other eaſtern languages, for which he had an annual penſion, and a preſent of a gold chain, with a very beautiful medal, which he wore as a badge of his office. He publiſhed, 1. The life of Tamerlane, written in Arabic. 2. The hiſtory of the Saracens, written by Elmacin. 3. Alferganus's Elements of Aſtronomy, with a new verſion, and learned commentaries. 4. An excellent Arabic lexicon. 5. A Perſian Dictionary. He died in 1667.

GOLTZIUS, Henry, a famous engraver and painter, born in 1558, at Mulbreck in the duchy of Juliers. He was taught the art of engraving by Theodore Cuerenhert; and ſucceeded very wonderfully in it, notwithſtanding the diſadvantage of a lame hand, which was occaſioned by his falling into the fire whilſt young. He was firſt employed by his maſter, and afterwards he worked for Philip Galle. Domeſtic troubles and ill health occaſioned him to travel. He went through Germany into Italy; and paſſed under a feigned name, that his ſtudies might not be interrupted. He viſited Bologna, Florence, Naples, and Venice, conſtantly applying himſelf to drawing from the antique ſtatues, and the works of the great maſters. At Rome he reſided the longeſt; and there he produced ſeveral excellent engravings from Polidoro Raphael, and other eminent painters. On his return to his native country he eſtabliſhed himſelf at Haerlem, where he engraved many of the drawings which he had made during his abode in Italy. He died at Haerlem in 1617, aged 59. He is ſaid to have been 40 years old before he began to paint: yet his pictures are ſpoken of with great commendation; but as he did not produce any great number of them, they are rarely to be met with. As an engraver, he deſerves the higheſt commendation. No man ever ſurpaſſed, and few have equalled, him in the command of the graver and freedom of execution. He copied the ſtyle of Albert Durer, Lucas of Leyden, and other old maſters, with aſtoniſhing exactneſs. Sometimes his engravings are neat in the extreme; at other times they are performed in a bold open manner, without the leaſt reſtraint. He alſo engraved ſeveral of his own deſigns on wood, in that manner which is diſtinguiſhed by the appellation of *chiaro-ſcuro*. Of his prints, which are very numerous, it may here ſuffice to ſpecify two or three of the moſt celebrated: 1. Six large upright plates, known by the name of his *maſterpieces*. Theſe, it is ſaid, he engraved to convince the public that he was perfectly capable of imitating the ſtyles of Albert Durer, Lucas Van Leyden, and other maſters, whoſe works were then held in higher eſtimation than his own: for he had adopted a new manner, which he purſued becauſe he thought it ſuperior, and not becauſe he was incapable of following the others. It is reported that with one of them, the Circumciſion, which he ſmoked to give it the more plauſible air of antiquity, he actually deceived ſome of the moſt capital connoiſſeurs of the day; by one of whom it was bought for an original engraving of Albert Durer. The ſubjects of theſe plates are, The Annunciation of the Virgin; the Meeting of the Virgin with Elizabeth, called the Viſitation; the Nativity of Chriſt; the Circumciſion of Chriſt; the Adoration of the Wiſe Men; the Holy Family. 2. The Judgment of Midas, a large plate lengthwiſe. 3. The Venetian Ball, a large plate lengthwiſe, from Theodore Bernard. 4. The Boy and

Gombauld, Gombroon. Dog, a middling fized upright plate, from a defign of his own; an admirable print. 5. The Necromancer, a middling-fized upright oval print, in chiaro-fcuro. 6. Night in her Chariot, the fame.

GOMBAULD, John Ogier de, one of the beft French poets in the 17th century, and one of the firft members of the French academy, was born at St Juft de Luffac. He acquired the efteem of Mary de Medicis, and of the wits of his time. He was a Proteftant, and died in a very advanced age. He wrote many works in verfe and profe. His epigrams, and fome of his fonnets, are particularly efteemed.

GOMBROON, by the natives called *Bander Abaffi*, a city of Perfia, fituated in N. Lat. 27. 40. E. Long. 55. 30. The name of *Gombroon*, or *Comerong*, Captain Hamilton tells us, it had from the Portuguefe; becaufe it was remarkable for the number of prawns and fhrimps caught on its coafts, by them called *comerong*. This city owes its wealth and grandeur to the demolition of Ormus, and the downfal of the Portuguefe empire in the Eaft Indies. It is now juftly accounted one of the greateft marts in the Eaft, was built by the great Shah Abas, and from him, as fome think, obtained the name of *Bander Abaffi*, which fignifies the court of Abas. It ftands on a bay about nine leagues to the northward of the eaft end of the ifland of Kifhmifh, and three leagues from the famous Ormus. The Englifh began to fettle here about the year 1631, when, in confideration of their fervices againft the Portuguefe, Shah Abas granted them half the cuftoms of that port. This was confirmed by a phirmaund, and duly regarded, till the Englifh began to neglect the fervices they had ftipulated. Whether the company has any emolument from the cuftoms at prefent, is what we cannot pretend to afcertain. The town is large, but its fituation bad; wanting almoft every thing that contributes to the happinefs and even fupport of life. Towards the land it is encompaffed by a fort of wall; and towards the fea are feveral fmall forts, with a platform, and a caftle or citadel, mounted with cannon to fecure it and the road from the attempts of an enemy by fea. The houfes in moft of the ftreets are fo out of repair, fome half down, others in a heap of rubbifh, that a ftranger would imagine the town had been facked and ravaged by a barbarous people; not a veftige of the wealth really contained in the place appearing in view. The bazars and fhops round them are kept, for the moft part, by Banians, whofe houfes are generally in good order. Moft of the houfes are built with earth and lime, but fome of the beft with ftone. Many of them have a fort of ventilators at top, which contributes greatly to the health of the inhabitants in the hot feafons of the year. The moft fickly months here are April, May, September, and October. With fifh and mutton the inhabitants are well fupplied. Rice is imported from India; and wheat is fo plenty, that the poor fubfift chiefly on bread and dates. The country hereabouts abounds in the moft delicious fruits, as apricots, peaches, pomegranates, pears, mangoes, grapes, quavas, plums, fweet quinces, and water melons. The apricots, however, are fmall, and extremely dangerous if eaten to excefs.

Thofe conveniences are more than overbalanced by the fcarcity of frefh water, with which the inhabitants are fupplied from Affeen, a place feven miles diftant, there not being a fpring or well in the town. Perfons of condition keep a camel conftantly employed in bringing frefh and wholefome water. Captain Hamilton gives it as his opinion, that one caufe of the unwholefomenefs of this city is the reflection of the rays of light from a high mountain to the north of it. He fays, that when the beams are reflected from this mountain, they almoft fire the air, and, for two or three months in the year, render the fituation intolerable. For this reafon the people of condition retire into the country, to pafs the heats of June, July, and Auguft. The very fea, during this feafon, is affected, infomuch that the ftench is no lefs difagreeable than that of putrid carcafes; and this is increafed by the quantities of fhell-fifh left on the fhore, from which an exhalation arifes that tarnifhes gold and filver, and is lefs tolerable than the bilge-water of a tight fhip. At Affeen the Englifh factory have a country houfe and gardens, to which they retire occafionally. Here they have whole groves of Seville orange trees, which, though not natural to the country, thrive very well, and are always verdant, bearing ripe and green fruit, with bloffoms, all at the fame time. They have likewife tanks and ponds of fine frefh water, with every thing elfe that can moderate the heat of the climate, and render life agreeable and elegant. About 10 miles from Affeen is a place called *Minoa*, where are cold and hot natural baths, reckoned infallible in the cure of all fcrophulous diforders, rheumatifms, and other difeafes, by bathing.

Gombroon, Gomera. Gombroon is extremely populous, on account of the commerce carried on by the Dutch and Englifh factories, as well as the natives. The Englifh factory is clofe by the fea, at fome diftance from the Dutch, which is a commodious and fine new building. A great part of the company's profits arifes from freights. As the natives have not one good fhip of their own, and are extremely ignorant of navigation, they freight their goods for Surat, and other Indian marts, in Englifh and Dutch bottoms, at an exorbitant rate. The commodities of the Gombroon market are, fine wines of different kinds, raifins, almonds, kifh-mifhes, prunellas, dates, piftachio-nuts, ginger, filks, carpets, leather, tutty, galbanum, ammoniac, affafœtida, tragacanth, with other gums, and a variety of fhop medicines. Thefe are in a great meafure the produce of Carmania, which they bring to Gombroon in caravans. The Englifh company had once a fmall factory in the province of Carmania, chiefly for the fake of a fine wool produced there, and ufed by the hatters. The faid company had once a project of carrying a breed of the Perfian goats to St Helena; but whether it was executed, or what fuccefs it met with, we cannot fay. Although the company pay no cuftoms, yet they ufually make a prefent to the fhabander, to avoid the trouble he has it in his power to give them. All private traders with the company's paffes, enjoy the fame privileges, on paying two per cent. to the company, one to the agent, and one to the broker. All private trade, either by European or country fhips, has long been engroffed by the company's fervants.

GOMERA, one of the Canary iflands, lying between Ferro and Teneriffe. It has one good town of the fame name, with an excellent harbour, where the

Spaniſh fleet often take in refreſhments. They have corn ſufficient to ſupply the inhabitants, with one ſugar-work, and great plenty of wine and fruits. It is ſubject to the Spaniards, who conquered it in 1445. W. Long. 17. 10. N. Lat. 28. 0.

GOMORRAH, in *Ancient Geography*, one of the cities of the plain or of the vale of Siddim in Judæa, deſtroyed together with Sodom by fire from heaven, on account of the wickedneſs of the people. To determine its particular ſituation at preſent, is impoſſible.

GOMOZIA, a genus of plants belonging to the tetrandria claſs. See BOTANY *Index*.

GOMPHOSIS, in *Anatomy*, that kind of articulation by which the teeth are fixed in the jaw-bone. See ANATOMY, N° 2.

GOMPHRÆNA, GLOBE AMARANTH; a genus of plants belonging to the pentandria claſs; and in the natural method ranking under the 54th order, *Miſcellaneæ*. See BOTANY *Index*.

GONAQUA, the name of a nation inhabiting about the Cape, and ſuppoſed by Dr Sparrman to be a mixture of Hottentots and Caffres. See HOTTENTOTS.

GONDAR, the capital of Abyſſinia; ſituated, according to Mr Bruce's obſervations, in latitude 12. 34. north, and longitude 37. 33. eaſt from Greenwich. It lies upon the top of a hill of conſiderable height, and conſiſts of about 10,000 families in times of peace. The houſes are chiefly of clay, with roofs thatched in the form of cones. At the weſt end of the town is the king's palace; formerly, as Mr Bruce informs us, a ſtructure of conſiderable conſequence, being a large ſquare building four ſtories high, flanked with ſquare towers, and affording from the top of it a magnificent view of all the country ſouthward to the lake Tzana. It was built in the time of Facilidas, by maſons from India, and by ſuch Abyſſinians as had been inſtructed in architecture by the Jeſuits before their expulſion. Great part of it is now in ruins, having been burnt at different times; but there is ſtill ample lodging in the two loweſt floors, the audience chamber being above 120 feet long. By the ſide of this ſtructure there have been built by different kings apartments of clay only, in the faſhion of their own country. The palace, with all its contiguous buildings, is ſurrounded by a double ſtone wall thirty feet high and a mile and a half in circumference, with battlements upon the outer wall, and a parapet roof between the outer and inner, by which you can go along the whole and look into the ſtreet. The hill on which the town is built riſes in the middle of a deep valley, through which run two rivers: one of which, the Kakha, coming from the Mountain of the Sun, flanks all the ſouth of the town; while the other, called the *Angrab*, falling from the mountain Woggora, encompaſſes it on the north and north-eaſt; and both rivers unite at the bottom of the hill about a quarter of a mile ſouth of the town. Upon the bank oppoſite to Gondar, on the other ſide of the river, is a large town of Mahometans; a great part of whom are employed in taking care of the king's and nobility's equipage, both when they take the field and when they return from it. They are formed into a body under proper officers; but never fight on either ſide, being entirely confined to the occupation juſt mentioned, in which by their care and dexterity in pitching and ſtriking the tents, and in leading and conducting the baggage-waggons, they are of great ſervice.—The valley of Gondar is deſcribed as having three outlets; one ſouth, to Dembea, Maitſha, and the Agows; another on the north-weſt, towards Sennaar, from which it is diſtant 180 miles, over the Mountain of the Sun; and the third north, leading to Woggora, over the high mountain Lamalmon, and ſo on through Tigre to the Red ſea.

GONDI, JOHN FRANCIS PAUL, Cardinal de Retz, was the ſon of Philip Emanuel de Gondi, Count de Joigny, lieutenant-general, &c. and was born in 1613. From a doctor of the Sorbonne, he firſt became coadjutor to his uncle John Francis de Gondi, whom he ſucceeded in 1654 as archbiſhop of Paris; and was finally made a cardinal. This extraordinary perſon has drawn his own character in his memoirs with impartiality. He was a man who, from the greateſt degree of debauchery, and ſtill languiſhing under its conſequences, made himſelf adored by the people as a preacher. At the age of 23, he was at the head of a conſpiracy againſt the life of Cardinal Richelieu; he precipitated the parliament into cabals, and the people into ſedition: he was (ſays M. Voltaire) the firſt biſhop who carried on a civil war without the maſk of religion. However, his intrigues and ſchemes turned out ſo ill, that he was obliged to quit France; and he lived the life of a vagrant exile for five or ſix years, till the death of his great enemy Cardinal Mazarin, when he returned on certain ſtipulated conditions. After aſſiſting in the conclave at Rome, which choſe Clement IX. he retired from the world, and ended his life like a philoſopher in 1679; which made Voltaire ſay, that in his youth he lived like Catiline, and like Atticus in his old age. He wrote his Memoirs in his retirement; the beſt edition of which is that of Amſterdam, 4 vols 12mo, 1719.

GONDOLA, a flat boat, very long and narrow, chiefly uſed at Venice to row on the canals. The word is Italian, *gondola*. Du Cange derives it from the vulgar Greek κουντελας, "a bark," or "little ſhip;" Lancelot deduces it from γονδυ, a term in Athenæus for a ſort of vaſe.

The middle-ſized gondolas are upwards of thirty feet long and four broad: they always terminate at each end in a very ſharp point, which is raiſed perpendicularly to the full height of a man.

The addreſs of the Venetian gondoliers, in paſſing along their narrow canals, is very remarkable: there are uſually two to each gondola, and they row by puſhing before them. The fore-man reſts his oar on the left ſide of the gondola: the hind-man is placed on the ſtern, that he may ſee the head over the tilt or covering of the gondola, and reſts his oar, which is very long, on the right ſide of the gondola.

GONDOLA is alſo the name of a paſſage-boat of ſix or eight oars, uſed in other parts of the coaſt of Italy.

GONIOMETRY, a method of meaſuring angles, ſo called by M. de Lagny, who gave ſeveral papers, on this method, in the Memoirs of the Royal Academy an. 1724, 1725, 1729. M. de Lagny's method of goniometry conſiſts in meaſuring the angles with a pair of compaſſes, and that without any ſcale whatever, except an undivided ſemicircle. Thus, having any angle drawn

drawn upon paper, to be meaſured; produce one of the ſides of the angle backwards behind the angular point; then with a pair of fine compaſſes deſcribe a pretty large ſemicircle from the angular point as a centre, cutting the ſides of the propoſed angle, which will intercept a part of the ſemicircle. Take then this intercepted part very exactly between the points of the compaſſes, and turn them ſucceſſively over upon the arc of the ſemicircle, to find how often it is contained in it, after which there is commonly ſome remainder: then take this remainder in the compaſſes, and in like manner find how often it is contained in the laſt of the integral parts of the firſt arc, with again ſome remainder: find in like manner how often this laſt remainder is contained in the former; and ſo on continually, till the remainder become too ſmall to be taken and applied as a meaſure. By this means he obtains a ſeries of quotients, or fractional parts, one of another, which being properly reduced into one fraction, give the ratio of the firſt arc to the ſemicircle, or of the propoſed angle to two right angles, or 180 degrees, and conſequently that angle itſelf in degrees and minutes. *Hutton's Math. Dict.*

GONORRHÆA, an efflux of white, greeniſh, or differently-coloured matter, from the urethra; moſt commonly owing to venereal infection. See MEDICINE and SURGERY *Index*.

GONZAGA, LUCRETIA, was one of the moſt illuſtrious ladies of the 16th century; and much celebrated for her wit, her learning, and her delicate ſtyle. Hortenſio Lando wrote a beautiful panegyric upon her, and dedicated to her his dialogue of moderating the paſſions. Her beautiful letters have been collected with the greateſt care. We learn from theſe, that her marriage with John Paul Manfrone was unhappy.—She was married when ſhe was not 14 years of age, and his conduct afterwards gave her infinite uneaſineſs. He engaged in a conſpiracy againſt the duke of Ferrara; was detected and impriſoned by him; but, though condemned by the judges, not put to death. She did all in her power to obtain his enlargement, but in vain; for he died in priſon, having ſhown ſuch impatience under his misfortunes, as made it imagined he had loſt his ſenſes. She never would liſten afterwards to any propoſals of marriage, though ſeveral were made to her. All that came from her pen was ſo much eſteemed, that a collection was made even of the notes ſhe writ to her ſervants; ſeveral of which are to be met with in the edition of her letters.

GOOD, in general, whatever is apt to increaſe pleaſure, to diminiſh pain in us; or, which amounts to the ſame, whatever is able to procure or preſerve to us the poſſeſſion of agreeable ſenſations, and remove thoſe of an oppoſite nature.

Moral GOOD, denotes the right conduct of the ſeveral ſenſes and paſſions, or their juſt proportion and accommodation to their reſpective objects and relations. See MORALS.

GOOD Abearing (*bonus geſtus*), ſignifies an exact carriage or behaviour of a ſubject towards the king and the people, whereunto ſome perſons upon their miſbehaviour are bound: and he that is bound to this, is ſaid to be more ſtrictly bound than to the peace: becauſe where the peace is not broken, the ſurety *de bono geſtu* may be forfeited by the number of a man's company, or by their weapons.

GOOD Behaviour, in *Law*, an exact carriage and behaviour to the king and his people.

A juſtice of the peace may, at the requeſt of another, or where he himſelf ſees cauſe, demand ſurety for the good behaviour; and to that end the juſtice may iſſue out his warrant againſt any perſons whatſoever, under the degree of nobility; but when it is a nobleman, complaint is to be made in the court of chancery, or king's bench, where ſuch nobleman may be bound to keep the peace. Infants and feme-coverts, who ought to find ſurety by their friends, may be bound over to their good behaviour; as alſo lunatics, that have ſometimes lucid intervals, and all others who break the peace, or being ſuſpected to do it by affrays, aſſaults, battery, wounding, fighting, quarrelling, threatening, &c. A perſon may be likewiſe bound to his good behaviour for a ſcandalous way of living, keeping bawdy-houſes, gaming houſes, &c. and ſo may common drunkards, whoremongers, common whores, cheats, libellers, &c. He who demands ſurety for the peace, on any violence offered, muſt take an oath before the juſtice, that he goes in fear of his life, or ſome bodily harm, &c. and that it is not out of malice, but from a regard to his own ſafety.

GOOD Breeding. See *Good MANNERS*.

GOOD Friday, a faſt of the Chriſtian church, in memory of the ſufferings and death of Jeſus Chriſt. It is obſerved on the Friday in *holy* or *paſſion week*; and it is called, by way of eminence, *good*, becauſe of the bleſſed effects of our Saviour's ſufferings, which were a propitiatory or expiating ſacrifice for the ſins of the world. The commemoration of our Saviour's ſufferings has been kept from the very firſt ages of Chriſtianity, and was always obſerved as a day of the ſtricteſt faſting and humiliation. Among the Saxons it was called *Long-Friday*; but for what reaſon, except on account of the long faſtings and offices then uſed, is uncertain. On Good Friday the pope ſits on a plain form: and, after ſervice is ended, when the cardinals wait on him back to his chamber, they are obliged to keep a deep ſilence, as a teſtimony of their ſorrow. In the night of Good-Friday, the Greeks perform the obſequies of our Saviour round a great crucifix, laid on a bed of ſtate, adorned with flowers; theſe the biſhops diſtribute among the aſſiſtants when the office is ended. The Armenians, on this day, ſet open a holy ſepulchre, in imitation of that of Mount Calvary.

GOOD Hope, or *Cape of Good Hope*, a promontory of Africa, where the Dutch have built a good town and fort. It is ſituated in the country of the Hottentots: for an account of whom, and of the country at large, with its firſt diſcovery, ſee the article HOTTENTOTS.

The Cape of Good Hope has been generally eſteemed the moſt ſoutherly point of Africa, though it is not truly ſo. In *Phillips's Voyage to Botany Bay* *, we are told, that the land which projects fartheſt to the ſouth is a point to the eaſt of it, called by the Engliſh *Cape Lagullus*; a name corrupted from the original Portugueſe *das Agulhas*, which, as well as the French appellation *des Aiguilles*, is deſcriptive of its form, and would rightly be tranſlated *Needle cape*. * P. 38.

On approaching the cape, a very remarkable eminence

Good Hope. nence may in clear weather be discovered at a considerable distance; and is called the *Table-mountain* from its appearance, as it terminates in a flat horizontal surface, from which the face of the rock descends almost perpendicularly. In the mild or summer season, which commences in September, and continues till March, the Table Land or Mountain, is sometimes suddenly capped with a white cloud, by some called the *spreading of the Table-cloth*. When this cloud seems to roll down the steep face of the mountain, it is a sure indication of an approaching gale of wind from the south-east; which generally blows with great violence, and sometimes continues a day or more, but in common is of short duration. On the first appearance of this cloud, the ships in Table Bay begin to prepare for it, by striking yards and top-masts, and making every thing as snug as possible.—A little to the westward of the Table Land, divided by a small valley, stands on the right hand side of Table Bay a round hill, called the *Sugar Loaf*; and by many the *Lion's Head*, as there is a continuance from it contiguous to the sea, called the *Lion's Rump*; and when you take a general view of the whole, it very much resembles that animal with his head erect. The Sugar Loaf or Lion's Head, and the Lion's Rump, have each a flag staff on them, by which the approach of ships is made known to the governor, particularizing their number, nation, and the quarter from which they come. To the eastward, separated by a small chasm from the Table Land, stands Charles's Mount, well known by the appellation of the *Devil's Tower*, or *Devil's Head*; and so called from the violent gusts of wind supposed to issue from it when it partakes of the cap that covers the Table Land, though these gusts are nothing more than a degree of force the wind acquires in coming through the chasm. When this phenomenon appears in the morning, which is by no means so frequent as in the evening, the sailors have a saying, as the Devil's Tower is almost contiguous to the Table Land, that the old gentleman is going to breakfast; if in the middle of the day, that he is going to dinner; and if in the evening, that the cloth is spread for supper. Table-mountain rises about 3567 feet above the level of the sea; the Devil's Tower, about 3368; and the Lion's Head, 2764. In the neighbourhood of the latter lies *Constantia*, a district consisting of two farms, wherein the famous wines of that name are produced.

The above described high lands form a kind of amphitheatre about the Table-valley, where the Cape-town stands. This is situated at the bottom of the middle height, or Table-mountain; and almost in the centre of the Table Bay, so called from that mountain.—This bay, it is observed in Phillips's Voyage, "cannot properly be called a port, being by no means a station of security; it is exposed to all the violence of the winds which set into it from the sea; and is far from sufficiently secured from those which blow from the land. The gusts which descend from the summit of Table-mountain are sufficient to force ships from their anchors, and even violently to annoy persons on the shore, by destroying any tents or other temporary edifices, which may be erected, and raising clouds of fine dust, which produce very troublesome effects. A gale of this kind, from the south-east, blew for three days successively when Captain Cook lay here in his first voyage; at which time, he informs us, the Resolution was the only ship in the harbour that had not dragged her anchor. The storms from the sea are still more formidable; so much so, that ships have frequently been driven by them from their anchorage, and wrecked at the head of the bay. But these accidents happen chiefly in the *quaade mousson*, or winter months, from May 14th to the same day of August; during which time few ships venture to anchor here. Our fleet arriving later, lay perfectly unmolested as long as it was necessary for it to remain in this station. —False Bay, on the south-east side of the Cape, is more secure than Table Bay during the prevalence of the north-west winds, but still less so in strong gales from the south-east. It is, however, less frequented, being 24 miles of very heavy road distant from Cape Town, whence almost all necessaries must be procured. The most sheltered part of False Bay is a recess on the west side, called *Simon's Bay*."

Mr White, in his Journal of a Voyage to New South Wales, thus describes Cape Town. From the shipping, he observes*, the town appears pleasantly situated, but at the same time small; a deception that arises from its being built in a valley with such stupendous mountains directly behind it. On landing, however, you are surprised, and agreeably disappointed, to find it not only extensive, but well built, and in a good style; the streets spacious, and intersecting each other at right angles with great precision. This exactness in the formation of the streets, when viewed from the Table Land, is observed to be very great. The houses in general are built of stone, cemented together with a glutinous kind of earth which serves as mortar, and afterwards neatly plastered and whitewashed with lime. As to their height they do not in common exceed two stories, on account of the violence of the wind, which at some seasons of the year blows with great strength and fury. For the same reason thatch has been usually preferred to tiles or shingles; but the bad effects that have proceeded from this mode when fires happen, has induced the inhabitants in all their new buildings to give the preference to slates and tiles. The lower parts of the houses, according to the custom of the Dutch nation, are not only uncommonly neat and clean in appearance, but they are really so; and the furniture is rather rich than elegant But this is by no means the case with the bedrooms or upper apartments; which are very barely and ill furnished. The streets are rough, uneven, and unpaved. But many of the houses have a space flagged before the door; and others have trees planted before them, which form a pleasant shade, and give an agreeable air to the streets.

* Page 87.

The only landing-place is at the east end of the town, where there is a wooden quay running some paces into the sea, with several cranes on it for the convenience of loading and unloading the scoots that come alongside. To this place excellent water is conveyed by pipes, which makes the watering of ships both easy and expeditious. Close to the quay, on the left hand, stands the castle and principal fortress; a strong extensive work, having excellent accommodations for the troops, and for many of the civil officers belonging to the company. Within the gates, the company have their principal stores; which are spacious as well as convenient. This fort covers and defends the east part of the town and harbour

Good Hope.

bour, as Amsterdam fort does the west part. The latter, which has been built since Commodore Johnston's expedition, and whereon both French and Dutch judgment have been united to render it effectual and strong, is admirably planned and calculated to annoy and harass ships coming into the bay. Some smaller detached fortifications extend along the coast, both to the east and west, and make landing, which was not the case before the late war, hazardous and difficult. In a word, Cape Town is at this time fortified with strength, regularity, and judgment.

The governor's house is delightfully situated, nearly in the centre of an extensive garden, the property of the Dutch East India company, usefully planted, and at the same time elegantly laid out. The governor's family make what use they please of the produce of the garden, which is various and abundant; but the original intention of the company in appropriating so extensive a piece of ground to this purpose was, that their hospital, which is generally pretty full when their ships arrive after long voyages, may be well supplied with fruits and vegetables, and likewise that their ships may receive a similar supply. This garden is as public as St James's park; and for its handsome, pleasant, and well-shaded walks, is much frequented by persons of every description, but particularly by the fashionable and gay. At the upper end of the principal walk is a small space walled in for the purpose of confining some large ostriches and a few deer; and a little to the right of this is a small menagery, in which the company have half a dozen wild animals and about the same number of curious birds.

There are two churches in the town; one large, plain, and unadorned, for the Calvinists, the prevailing sect; and a smaller one for the Lutherans. The hospital, which is large and extensive, is situated at the upper end of the town, close to the company's garden; where the convalescents reap the benefit of a wholesome pure air, perfumed with the exhalations of a great variety of rich fruit trees, aromatic shrubs, and odorous plants and flowers; and likewise have the use of every production of it.

Besides their hospital, the Dutch East India company have several other public buildings, which tend to improve the appearance of the town. The two principal of these are, the stables and a house for their slaves. The former is a handsome range of buildings, capable of containing an incredible number of horses. Those they have at the Cape are small, spirited, and full of life. The latter is a building of considerable extent, where the slaves, both male and female, have separate apartments, in a very comfortable style, to reside in after the fatigues and toil of the day; and there are several officers placed over them, who have commodious apartments, and treat them humanely.

The inhabitants of the Cape, though in their persons large, stout, and athletic, have not all that phlegm about them which is the characteristic of Dutchmen in general. The physical influence of climate may in some degree account for this; for it is well known that in all southern latitudes the temper and disposition of the people are more gay, and that they are more inclined to luxury and amusements of every kind, than the inhabitants of the northern hemisphere. The ladies are lively, good natured, and familiar; and from a peculiar gay turn, they admit of liberties that would be thought reprehensible in England, though perhaps they as seldom overleap the bounds of virtue as the women of other countries.

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The heavy draft work about the Cape is mostly performed by oxen; which are here brought to an uncommon degree of usefulness and docility. It is not uncommon to see 14, 16, and sometimes 18, in one of their teams; when the roads are heavy, they sometimes, though rarely, yoke 20; all which the Hottentots, Malays, and Cape slaves, have in the most perfect subjection and obedience. One of these fellows places himself on the fore part of the waggon, or, when loaded, on the top of the load, and with a tremendous long whip, which from its size he is obliged to hold in both his hands, manages these creatures with inexpressible address. When he finds expedition needful, he can make them keep whatever pace he chooses, either trot or gallop, (a gait performed or kept up with difficulty by European oxen), and that with as much ease as if he was driving horses. They likewise manage horses with the same dexterity; and to see one of them driving three, four, five, and sometimes six pair, in hand, with one of these long whips, would make the most complete master of the whip in England cut a despicable figure. Carriages are not very numerous at the Cape, as the inhabitants in general travel in covered waggons, which better suit the roughness of the country. The governor and some few of the principal people keep coaches, which are a good deal in the English style, and always drawn by six horses.

The Cape of Good Hope was taken by the British on 17th August 1796, with little or no difficulty, and afterwards given up at the peace of 1801. It has been since retaken, and is at present (1806) in the possession of the British.

When the news of the capture of this important settlement reached England, it was considered as of incalculable value to the East India Company in particular, forming a barrier or grand outwork to their immense possessions in India. They obtained the unconditional grant of supplying the Cape with India and China goods, and care was taken to defeat every attempt that could be made to undermine their interest. Aware of its great importance, it was the resolution of ministry, "that no foreign power, directly or indirectly, should obtain possession of the Cape of Good Hope, for that it was the physical guarantee of the British territories in India." While all were convinced of its political importance, none disputed its commercial advantages.

Its geographical position on the globe is so commanding a feature, that the mere looking at a map, independent of any other information, must shew its value and importance in various respects. Its distance from the coast of Brazil is a month's voyage; from the Dutch colonies of Surinam, Berbice, and Essequibo, it is a voyage of six weeks; it is about equally distant from the Red sea, and two months from Coromandel and Malabar. It is half way between Britain and India, in a temperate climate, and productive of every species of refreshment in great abundance.

Considered in the light of a naval station, the importance of the Cape is equally conspicuous. It may serve as a port for refreshing and refitting the ships of the

the East India Company; a station, for ships of war keeping the entrance into the Indian seas, and affording by its geographical position, a ready communication with every part of the globe. There is no place, in the homeward bound voyage from India, so proper or convenient for the valuable fleets of the East India Company, to assemble at for convoy, as the Cape of Good Hope. Their crews might be refreshed with fruits, vegetables, and fresh provisions, at a very reasonable rate. Salt beef for the remainder of the voyage might there be laid in. An establishment for curing salt provisions, would be an incalculable saving to the Company, as well as a singular convenience. The moderate expence at which a fleet could here be maintained, is a circumstance that deserves attention. At the Cape a sailor may be furnished his ration of fresh beef or mutton, biscuit and wine, for one-fourth of what the same ration of salt beef costs the government when sent out from Britain. He can have a pint of wine for threepence, and were it not for the monopoly of that article, he might purchase it for half the sum.

If a naval establishment was formed at Saldanha bay, many coasting vessels and fishing ships would be constructed in it, as it abounds with every convenience that could be required for building ships, which would be the means of very much increasing the coasting trade.

To what extent the Cape might have been rendered advantageous to the British empire as an emporium of eastern produce, as furnishing articles of export for consumption in Europe and the West Indies, and taking articles of British growth and manufacture in exchange for colonial produce, it may be proper to enquire. The chief objection against this use of the Cape is the prejudice it would occasion to the sales of Leadenhall street, and the diminution of his majesty's customs; for though the East India Company might be made responsible to the crown for the duties on the amount of its sales at the Cape, yet the intention of the emporium would be entirely defeated, if the duties demanded there so far enhanced the value of the Indian commodities, as to make it equally eligible for foreign shipping to proceed to India, or to resort to the London market. The East India Company could supply their emporium at the Cape with the produce and manufacture of Great Britain to any amount, and at so cheap a rate as to undersell any other nation.

Should the Cape become a commercial depot in the hands of the East India Company, the consumption in Spanish and Portuguese America, of eastern produce, would increase to a very great extent, for all which they would pay in specie, of which the Company stand in the greatest need for their China trade.

A new branch of traffic might be opened between the Cape and New South Wales, the latter supplying the former with coals, of which they have abundant mines, in exchange for cattle, butter, wine, and articles of clothing.

The Cape may also be considered as of advantage to the British nation, by furnishing articles of export for general consumption in Europe and the West Indies. These are grain and pulse, wine and brandy, wool, hides, and skins, whale oil and bone, dried fruits, salt provisions, soap and candles, aloes, ivory, and tobacco.

Were a depot for the southern whale fishery established at the Cape, it might be attended with beneficial consequences. By promoting navigation, the strength and security of the British empire are also promoted, and its very existence as an independent nation is owing to the superiority of its navy. A nation of fishermen implies a nation of seamen, a race of bold and hardy warriors. The cultivation of the fisheries would afford a never-failing supply of men so instructed, increase our conveniency, and promote our commerce.

The colony of the Cape comprehends at least 120,000 square miles, yet the whole population of whites, blacks, and Hottentots, does not exceed 60,000 souls, or a single individual for every two square miles. The upper regions of the mountains are masses of sandstone, and where the waters break out in springs upon the surface of the plains, vegetation is very luxuriant. In the vicinity of the Cape, where the soil is coloured with iron, or oxide of iron combined with clay, the most luxuriant crops of grapes are produced. The climate in general is friendly to vegetation, but being within the influence of the periodical winds, the rains are very unequal.

The chief rivers on the south coast are the Gauritz, Knysna, Keurboom, Camtoos, Zwartkops, Sunday, and Great Fish rivers, and the two principal rivers on the western coast are the Berg, or mountain river, and the Oliphant river, which falls into the Southern Atlantic in 31° 30′ S. Lat. *

* Barrow's Travels in Africa, vol. ii.

Good Manners. See Manners.

GOOINGS, in sea-language, are clamps of iron bolted on the stern-post of a ship, whereon to hang the rudder and keep it steady; for which purpose there is a hole in each of them, to receive a correspondent spindle bolted on the back of the rudder, which turns thereby as upon hinges.

GOOSE. See Anas, Ornithology *Index*. The goose was held in great esteem amongst the Romans, for having saved the Capitol from the invasion of the Gauls by cackling and clapping its wings. Geese were kept in the temple of Juno; and the censors, when they entered upon their office, provided meat for them. There was also an annual feast at Rome, at which they carried a silver image of a goose in state; and hanged a dog, to punish that animal because he did not bark at the arrival of the Gauls.

Goose-Ander. See Mergus, Ornithology *Index*.

Goose-Berry. See Ribes, Botany *Index*.

Goose-Neck, in a ship, a piece of iron fixed on the one end of the tiller, to which the laniard of the whip-staff or the wheel-rope comes, for steering the ship.

Goose-Wing, in the sea language. When a ship sails before, or with a quarter-wind on a fresh gale, to make the more haste, they launch out a boom and sail on the lee-side; and a sail so fitted is called a *goose-wing*.

GORCUM, a town in South Holland, which carries on a considerable trade in cheese and butter. It is situated on the rivers Ligne and Maese, in E. Long. 4. 55. N. Lat. 51. 49.

GORDIANUS I. (a Roman general), was for his valour and virtues chosen emperor by the army in the reign of Maximinus, A. D. 237; but his son, whom he had associated with himself in the throne, being slain by Capellian, the governor of Mauritania for Maximinus,

Maximinus, Gordianus killed himſelf the ſame year. See ROME.

GORDIANUS III. (grandſon of the former), a renowned warrior, and ſtyled *The guardian of the Roman commonwealth*. He was treacherouſly aſſaſſinated by Philippus, an Arabian, one of his generals; who, to the eternal diſgrace of the Romans of that era, ſucceeded him in the empire, A. D. 244. See ROME.

GORDIAN-KNOT, in antiquity, a knot made in the leathers or harneſs of the chariot of Gordius king of Phrygia, ſo very intricate, that there was no finding where it began or ended. The inhabitants had a tradition, that the oracle had declared, that he who untied this knot ſhould be maſter of Aſia. Alexander having undertaken it, was unable to accompliſh it; when fearing leſt his not untying it ſhould be deemed an ill augury, and prove a check in the way of his conqueſts, he cut it aſunder with his ſword, and thus either accompliſhed or eluded the oracle.

GORDIUS, the HAIR-WORM, a genus of inſects belonging to the claſs of *vermes inteſtina*. See HELMINTHOLOGY *Index*.

GORDIUS, king of Phrygia, and father of Midas, was a poor huſbandman, with two yokes of oxen, wherewith he ploughed his land and drew his wain. An eagle ſitting a long while upon one of his oxen, he conſulted the ſoothſayers; a virgin bid him ſacrifice to Jupiter in the capacity of king. He married the virgin, who brought forth Midas. The Perſians inſtructed by the oracle to ſet the firſt perſon they met in a wain upon the throne, met Gordius, and made him king. Midas for this good fortune dedicated to Jupiter his father's cart. The knot of the yoke, they ſay, was ſo well twiſted, that he who could unlooſe it was promiſed the empire of Aſia; hence the proverb of *the Gordian knot* had its original. See *GORDIAN Knot*.

GORDON, ALEXANDER, an excellent draughtſman and a good Greek ſcholar, who reſided many years in Italy, viſited moſt parts of that country, and had alſo travelled into France, Germany, &c. was ſecretary to the Society for Encouragement of Learning: and afterwards to the Egyptian Club, compoſed of gentlemen who had viſited Egypt (viz. Lord Sandwich, Dr Shaw, Dr Pococke, &c.) He ſucceeded Dr Stukeley as ſecretary to the Antiquarian Society, which office he reſigned in 1741 to Mr Joſeph Ames. He went to Carolina with governor Glen, where, beſides a grant of land, he had ſeveral offices, ſuch as regiſter of the province, &c.; and died a juſtice of the peace, leaving a handſome eſtate to his family. He publiſhed, 1. *Itinerarium Septentrionale*, or a Journey through moſt parts of the Counties of Scotland, in two parts, with 66 copperplates, 1726, folio. 2. Supplement to the *Itinerarium*, 1732, folio. 3. The Lives of Pope Alexander VI. and his ſon Cæſar Borgia. 4. A complete Hiſtory of the ancient Amphitheatres, 1730, 8vo. afterwards enlarged in a ſecond edition. 5. An Eſſay towards explaining the hieroglyphical figures on the Coffin of the ancient Mummy belonging to Capt. William Lethieuller, 1737, folio, with cuts. 6. Twenty-five Plates of all the Egyptian Mummies and other Egyptian Antiquities in England, 1739, folio.

GORDON, *Thomas*, noted for his tranſlations and political writings, was born at Kirkcudbright in North Britain. He came young to London; where he ſupported himſelf by teaching languages, until he procured employment under the earl of Oxford in Queen Anne's time, but in what capacity is not now known. He firſt diſtinguiſhed himſelf in the defence of Dr Hoadley in the Bangorian controverſy; which recommended him to Mr Trenchard, in conjunction with whom he wrote the well-known Cato's Letters, upon a variety of important public ſubjects. Theſe were followed by another periodical paper, under the title of the Independent Whig; which was continued ſome years after Mr Trenchard's death, by Gordon alone, againſt the hierarchy of the church; but with more acrimony than was ſhown in Cato's Letters. At length Sir Robert Walpole retained him to defend his adminiſtration, to which end he wrote ſeveral pamphlets. At the time of his death, July 28th 1750, he was firſt commiſſioner of the wine licences, an office which he had enjoyed many years. He was twice married. His ſecond wife was the widow of his great friend Trenchard, by whom he had children.—He publiſhed Engliſh tranſlations of Salluſt and Tacitus, with additional diſcourſes to each author, which contain much good matter. Alſo, two collections of his tracts have been preſerved: the firſt entitled, A Cordial for Low-ſpirits, in three volumes: and the ſecond, The Pillars of Prieſtcraft and Orthodoxy ſhaken, in two volumes. But theſe, like many other poſthumous things, had better have been ſuppreſſed. In his tranſlations as well as his other works he places the verbs at the ends of ſentences, according to the Latin idiom, in a very ſtiff and affected manner.

GORDONIA, a genus of plants, belonging to the monadelphia claſs. See BOTANY *Index*.

GORE, in *Heraldry*, one of the abatements, which, according to Gullim, denotes a coward. It is a figure conſiſting of two arch lines drawn one from the ſiniſter chief, and the other from the ſiniſter baſe, both meeting in an acute angle in the middle of the feſs point. See HERALDRY.

GOREE, a ſmall iſland of Africa, near Cape de Verd, ſubject to the French. It is a ſmall ſpot not exceeding two miles in circumference, but its importance ariſes from its ſituation for trade ſo near Cape Verd, and it has been therefore a bone of contention between European nations. It was firſt poſſeſſed by the Dutch, from whom, in 1663, it was taken by the Engliſh; but in 1665 it was retaken by the Dutch, and in 1677 ſubdued by the French, in whoſe poſſeſſion it remained till the year 1759, when the Britiſh arms were every where triumphant; and it was reduced by Commodore Keppel, but reſtored to the French at the treaty of peace in 1763. It was retaken by the Engliſh in the laſt war, but again reſtored at the peace of 1783. E. Long. 17. 20. N. Lat. 14. 43.

GOREE, the capital town of an iſland of the ſame name in Holland, eight miles ſouth of Briel. E. Long. 3. 50. N. Lat. 51. 55.

GOREY, a borough, fair, and poſt-town in the county of Wexford, province of Leinſter, otherwiſe called *Newborough*. It ſtands about 18 miles north of Wexford town, and 45 from Dublin. N. Lat. 52. 40. W. Long. 6. 30. It ſends two members to parliament; patronage in the family of Ram.

GORGE, in *Architecture*, the narroweſt part of the Tuſcan and Doric capitals, lying between the aſtragal, above the ſhaft of the pillar, and the annulets.

GORGE, in *Fortification*, the entrance of the platform of any work. See FORTIFICATION.

GORGED, in *Heraldry*, the bearing of a crown, coronet, or the like, about the neck of a lion, a ſwan, &c. and in that caſe it is ſaid, the lion or cygnet is gorged with a ducal coronet, &c.

GORGED is alſo uſed when the gorge or neck of a peacock, ſwan, or the like bird, is of a different colour or metal from the reſt.

GORGET, a kind of breaſt-plate like a half-moon, with the arms of the prince thereon; worn by the officers of foot. They are to be either gilt or ſilver, according to the colour of the buttons on the uniforms.

GORGET, or GORGERET, in *Surgery*, is the name which the French give to the concave or cannulated conductor, uſed in lithotomy. See SURGERY *Index*.

GORGONA, a ſmall iſland of Italy, in the ſea of Tuſcany, and near that of Corſica, about eight miles in circumference; remarkable for the large quantity of anchovies taken near it. E. Long. 10. 0. N. Lat. 43. 22.

GORGONA, a ſmall iſland of the South ſea, 12 miles weſt of the coaſt of Peru, in America. It is indifferent high land, very woody, and ſome of the trees are very tall and large, and proper for maſts. It is about 10 miles in circumference, and has ſeveral ſprings and rivulets of excellent water, but is ſubject to conſtant rains. W. Long. 79. 3. S. Lat. 30.

GORGONIA, in *Natural Hiſtory*, a genus of zoophytes, which formerly were called *ceratophytons*, and are known in Engliſh by the names of *ſea-fans*, *ſea-feathers*, and *ſea-whips*. Linnæus and Dr Pallas conſider them as of a mixed nature in their growth, between animals and vegetables; but Mr Ellis ſhows them to be true animals of the polype kind, growing up in a branched form reſembling a ſhrub, and in no part vegetable. They differ from the freſh water polype in many of their qualities, and particularly in producing from their own ſubſtance a hard and ſolid ſupport, ſerving many of the purpoſes of the bone in other animals. This is formed by a concreting juice thrown out from a peculiar ſet of longitudinal parallel tubes, running along the internal ſurface of the fleſhy part: in the coats of theſe tubes are a number of ſmall orifices, through which the oſſeous liquor exudes, and concreting, forms the layers of that hard part of the annular circles, which ſome, judging from the conſiſtence rather than the texture, have erroneouſly denominated *wood*. The ſurface of the gorgonia is compoſed of a kind of ſcales, ſo well adapted to each other as to ſerve for defence from external injuries: and the fleſh, or, as ſome have called it, the *bark* or *cortex*, conſiſts of proper muſcles and tendons for extending the openings of their cells; for ſending forth from thence their polype ſuckers in ſearch of food; and for drawing them in ſuddenly, and contracting the ſphincter muſcles of theſe ſtarry cells, in order to ſecure theſe tender parts from danger; and alſo of proper ſecretory ducts, to furniſh and depoſit the oſſeous matter that forms the ſtem and branches as well as the baſe of the bone. Mr Ellis affirms, that there are ovaries in theſe animals, and thinks it very probable that many of them are viviparous. See CORALLINES.

GORGONS, in *Antiquity* and *Mythology*. Authors are not agreed in the account they give of the Gorgons. The poets repreſent them as three ſiſters, whoſe names were *Stheno*, *Euryale*, and *Meduſa*; the latter of whom was mortal, and, having been deflowered by Neptune, was killed by Perſeus; the two former were ſubject neither to age nor death. They are deſcribed with wings on their ſhoulders, with ſerpents round their heads, their hands were of braſs, and their teeth of a prodigious ſize, ſo that they were objects of terror to mankind. After the death of Meduſa, her ſiſters, according to Virgil, were appointed to keep the gate of the palace of Pluto.

Multaque præterea variarum monſtra ferarum—
GORGONES, *Harpyiæque*——

Diodorus Siculus will have the Gorgons and Amazons to have been two warlike nations of women, who inhabited that part of Libya which lay on the lake Tritonidis. The extermination of theſe female nations was not effected till Hercules undertook and performed it.

Pauſanias ſays, the Gorgons were the daughters of Phorbus; after whoſe death Meduſa, his daughter, reigned over the people dwelling near the lake Tritonidis. The queen was paſſionately fond of hunting and war, ſo that ſhe laid the neighbouring countries quite waſte. At laſt, Perſeus having made war on them, and killed the queen herſelf, when he came to take a view of the field of battle, he found the queen's corpſe ſo extremely beautiful, that he ordered her head to be cut off, which he carried with him to ſhow his countrymen the Greeks, who could not behold it without being ſtruck with aſtoniſhment.

Others repreſent them as a kind of monſtrous women, covered with hair, who lived in woods and foreſts. Others, again, make them animals, reſembling wild ſheep, whoſe eyes had a poiſonous and fatal influence.

GORITIA, or GORITZ, a ſtrong town of Germany, in the circle of Auſtria, and duchy of Carniola, with a caſtle; ſeated on the river Lizonzo, 20 miles north eaſt of Aquileia, and 70 north-eaſt of Venice. E. Long. 13. 43. N. Lat. 46. 12.

GORLÆUS, ABRAHAM, an eminent antiquary, was born at Antwerp, and gained a reputation by collecting medals and other antiques. He was chiefly fond of the rings and ſeals of the ancients, of which he publiſhed a prodigious number in 1601, under this title, *Dactyliotheca; ſive Annulorum Sigillarium, quorum apud priſcos tam Græcos quam Romanos uſus ex ferro, ære, argento, et auro, Promptuarium*. This was the firſt part of the work: the ſecond was entitled, *Variarum Gemmarum, quibus antiquitas in ſignando uti ſolita ſculpturæ*. This work has undergone ſeveral editions, the beſt of which is that of Leyden, 1695: for it not only contains a vaſt number of cuts, but alſo a ſhort explication of them by Gronovius. In 1608, he publiſhed a collection of medals: which, however, if we may believe the *Scaligerana*, it is not ſafe always to truſt. Gorlæus pitched upon Delft for the place of his reſidence, and died there in 1609. His collections of antiques were ſold by his heirs to the prince of Wales.

GORLITZ, a town of Germany, in Upper Luſatia, ſubject

subject to the elector of Saxony. It is a handsome strong place, and seated on the river Neisse, in E. Long. 15. 15. N. Lat. 51. 10.

GORTERIA, a genus of plants belonging to the syngenesia class, and in the natural method ranking under the 49th order, *Compositæ*. See BOTANY *Index*.

GOSHAWK. See FALCO, ORNITHOLOGY *Index*.

GOSHEN, in *Ancient Geography*, a canton of Egypt, which Joseph procured for his father and his brethren when they came to dwell in Egypt. It was the most fruitful part of the country: and its name seems to be derived from the Hebrew, *Geshem*, which signifies "rain;" because this province lying very near the Mediterranean, was exposed to rains, which were very rare in other cantons, and more especially in Upper Egypt. Calmet does not question but that Goshen, which Joshua (x. 41. xi. 16. xv. 51.) makes part of the tribe of Judah, is the same as the land of Goshen, which was given to Jacob and his sons by Pharaoh king of Egypt; (Gen. xlvi. 28). It is certain that this country lay between Palestine and the city of Tanais, and that the allotment of the Hebrews reached southward as far as the Nile, (Josh. xiii. 3.).

GOSLAR, a large and ancient town of Lower Saxony, and in the territory of Brunswick: it is a free imperial city, and it was here that gunpowder was first invented, by a monk as is generally supposed. It is a large place, but the buildings are in the ancient taste. In 1728, 280 houses, and St Stephen's fine church, were reduced to ashes. It is seated on a mountain, near the river Gose, and near it are rich mines of iron. The inhabitants are famous for brewing excellent beer. E. Long. 3. 37. N. Lat. 51. 55.

GOSPEL, the history of the life, actions, death, resurrection, ascension, and doctrine of Jesus Christ.—The word is Saxon, and of the same import with the Latin term *evangelium*, which signifies "glad tidings," or "good news."

This history is contained in the writings of St Matthew, St Mark, St Luke, and St John; who from thence are called *evangelists*. The Christian church never acknowledged any more than these four gospels as canonical; notwithstanding which, several apocryphal gospels are handed down to us, and others are entirely lost.

GOSPORT, a town of Hampshire, 79 miles from London, in the parish of Alverstock. It has a ferry over the mouth of the harbour to Portsmouth, and is a large town and of great trade, especially in time of war. Travellers choose to lodge here, where every thing is cheaper and more commodious for them than at Portsmouth. The mouth of the harbour, which is not so broad here as the Thames at Westminister, is secured on this side by four forts, and a platform of above 20 cannon level with the water. Here is a noble hospital built for the cure of the sick and wounded sailors in the service of the navy; besides a free school.

GOSSAMER is the name of a fine filmy substance, like cobwebs, which is seen to float in the air, in clear days in autumn, and is more observable in stubble-fields, and upon furze and other low bushes. This is probably formed by the flying spider, which, in traversing the air for food, shoots out these threads from its anus, which are borne down by the dew, &c.

GOSSYPIUM, or COTTON, a genus of plants belonging to the monadelphia class, and in the natural method ranking under the 37th order, *Columniferæ*. See BOTANY *Index*.

The American islands produce cotton shrubs of various sizes, which rise and grow up without any culture; especially in low and marshy grounds. Their produce is of a pale red; some paler than others; but so short that it cannot be spun. None of this is brought to Europe, though it might be usefully employed in making of hats. The little that is picked up, serves to make matrasses and pillows.

The cotton-shrub that supplies our manufactures, requires a dry and stony soil, and thrives best in grounds that have already been tilled. Not but that the plant appears more flourishing in fresh lands than in those which are exhausted; but while it produces more wood, it bears less fruit.

A western exposure is fittest for it. The culture of it begins in March and April, and continues during the first spring-rains. Holes are made at seven or eight feet distance from each other, and a few seeds thrown in. When they are grown to the height of five or six inches, all the stems are pulled up, except two or three of the strongest. These are cropped twice before the end of August. This precaution is the more necessary, as the wood bears no fruit till after the second pruning; and, if the shrub was suffered to grow more than four feet high, the crop would not be the greater, nor the fruit so easily gathered. The same method is pursued for three years; for so long the shrub may continue, if it cannot conveniently be renewed oftener with the prospect of an advantage that will compensate the trouble.

This useful plant will not thrive if great attention is not paid to pluck up the weeds that grow about it. Frequent rains will promote its growth; but they must not be incessant. Dry weather is particularly necessary in the months of March and April, which is the time of gathering the cotton, to prevent it from being discoloured and spotted.

When it is all gathered in, the seeds must be picked out from the wool with which they are naturally mixed. This is done by means of a cotton-mill; which is an engine composed of two rods of hard wood, about 18 feet long, 18 lines in circumference, and fluted two lines deep. They are confined at both ends, so as to leave no more distance between them than is necessary for the seed to slip through. At one end is a kind of little millstone, which, being put in motion with the foot, turns the rods in contrary directions. They separate the cotton, and throw out the seed contained in it.

GOTHA, a town of Germany, in the circle of Upper Saxony, and capital of the duchy of Saxe-Gotha, in E. Long. 10. 36. N. Lat. 51. Some fancy this town had its name from the Goths, and that they fortified it in their march to Italy; but it was only a village till surrounded with walls by the bishop of Mentz in 964. It is situated in a fine plain on the river Leina, well built and strongly fortified. Here are two handsome churches and a very good hospital. Its chief trade is in dyers wood, of which they have three crops, but the third grows wild. The neighbouring country produces a vast deal of corn. The castle or ducal palace of Gotha was rebuilt in the 16th century by duke Ernest, surnamed *the Pious*, who caused both that and the town to be encompassed with ditches and ramparts; and gave it the name of *Friedenstein*, or the *Castle of Peace*, in opposition to its ancient name of *Grimmerstein*, or the *Castle of the Furies*. It is situated on a neighbouring eminence, from whence there is a vast prospect of a fruitful plain. In one of the apartments there is a collection of valuable rarities, and a noble library.

The dukedom of Saxe Gotha is about 30 miles long, and 12 broad. The reigning duke is Lewis Ernest, born in 1745, and married to the princess Maria Charlotte of Saxe Meningen, by whom he has issue. He is the head of the Ernestine line of Saxony, descended from the elector John Frederick the Magnanimous, who was deprived of the electorate by the emperor Charles V. in 1574; since which the youngest branch called the *Albertine* has enjoyed it. He has several other principalities besides that of Saxe Gotha; and his revenues are computed at 200,000l. a-year, with which he maintains about 3000 regular troops. As he is the most powerful of all the Saxon princes of the Ernestine branch; so of all the courts of Saxony, next to that of Dresden, he has the most numerous and the most magnificent. His guards are well clothed, his liveries rich, and his tables served with more elegance than profusion. And yet by the prudent management of his public finances, his subjects are the least burdened with taxes of any state in Germany. The religion is Lutheran.

GOTHARD, one of the highest mountains of Switzerland; and from the top, where there is an hospital for monks, is one of the finest prospects in the world. It is eight miles from Aldorf.

GOTHEBORG, GOTHENBURG, or *Gottenburg*. See GOTTENBURG.

GOTHIC, in general, whatever has any relation to the Goths: thus we say, Gothic customs, Gothic architecture, &c. See ARCHITECTURE.

GOTHLAND, the most southern province of Sweden, being a peninsula, encompassed on three sides by the Baltic Sea, or the channel at the entrance of it. It is divided into several parts, which are, East Gothland, West Gothland, Smaland, Halland, Bleaking, and Schonen. It was a long time in the possession of the kings of Denmark, but was ceded to Sweden in 1654. The principal towns of Gothland are Calmar, Landscroon, Christianople, Daleburg, Gothenburgh, Helmstat, Lunden, Malmone, and Vexio.

GOTHS, a warlike nation, and above all others famous in the Roman history, came originally out of Scandinavia (the name by which the ancients distinguished the present countries of Sweden, Norway, Lapland, and Finmark). According to the most probable accounts they were the first inhabitants of those countries; and from thence sent colonies into the islands of the Baltic, the Cimbrian Chersonesus, and the adjacent places yet destitute of inhabitants. The time of their first settling in Scandinavia, and the time when they first peopled with their colonies the above-mentioned islands and Chersonesus, are equally uncertain; though the Gothic annals suppose the latter to have happened in the time of Serug the great grandfather of Abraham. This first migration of the Goths is said to have been conducted by their king Eric; in which all the ancient Gothic chronicles, as well as the Danish and Swedish ones, agree. Their second migration is supposed to have happened many ages after; when, the above-mentioned countries being overstocked with people, Berig, at that time king of the Goths, went out with a fleet in quest of new settlements. He landed in the country of the Ulmerugians, now Pomerania, drove out the ancient inhabitants, and divided their lands among his followers. He fell next upon the Vandals, whose country bordered on that of the Ulmerugians, and overcame them; but instead of forcing them to abandon their country, he only made them share their possessions with the Goths.

The Goths who had settled in Pomerania and the adjacent parts of Germany being greatly increased, insomuch that the country could no longer contain them, they undertook a third migration in great numbers, under Filimer surnamed the *Great*, their fifth prince after leaving Scandinavia; and taking their route eastward, entered Scythia, advanced to the Cimmerian Bosphorus, and driving out the Cimmerians, settled in the neighbourhood of the Palus Mæotis. Thence in process of time, being greatly increased in Scythia, they resolved to seek new settlements; and, accordingly taking their route eastward, they traversed several countries, and at length returned into Germany.

Their leader in this expedition was the celebrated Woden, called also *Voden*, *Othen*, *Oden*, *Godan*, and *Guadan*. Of this Woden many wonderful things are related in the Sueo-gothic chronicles. He was king of the Asgardians, whom the northern writers will have to be the same with a people called *Aspurgians* mentioned by Strabo and Ptolemy. By Strabo they are placed near the Cimmerian Bosphorus. Aspurgia was the metropolis of a province which Strabo calls *Asia*; and Woden and his followers are styled by the ancient Gothic writers *Asæ*, *Asianæ*, and *Asiotæ*. The kings of Aspurgia were masters of all that part of Scythia which lay to the westward of Imaus, and was by the Latins called *Scythia intra Imaum*, or "Scythia within Imaus."

At what time Woden reigned in this country, is quite uncertain; but all historians agree, that he went out in quest of new settlements with incredible numbers of people following him. He first entered Roxolania, comprehending the countries of Prussia, Livonia, and great part of Muscovy. From thence he went by sea into the north parts of Germany; and having reduced Saxony and Jutland, he at last settled in Sweden, where he reigned till his death, and became so famous that his name reached all countries, and he was by the northern nations worshipped as a god. He is supposed to have brought with him the Runic characters out of Asia, and to have taught the northern nations the art of poetry; whence he is styled the father of the Scaldi or Scaldri, their poets, who described in verse the exploits of the great men of their nation, as the bards did among the Gauls and Britons.

The Romans distinguished the Goths into two classes; the Ostrogoths and Visigoths. These names they received before they left Scandinavia, the *Visigoths* being

Goths.

ing softened by the Latins from *Westerogoths*, or those who inhabited the western part of Scandinavia, as the Ostrogoths were those who inhabited the eastern part of that country. Their history affords nothing of moment till the time of their quarrelling with the Romans; which happened under the reign of the emperor Caracalla, son to Severus. After that time their history becomes so closely interwoven with that of the Romans, that for the most remarkable particulars of it we must refer to the article ROME. After the destruction of the Roman empire by the Heruli, the Ostrogoths, under their king Theodoric, became masters of the greatest part of Italy, having overcome and put to death Odoacer king of the Heruli in 494. They retained their dominion in this country till the year 553; when they were finally conquered by Narses, the emperor Justinian's general. See (History of) ITALY. The Visigoths settled in Spain in the time of the emperor Honorius, where they founded a kingdom which continued till the country was subdued by the Saracens. See SPAIN.

The Goths were famous for their hospitality and kindness to strangers, even before they embraced the Christian religion. Nay, it is said, that from their being eminently good, they were called *Goths* by the neighbouring nations; that name, according to Grotius and most other writers, being derived from the German word *goten*, which signifies "good." They encouraged, says Dio, the study of philosophy above all other barbarous or foreign nations, and often chose kings from among their philosophers. Polygamy was not only allowed but countenanced among them; every one being valued or respected according to the number of his wives. By so many wives they had an incredible number of children, of whom they kept but one at home, sending out the rest in quest of new settlements; and hence those swarms of people which overran so many countries. With them adultery was a capital crime, and irremissibly punished with death. This severity, and likewise polygamy, prevailed among them when they were known to the Romans only by the name of *Getæ* (their most ancient name); as appears from the poet Menander, who was himself one of that nation; and from Horace, who greatly commends the chastity of their women. Their laws fell little short of those of the ancient Romans. Their government was monarchical; their religion was much the same with that of the ancient Germans or Celtes; and their dress is described by Apollinaris Sidonius in the following words: "They are shod (says he) with high shoes made of hair, and reaching up to their ankles; their knees, thighs, and legs, are without any covering; their garments of various colours scarce reaching to the knee; their sleeves only cover the top of their arms; they wear green cassocks with a red border; their belts hang on their shoulder; their ears are covered with twisted locks; they use hooked lances and missile weapons."

END OF THE NINTH VOLUME.

ERRATA.—Page 332 col. 1. lines 19 and 31, *for* iron wire, *read* zinc wire.
339 col. 1. lines 27 and 30, *for* iron wire, *read* zinc wire.

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